Beaver-Camas Subbasin
Total Maximum Daily Loads

2022 Temperature, Sediment, and Bacteria TMDLs and Five-Year Review

Hydrologic Unit Code 17040214



State of Idaho
Department of Environmental Quality
July 2022

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Abbreviations, Acronyms, and Symbols

§	section (usually a section of federal or state rules or statutes)
§303(d)	refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section
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 Regulation
cfu	colony forming unit
cfs	cubic feet per second
CGP	Construction General Permit
CWA	Clean Water Act
COLD	cold water aquatic life
DEQ	Idaho Department of Environmental Quality
DWS	domestic water supply
E. coli	*Escherichia coli*
EPA	United States Environmental Protection Agency
GIS	geographic information system
IDAPA	refers to citations of Idaho administrative rules
IDFG	Idaho Department of Fish and Game
IDWR	Idaho Department of Water Resources
IPDES	Idaho Pollutant Discharge Elimination System
kWh	kilowatt-hour
L	liter
LA	load allocation
LC	load capacity
m	meter
mg	milligrams
mL	milliliter
MOS	margin of safety
N/A	not applicable
NA	not assessed
NB	natural background
NREL	National Renewable Energy Laboratory
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service

PCR	primary contact recreation
PNV	potential natural vegetation
SCR	secondary contact recreation
SFI	DEQ's Stream Fish Index
SHI	DEQ's Stream Habitat Index
SMI	DEQ's Stream Macroinvertebrate Index
SNOTEL	snow telemetry
SS	salmonid spawning
SWPPP	Stormwater Pollution Prevention Plan
TMDL	total maximum daily load
USC	United States Code
USDA	United States Department of Agriculture
USFS	United States Forest Service
USGS	United States Geological Survey
WAG	watershed advisory group
WLA	wasteload allocation

Executive Summary

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. 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. CWA §303(d) 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 is published every 2 years as the list of Category 5 water bodies in Idaho's Integrated Report. 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.

Idaho's 2018/2020 Integrated Report (DEQ 2020) lists nine water bodies [16 assessment units (AUs)] within Category 5 as potentially impaired waters requiring TMDLs. TMDLs for one or more pollutants in 13 of the 16 AUs in Category 5 were developed with this document based on 2018 fieldwork results and/or previously collected Beneficial Use Reconnaissance Program (BURP) and *Escherichia coli* (*E. coli*) data. The TMDL analysis establishes water quality targets and load capacities, estimates existing pollutant loads, and allocates responsibility for load reductions needed to return listed waters to a condition meeting water quality standards. It also identifies implementation strategies—including reasonable time frames, approach, responsible parties, and monitoring strategies—necessary to achieve load reductions and meet water quality standards.

This document also includes a 5-year review based on monitoring and the implementation of water quality improvement projects within the subbasin. Six water bodies (16 AUs) with previously developed TMDLs (*Beaver-Camas Subbasin Assessment and Total Maximum Daily Loads* DEQ 2005a) were revised to reflect updates to the PNV methodology.

Subbasin at a Glance

The Beaver-Camas subbasin is located in southeastern Idaho, contiguous to the Montana border (Figure A). The majority of the subbasin is located in Clark County with portions in Jefferson and Fremont Counties. Elevations range from approximately 4,800 feet in the lower southern portion to over 9,000 feet in the northern mountainous portion (NRCS 2007). The Beaver-Camas subbasin is considered a closed drainage and has no connection to the Snake River Plain or Snake River. Instead, surface water infiltrates into the Snake River Plain aquifer, or it is diverted for agricultural use. Two main drainages form the Beaver-Camas subbasin; Beaver Creek and Camas Creek. Both drainages receive flow from the northern mountainous regions in the upper watershed and are primarily spring flow and precipitation driven.

Approximately 39% of land in the subbasin is privately owned and 61% is publicly owned. The Caribou-Targhee National Forest owns and manages the highest percentage of public land at approximately 28%. Most of this land is located in the mountainous region of the subbasin. The United States Department of Agriculture Sheep Experiment Station owns and manages a portion of this land within the lower region of the subbasin. The remainder of public ownership percentages include Bureau of Land Management (BLM)—20%, State of Idaho—12%, and United States Fish and Wildlife Service, which owns and manages the Camas National Wildlife Refuge—2%. The refuge is located at the southern portion of the subbasin (DEQ 2005a).

Figure A depicts the land ownership within the subbasin, as well as the 2018/2020 Integrated Report (DEQ 2020) Category 4a and Category 5 AUs. If an AU is in both Category 4a and 5, as indicated in blue on the map, a TMDL has been approved for an impairment and the AU is listed in Category 5 for a different impairment.

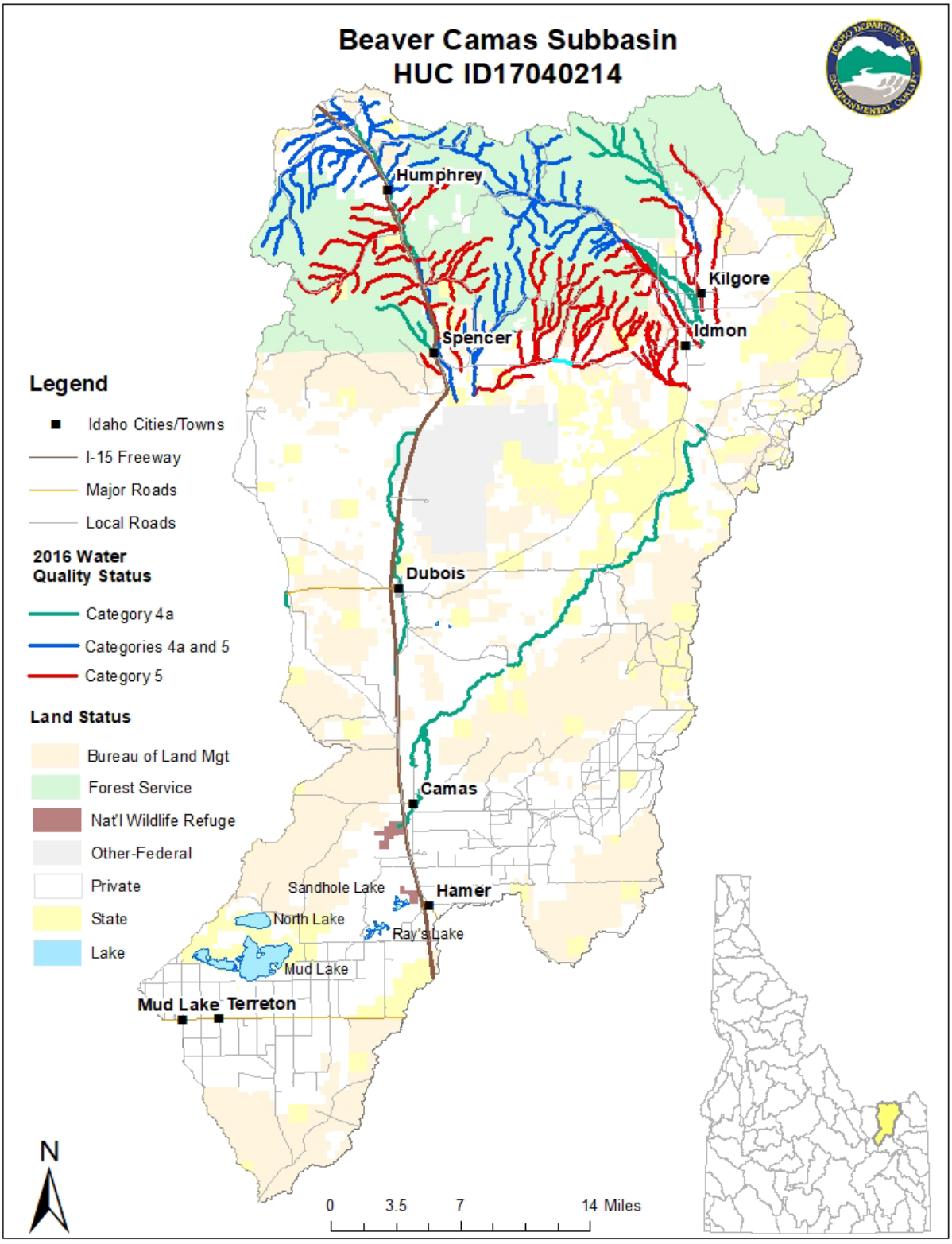


Figure A. Beaver-Camas subbasin 2018/2020 Integrated Report water quality status (DEQ 2020).

Key Findings

AUs associated with the following streams were placed on the 2016 §303(d) list of impaired waters, or subsequent lists, for temperature, *E. coli*, combined biota/habitat bioassessments, and/or sedimentation/siltation criteria violations: Ching, Crooked, Crab, Warm, East Camas, West Camas, Rattlesnake, Threemile, Beaver, and Pleasant Valley Creeks. The Idaho Department of Environmental Quality developed TMDLs for the AUs listed in Table A, where impairments were identified by previously collected BURP surveys, previous bacteria sampling, and results from fieldwork completed in 2018.

According to the Beaver-Camas subbasin TMDLs (DEQ 2005a), the primary source of nonpoint pollution to the streams is from solar radiation (temperature) due to the loss of riparian habitat resulting from agricultural practices. In addition to temperature, the Camas Creek AU was found to be impaired with sedimentation due to streambank erosion. Assessments performed on Beaver-Camas subbasin streams since approval of the original Beaver-Camas subbasin TMDLs (DEQ 2005a) indicate that they also experience elevated levels of bacteria.

Sampling was conducted to determine if AUs were meeting bacteria water quality standards. Results from the geometric mean of five samples collected over a 30-day period on 7 of 10 streams indicated bacteria concentrations exceeded the water quality criterion of 126 colony forming units per 100 milliliters (cfu/100 mL). Bacteria TMDLs were developed for the seven AUs with bacteria exceedances. TMDLs were not required for Crooked/Crab, Warm, or Sheep Creeks because the geometric mean values were below the criterion threshold and not considered impaired by bacteria. Therefore, it is proposed that these AUs be delisted from Category 5 of the Integrated Report (DEQ 2016).

Following review of previously collected Beneficial Use Reconnaissance Program (BURP) data, SEI surveys were performed on six AUs listed in the 2018/2020 Integrated Report (DEQ 2020) as impaired for sediment or combined biota/habitat bioassessments in representative stream reaches. SEIs are used to measure streambank stability by estimating erosion rates and sediment load in streams. Erosion rates are calculated by measuring height and length of areas of streambank erosion along AUs and ranking six streambank characteristics based on field observations. SEIs performed on five of the streams did not result in excess streambank erosion. The SEI performed on Beaver Creek (17040214SK018_02) measured 24% eroded banks, compared to a target value of 20%. Appendix C presents the sediment load analyses completed for the Beaver-Camas subbasin.

Temperature data loggers were deployed within 15 AUs, in both Category 4a and Category 5, to evaluate if the AUs met temperature criteria for their beneficial uses [cold water aquatic life (COLD) and salmonid spawning (SS)]. Pursuant to Idaho's "Water Quality Standards" (IDAPA 58.01.02), numeric temperature criteria supportive of COLD are 22 °C or less for the daily maximum or 19 °C or less for a daily average. For SS, the numeric criteria are 13 °C or less for a daily maximum or 9 °C or less for a daily average. When compared to the water quality standards, SS temperature exceedances were recorded for all 15 AUs. Temperatures for COLD were exceeded in five AUs.

In addition to temperature data loggers, shade deficiencies can be verified through the PNV method. For PNV temperature TMDLs, it is assumed that natural temperatures may exceed these criteria during certain time periods. If PNV targets are achieved yet stream temperatures are warmer than these criteria, it is assumed that the stream's temperature is natural (provided there are no point sources or human-induced ground water sources of heat) and natural background provisions of Idaho's water quality standards apply (IDAPA 58.01.02.200.09). The PNV method was applied to 20 AUs and established effective target shade levels based on the concept of maximum shading under PNV, resulting in natural background temperature levels. Shade targets were derived from effective shade curves developed for similar vegetation types in Idaho. Existing shade was determined from aerial photo interpretation that was partially field verified with Solar Pathfinder data. Target and existing shade levels were compared to determine if an AU demonstrates excess solar loads. Seventeen of the AUs were identified with excess solar loads, but TMDLs were developed for all 20 AUs. Further investigations are needed to determine whether temperature is fully supporting for the three AUs that did not exhibit excess solar loads.

Best management practices (BMP) implementation is recommended to reduce sediment, temperature, and bacteria impairments where livestock grazing or field cultivation occurs. Depending on the BMP, water quality recovery times can vary greatly. For example, reductions in temperature and sediment loads can be realized by planting riparian vegetation along streambanks. The vegetation, when established, acts as an anchor for the sediment reducing erosion and providing shade to the stream. This process may take a decade to achieve; whereas, limiting livestock access to a stream while grazing can significantly decrease bacteria load to the water body and water quality improvements can be achieved almost immediately.

Table A lists the TMDLs developed in this document. Table B and Table C summarize Category 5 and Category 4a assessment outcomes and recommends changes to the listing status in the next Integrated Report.

Table A. Temperature, sediment, and bacteria TMDLs developed in the Beaver-Camas subbasin.

Water Body	AU Number	Confirmed Impairments
Camas Creek—Spring Creek to Beaver Creek	ID17040214SK002_05	Temperature—Updated
Ching Creek—source to mouth	ID17040214SK006_03	*E. coli*
Crooked/Crab Creek—source to mouth	ID17040214SK008_03	Temperature
Warm Creek—Cottonwood Creek to mouth and East Camas Creek	ID17040214SK009_02	Temperature
East Camas Creek	ID17040214SK010_02	Temperature—Updated
East Camas Creek	ID17040214SK010_03	Temperature—Updated *E. coli*
East Camas Creek—source to Larkspur Creek	ID17040214SK011_02	Temperature—Updated
East Camas Creek—source to Larkspur Creek	ID17040214SK011_03	Temperature—Updated
West Camas Creek	ID17040214SK012_03	Temperature—Updated
West Camas Creek—source to Targhee National Forest Boundary	ID17040214SK013_02	Temperature—Updated
West Camas Creek—source to Targhee National Forest Boundary	ID17040214SK013_03	Temperature—Updated *E. coli*
Rattlesnake Creek—source to mouth	ID17040214SK016_02	Temperature
Threemile Creek—source to mouth	ID17040214SK017_02	Temperature—Updated
Threemile Creek—source to mouth	ID17040214SK017_03	Temperature—Updated *E. coli*
Beaver Creek)—Miner's Creek to Rattlesnake Creek	ID17040214SK018_02	Sedimentation/siltation Temperature—Updated
Beaver Creek—Miner's Creek to Rattlesnake Creek	ID17040214SK018_04	Temperature—Updated *E. coli*
Beaver Creek —Idaho Creek to Miner's Creek	ID17040214SK020_03	Temperature—Updated
Beaver Creek—source to Idaho Creek	ID17040214SK021_02	Temperature—Updated *E. coli*
Beaver Creek—source to Idaho Creek	ID17040214SK021_03	Temperature—Updated
Pleasant Valley Creek—source to mouth	ID17040214SK023_02	*E. coli* Temperature
Huntley Canyon Creek—source to mouth	ID17040214SK024_02	Temperature—Updated

Table B. Summary of assessment outcomes for Category 5 assessment units evaluated.

AU NAME	AU ID	CAUSE	TMDL	Recommended Changes to Next IR	Justification
Ching Creek - source to mouth	ID17040214SK006_03	ESCHERICHIA COLI (*E. COLI*)	Yes	Delist from Category 5 for E. coli; include in Category 4a for E. coli.	Bacteria TMDL completed based on 30-day geometric mean concentrations.
Crooked/Crab Creek - source to mouth	ID17040214SK008_03	COMBINED BIOTA/HABITAT BIOASSESSMENTS	Yes	Include in Category 4a for temperature	Temperature critiera exceeded. TMDL developed based on PNV methodology.
Warm Creek - Cottonwood Cr. to mouth and East Camas Creek	ID17040214SK009_02	COMBINED BIOTA/HABITAT BIOASSESSMENTS	Yes	Include in Category 4a for temperature	Temperature criteria exceeded. TMDL developed based on PNV methodology.
East Camas Creek	ID17040214SK010_03	ESCHERICHIA COLI (*E. COLI*)	Yes	Include in Category 4a for E. Coli	Bacteria TMDL completed based on 30-day geometric mean concentrations.
West Camas Creek -source to Targhee National Forest Boundary	ID17040214SK013_03	ESCHERICHIA COLI (*E. COLI*)	Yes	Delist from Category 5 for E. coli; include in Category 4a for *E. coli.*	Bacteria TMDL completed based on 30-day geometric mean concentrations.
Rattlesnake Creek - source to mouth	ID17040214SK016_02	COMBINED BIOTA/HABITAT BIOASSESSMENTS	Yes	Delist from Category 5 for combined biota/habitat bioassessments. Include in Category 4a for temperature.	Temperature critiera exceeded. TMDL developed based on PNV methodology. BURP data and SEI survey indicate sediment is not an impairment cause.
Threemile Creek - source to mouth	ID17040214SK017_03	FECAL COLIFORM	Yes	Delist from Category 5 for fecal coliform, included in Category 4a for E. coli	Bacteria TMDL completed based on 30-day geometric mean concentrations.
Beaver Creek - Miners Creek to Rattlesnake Creek	ID17040214SK018_02	COMBINED BIOTA/HABITAT BIOASSESSMENTS	Yes	Delist from Category 5 for combined biota/habitat bioassessments, move to category 4a for sedimentation/siltation	BURP metrics showed low FSBI score, high % fines, and low substrate size diversity indicating sediment is likely causing impairment. SEI survey showed bank stability below natural conditions. Sediment TMDL completed based on SEI survey.
Beaver Creek - Miners Creek to Rattlesnake Creek	ID17040214SK018_04	ESCHERICHIA COLI (*E. COLI*)	Yes	Delist from Category 5 for E. coli; include in Category 4a for E. coli.	Bacteria TMDL completed based on 30-day geometric mean concentrations.
Miner's Creek - source to mouth	ID17040214SK019_03	COMBINED BIOTA/HABITAT BIOASSESSMENTS	No	No	Not included in this project.
Beaver Creek - source to Idaho Creek	ID17040214SK021_02	ESCHERICHIA COLI (*E. COLI*)	Yes	Delist from Category 5 for *E. coli*; include in Category 4a *for E.* coli.	Bacteria TMDL completed based on 30-day geometric mean concentrations.

Pleasant Valley Creek - source to mouth	ID17040214SK023_02	COMBINED BIOTA/HABITAT BIOASSESSMENTS	Yes	Delist from Category 5 for combined biota/habitat bioassessments, move to Category 4a for temperature.	Temperature criteria exceeded. TMDL developed based on PNV methodology.
		ESCHERICHIA COLI (*E. COLI*)	Yes	Delist from Category 5 for E. coli; include in Category 4a for E. coli	Bacteria TMDL completed based on 30-day geometric mean concentrations.

Table C. Summary of assessment outcomes for Category 4a assessment units evaluated.

AU NAME	AU ID	Impairment	Five Year Review	New TMDL	Recommended Changes to Next IR	Justification
Camas Creek - Spring Creek to Beaver Creek	ID17040214SK002_05	SEDIMENTATION/ SILTATION	Yes	No	Keep in Category 4a for sedimentation/ siltation.	Access to AU was not available. No data is available to recommend delisting.
Camas Creek - Spring Creek to Beaver Creek	ID17040214SK002_05	TEMPERATURE	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
East Camas Creek	ID17040214SK010_02	TEMPERATURE	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
East Camas Creek	ID17040214SK010_03	TEMPERATURE	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
East Camas Creek - source to Larkspur Creek	ID17040214SK011_02	TEMPERATURE	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
East Camas Creek - source to Larkspur Creek	ID17040214SK011_03	TEMPERATURE	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
West Camas Creek	ID17040214SK012_03	TEMPERATURE	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
West Camas Creek -source to Targhee National Forest Boundary	ID17040214SK013_02	TEMPERATURE	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
West Camas Creek -source to Targhee National	ID17040214SK013_03	TEMPERATURE	Yes	Yes	Keep in Category 4a	Temperature TMDL completed based on updated PNV method.

Forest Boundary					for temperature.	Excess solar load from lack of existing shade
Beaver Creek - Dry Creek to canal (T09N, R36E)	ID17040214SK014_05	TEMPERATURE	No	No	Keep in Category 4a for temperature.	Not inlcuded in this project.
Threemile Creek - source to mouth	ID17040214SK017_02	TEMPERATURE	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
Threemile Creek - source to mouth	ID17040214SK017_03	TEMPERATURE	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
Beaver Creek - Miners Creek to Rattlesnake Creek	ID17040214SK018_02	TEMPERATURE	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
Beaver Creek - Miners Creek to Rattlesnake Creek	ID17040214SK018_04	TEMPERATURE	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
Beaver Creek - Idaho Creek to Miners Creek	ID17040214SK020_03	TEMPERATURE	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
Beaver Creek - source to Idaho Creek	ID17040214SK021_02	TEMPERATURE	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
Beaver Creek - source to Idaho Creek	ID17040214SK021_03	TEMPERATURE	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
Huntley Canyon Creek - source to mouth	ID17040214SK024_02	TEMPERATURE	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade

Public Participation

The Clark Soil Conservation District acts as the watershed advisory group (WAG) for the Medicine Lodge, Beaver-Camas, and Birch Creek watersheds. The WAG was presented with the pre-public comment draft on March 5, 2020 and on October 7, 2021. Additionally, the Upper Snake Basin Advisory Group supported the start of public comment April 5, 2021. The public comment period was conducted August 24, 2021-September 23 2021. There were no public comments submitted during the comment period.

Introduction

This document includes TMDLs and a five-year review of the Beaver-Camas Subbasin. Twelve TMDLs were developed for ten AUs in the Beaver-Camas subbasin (hydrologic unit code 17040214) that have been placed in Category 5 of Idaho's most recent federally approved Integrated Report (DEQ 2020). Additionally, a TMDL Five-year review was completed on 17 AUs in Category 4a. Of those 17 AUs in Category 4a, 16 AUs had new TMDLs developed as part of this TMDL. The purpose of this total maximum daily load (TMDL) is to characterize and document pollutant loads within the Beaver-Camas subbasin. The first portion of this document presents key characteristics or updated information for the subbasin assessment, which is divided into four major sections: subbasin characterization (section 1), water quality concerns and status (section 2), pollutant source inventory (section 3), and a summary of past and present pollution control efforts (section 4).

The subbasin assessment is used to develop a TMDL for each pollutant of concern for the Beaver-Camas subbasin. The TMDL (section 5) is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (40 CFR 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. TMDLs were developed for temperature, sediment, and bacteria impaired waters.

In addition, the results of ongoing monitoring and watershed improvement projects are reported in this document for six water bodies (16 AUs) and serve as a five-year review of the original TMDLs (DEQ 2005a) in accordance with Idaho Code 39-3611(7).

Regulatory Requirements

This document was prepared in compliance with both federal and state regulatory requirements. The federal government, through the United States Environmental Protection Agency (EPA), assumed the dominant role in defining and directing water pollution control programs across the country. DEQ implements the Clean Water Act (CWA) in Idaho, while EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

Congress passed the Federal Water Pollution Control Act, or CWA, in 1972. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (33 USC §1251). 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 ensure "swimmable and fishable" conditions. These goals relate water quality to more than just chemistry.

The 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 CWA §303, 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. DEQ must review those standards every 3 years, and EPA must approve Idaho's water quality standards. Idaho adopts water quality standards to protect public health and welfare, enhance water quality, 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 CWA §303(d) 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 is published every 2 years as the list of Category 5 waters in Idaho's Integrated Report. For waters identified on this list, states and tribes must develop a TMDL for the pollutants, set at a level to achieve water quality standards.

DEQ monitors waters, and for those not meeting water quality standards, DEQ must establish a TMDL for each pollutant impairing the waters. However, some conditions that impair water quality do not require TMDLs. EPA considers certain unnatural conditions—such as flow alteration, human-caused lack of flow, or habitat alteration—that are not the result of discharging a specific pollutant as "pollution." TMDLs are not required for water bodies impaired by pollution, rather than a specific pollutant.

1 Subbasin Characterization

Located in southeastern Idaho, the Beaver-Camas subbasin drains an area of approximately 643,083 acres and is bounded by the western edge of the Centennial Mountains and the eastern edge of the Beaverhead Mountains in the northern region. It is one of five watersheds that comprise the sink drainages; the others are Medicine Lodge Creek, Birch Creek, Little Lost River, and Big Lost River. These drainages disappear into valley fill material of longitudinal valleys formed by the Pioneer Mountain range, White Knob Mountains, Lost River Range, Lemhi Range, and Beaverhead Range of the Basin and Range province. Surface water is principally sourced by snowpack resulting in high runoff peaks in the spring and dry streambed conditions in the fall due to the natural infiltration of the surface water into the basalt streambed.

The Beaver-Camas subbasin is rural with small towns. The largest town in the subbasin is Dubois, with an estimated 2018 population of 588 (US Census Bureau 2018). Most of the land in the subbasin is used for agriculture, which has been the economic driver for this area for 100 years. Shrublands or rangelands make up the highest land use at 58% in the subbasin and are located in the central and southern portions of the watershed. The second highest land use in the subbasin is grass, pasture, and hay production at 19%. These land uses are scattered in the northern, western, and southern portions of the subbasin. Forest lands hold the third highest land use at 15%, located in the northern subbasin in higher elevations. Figure 1 depicts the land uses and crops typically grown in the Beaver-Camas subbasin.

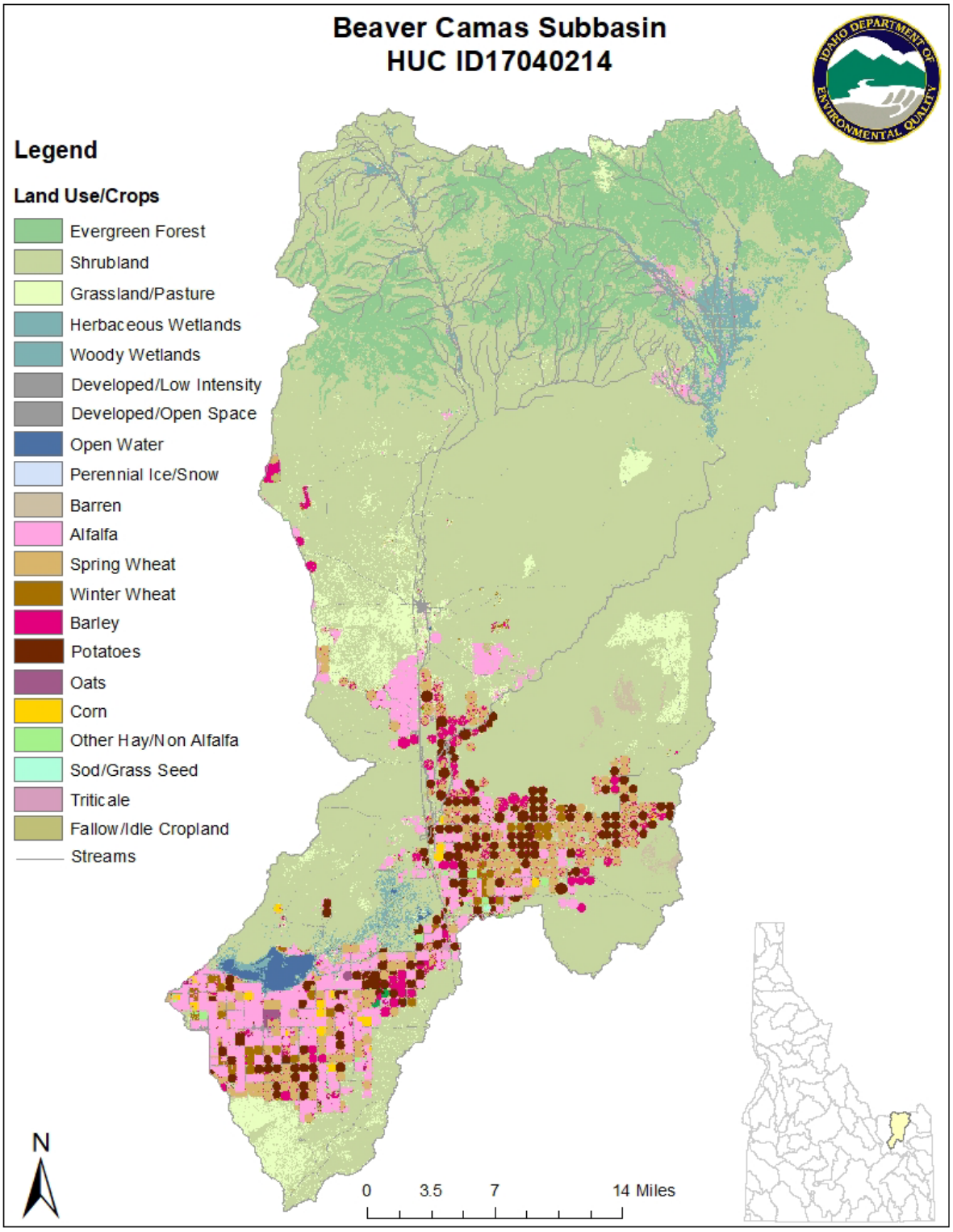


Figure 1. Land uses and crops grown in the Beaver-Camas subbasin sourced from 2019 Cropland Data Layer.

Maritime air from the prevailing westerly winds is the main source of Idaho's moisture. Precipitation typically occurs in late spring and late fall and varies from 9 inches in the lower valleys to 43 inches in the mountainous elevations along the continental divide (WRCC 2018). Most snowfall occurs between November and March with light snowfall beginning in September and occurring through June. One snow telemetry (SNOTEL) site operates in the Beaver-Camas subbasin. It is located at Crooked/Crab Creek (6,900-feet elevation) near Kilgore, Idaho. In 2018, the average snow depth was 21 inches with the most snow recorded in March at 48 inches.

Although the landscape of the Beaver-Camas subbasin is diverse with wetlands, riparian corridors, and forested mountains, the majority of vegetative cover is rangeland vegetation. Soil types range from gravelly loam in the mountainous region, fine sandy loam in the central region, to silty clay loam in the southern region (NRCS 2007).

Hydrology in the Beaver-Camas subbasin is complex. The two major drainages are Beaver Creek and Camas Creek. Beaver Creek is spring runoff driven. All of the Beaver Creek major tributaries above the town of Spencer are perennial streams. The land surrounding Beaver Creek above Spencer is mountainous and has few diversions so this reach flows all year. Several miles below Spencer, flows are not sustained throughout the year because the water infiltrates into the porous basalt streambed.

East to west tributaries to Camas Creek drain from the continental divide to wetlands just south of the town of Kilgore, and converge south of the wetlands to form the Camas Creek headwaters. In this portion of the drainage, surface water flows are diverted for irrigated agriculture. Camas Creek below the town of Camas does not sustain flows, and further downstream, flows are pumped from ground water into a dry Camas Creek to return flows for irrigation. This ground water also sustains Mud Lake, which is located at the southern end of the subbasin and is considered the hydrologic endpoint. The entire length of Camas Creek is a losing reach through the porous basalt streambed (DEQ 2005a).

Yellowstone Cutthroat Trout inhabit just 10% of the stream range in the Beaver-Camas subbasin. Brook Trout are the most prevalent species in the Beaver-Camas subbasin. Unfavorable habitat, overgrazing, and irrigation diversion allow limited amounts of Brook Trout to survive south of Red Road in Camas Creek. Other Salmonidae species residing in the Beaver-Camas subbasin include Brown Trout, Rainbow Trout, and Rainbow x Cutthroat hybrids.

The *Beaver-Camas Subbasin Assessment and Total Maximum Daily Loads* (DEQ 2005a) provides detailed information on the subbasin characteristics. Figure 2 is an overview of *Idaho's 2018/2020 Integrated Report* (DEQ 2020) water quality status for the Beaver-Camas subbasin.

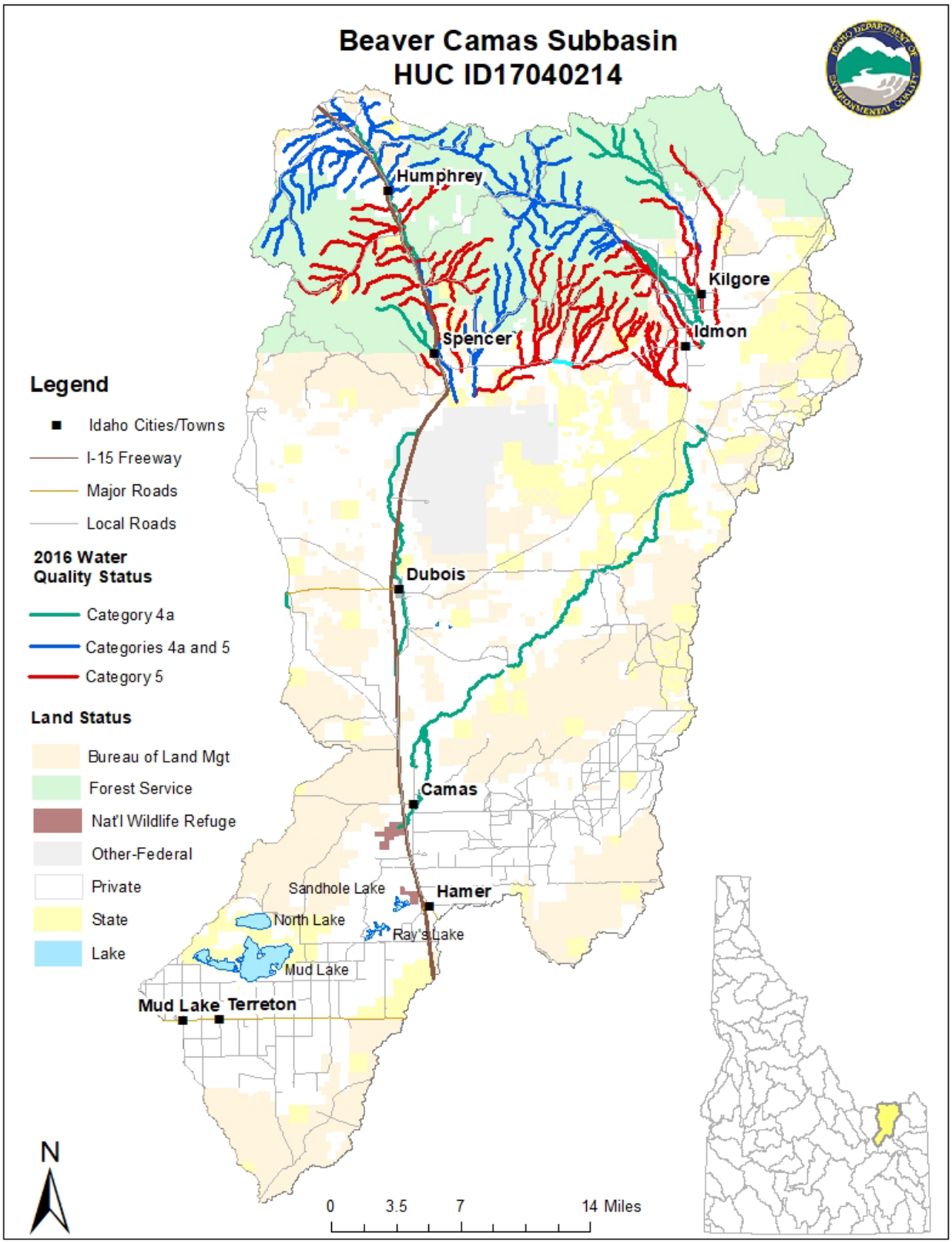


Figure 2. Beaver-Camas subbasin 2018/2020 Integrated Report water quality status (DEQ 2020).

2 Water Quality Concerns and Status

2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

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

2.1.1 Assessment Units

Assessment units are groups of similar streams that have similar land use practices, ownership, or land management. Stream order is the main basis for determining AUs—even if ownership and land use change significantly, the AU usually remains the same for the same stream order.

Using AUs to describe water bodies offers many benefits in that all waters of the state are defined consistently. AUs are a subset of water body identification numbers, which allows them to relate directly to the water quality standards.

2.1.2 Listed Waters

Table 1 shows the pollutants listed and the basis for listing for each §303(d)-listed AU in the subbasin (i.e., AUs in Category 5 of the Integrated Report).

2.2 Applicable Water Quality Standards and Beneficial Uses

Idaho's "Water quality Standards" (IDAPA 58.01.02) list beneficial uses and set water quality goals for waters of the state. IDAPA 58.01.02 requires that surface waters of the state be protected for beneficial uses, wherever attainable. These beneficial uses are interpreted as existing uses, designated uses, and presumed uses as described briefly in Appendix A. Idaho's *Water Body Assessment Guidance* (DEQ 2016a) provides a detailed description of beneficial use identification for assessment purposes.

Beneficial uses include the following:

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

Table 1. Listing basis for Beaver-Camas subbasin Category 5 streams.

AU Name	AU Number	Listed Pollutants	First Listed
Ching Creek—source to mouth	ID17040214SK006_03	*E. coli*	2002 §303(d) list
		Combined biota/habitat bioassessments	2016 §303(d) list
Crooked/Crab Creek—source to mouth	ID17040214SK008_02	Combined biota/habitat bioassessments	2002 §303(d) list
Crooked/Crab Creek—source to mouth	ID17040214SK008_03	Combined biota/habitat bioassessments; *E. coli*	2002 §303(d) list
Warm Creek—Cottonwood Creek to mouth and East Camas Creek	ID17040214SK009_02	Combined biota/habitat bioassessments; fecal coliform	2002 §303(d) list
East Camas Creek	ID17040214SK010_03	*E. coli*	2008 §303(d) list
West Camas Creek—source to Targhee National Forest Boundary	ID17040214SK013_02	Sedimentation/ siltation	2008 §303(d) list
West Camas Creek—source to Targhee National Forest Boundary	ID17040214SK013_03	*E. coli*	2014 §303(d) list
Rattlesnake Creek—source to mouth	ID17040214SK016_02	Combined biota/habitat bioassessments	2002 §303(d) list
Rattlesnake Creek—source to mouth	ID17040214SK016_03	Combined biota/habitat bioassessments	2002 §303(d) list
Threemile Creek—source to mouth	ID17040214SK017_02	Combined biota/habitat bioassessments	2002 §303(d) list
Threemile Creek—source to mouth	ID17040214SK017_03	Fecal coliform	2002 §303(d) list
Beaver Creek—Miner's Creek to Rattlesnake Creek	ID17040214SK018_02	Combined biota/habitat bioassessments	2002 §303(d) list
Beaver Creek—Miner's Creek to Rattlesnake Creek	ID17040214SK018_04	*E. coli*	2002 §303(d) list
Miner's Creek—source to mouth	ID17040214SK019_03	Combined biota/habitat bioassessments	2018/2020 §303(d) list
Beaver Creek—Idaho Creek to Miner's Creek	ID17040214SK020_02	Combined biota/habitat bioassessments; *E. coli*	2008 §303(d) list
Beaver Creek—source to Idaho Creek	ID17040214SK021_02	*E. coli*	2002 §303(d) list
Pleasant Valley Creek—source to Idaho Creek	ID17040214SK023_02	*E. coli*	2014 §303(d) list
		Combined biota/habitat bioassessments	2016 §303(d) list

2.2.1 Beneficial Uses in the Subbasin

The beneficial uses within the Beaver-Camas subbasin for the AUs addressed in this document and whether they are designated or existing are listed in Table 2. Beneficial uses specific to the Beaver-Camas subbasin include the following:

- Cold water aquatic life (COLD)—Applies to water quality appropriate for protecting and maintaining a viable aquatic life community for coldwater species.
- Salmonid spawning (SS)—Applies to waters that provide or could provide a habitat for active self-propagating populations of salmonid fishes.
- Primary contact recreation (PCR)—Applies to waters where people engage in activities that involve immersion in and likely ingestion of water. Examples of these activities include swimming, waterskiing, and skin diving.
- Secondary contact recreation (SCR)—Applies to waters where people engage in activities in which ingestion of water may occasionally occur. Examples of these activities include fishing, boating, wading, and infrequent swimming.
- Domestic water supply (DWS)—Applies to water quality appropriate for drinking water supplies.

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." Any water body in Idaho that has been assigned a designated use has been officially recognized by the state and will be listed in IDAPA 58.01.02.150.16. These uses include aquatic life support, recreation in or on the water, domestic water supply, and agricultural uses. Water quality must be maintained to support the most sensitive use.

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." Existing uses include uses actually occurring, whether or not the level of quality to fully support the uses exists.

All smaller tributaries to the larger designated water bodies (i.e., undesignated water bodies) are presumed to support COLD and PCR or SCR (IDAPA 58.01.02.150.16). Existing uses for undesignated water bodies are identified using water quality data, such as Beneficial Use Reconnaissance Program (BURP) data. If there is evidence of salmonids or SS that has occurred in the past or is currently occurring in a stream, the existing use of SS would be applied to the stream. PCR or SCR uses can be determined by the characteristics of a water body. PCR would be the assumed recreation category for a water body that is a minimum of 2 feet deep, swimmable, and where ingestion of water is likely; SCR would be the assumed recreation category for a water body where activities such as boating or fishing would occur and where water ingestion is not as likely.

The Beaver-Camas subbasin TMDL (DEQ 2005a) provides detailed information on the beneficial uses in the subbasin.

Table 2. Beneficial uses of Beaver-Camas subbasin Category 5 streams.

AU Name/Water Bodies	AU Number	Beneficial Uses	Type of Use
Ching Creek—source to mouth (Ching Creek, Spring Creek, and Cottonwood Creek)	ID17040214SK006_03	COLD, SS, SCR	Existing
Crooked/Crab Creek—source to mouth (Crooked Creek, Crab Creek, and McGarry Creek)	ID17040214SK008_02	COLD, SCR	Existing
Crooked and Crab Creeks—source to mouth	ID17040214SK008_03	COLD, SS, SCR	Existing
Warm Creek—Cottonwood Creek to mouth and East Camas Creek (Saw Creek and Warm Creek)	ID17040214SK009_02	COLD, SS, SCR	Existing
East Camas Creek	ID17040214SK010_03	COLD, SS, SCR	Existing
West Camas Creek—source to Targhee National Forest Boundary (Stump Creek, Alex Draw Creek, Allan Canyon Creek, Pete Creek, West Camas Creek, East Steel Creek, West Steel Creek, Jug Creek, Castle Creek, Pass Creek, Disaster Creek, and Steel Creek)	ID17040214SK013_02	COLD, SS, SCR	Existing
West Camas Creek—source to Targhee National Forest Boundary	ID17040214SK013_03	COLD, SS, SCR	Existing
Rattlesnake Creek—source to mouth (Corral Creek, Spring Creek, Rattlesnake, East Fork Rattlesnake Creek, and West Fork Rattlesnake Creek)	ID17040214SK016_02	COLD, SS, SCR	Existing
Rattlesnake Creek—source to mouth (Rattlesnake Creek, Corral Creek, Spring Creek, and East Fork Rattlesnake)	ID17040214SK016_03	COLD, SCR	Existing
Threemile Creek—source to mouth (Threemile Creek, West Threemile Creek, East Threemile Creek, and Middle Threemile Creek)	ID17040214SK017_02	COLD, SS, SCR	Existing
Threemile Creek—source to mouth	ID17040214SK017_03	COLD, SCR	Existing
Beaver Creek—Miner's Creek to Rattlesnake Creek (Beaver Creek, Cobble Creek, Calf Creek, Dairy Creek, Clay Creek, Left Fork Creek, Telephone Creek, Stoddard Creek, Van Noy Canyon Creek, Picnic Hollow Creek, and Thomas Draw Creek)	ID17040214SK018_02	COLD, SS, PCR, DWS	Designated
Beaver Creek—Miner's Creek to Rattlesnake Creek	ID17040214SK018_04	COLD, SS, PCR, DWS	Designated
Miner's Creek—source to mouth	ID17040214SK019_03	COLD	Existing
Beaver Creek—Idaho Creek to Miner's Creek (Sheep Creek, Flat Creek, and Camp Creek)	ID17040214SK020_02	COLD, SS, PCR, DWS	Designated
Beaver Creek—source to Idaho Creek (Beaver Creek, Modoc Creek, Long Creek, East Modoc Creek, Middle Modoc Creek, West Modoc Creek, Horse Creek, Kettle Creek, Robbins Creek, Chicken Creek, Berry Creek, and Tenpin Gulch)	ID17040214SK021_02-	COLD, SS, PCR, DWS	Designated
Pleasant Valley Creek—source to mouth (Headquarters Creek, School Section Creek, Ramshorn Creek, Pleasant Valley Creek, Kite Canyon Creek, White Pine Canyon Creek, Brooks Canyon Creek, and Swampy Draw Creek)	ID17040214SK023_02	COLD, SS, SCR	Existing

2.2.2 Water Quality Criteria to Support Beneficial Uses

Beneficial uses are protected by a set of water quality criteria, which include *numeric* criteria for pollutants such as bacteria, dissolved oxygen, pH, ammonia, temperature, and turbidity (Appendix B) and *narrative* criteria for pollutants such as sediment and nutrients (IDAPA 58.01.02.250–251). For more about temperature criteria and natural background provisions relevant to the potential natural vegetation (PNV) approach, see Appendix B.

Narrative criteria for excess sediment are described in the water quality standards:

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

DEQ's procedure to determine whether a water body fully supports designated and existing beneficial uses is outlined in IDAPA 58.01.02.050.02. The procedure relies heavily upon biological parameters and is presented in detail in the *Water Body Assessment Guidance* (DEQ 2016a). This guidance requires DEQ to use the most complete data available to make beneficial use support status determinations.

Table 3 provides applicable numeric criteria for the beneficial uses in the Beaver-Camas subbasin and Table 4 provides the critical time frames for AUs meeting the water quality criteria and targets associated with their respective impairments (DEQ 2020). For example, Threemile Creek (ID17040214SK017_02) is listed in Category 5 for combined biota/habitat bioassessments. The 2018 investigations of the stream deployed a temperature data logger and conducted a PNV analysis. The temperature logger showed that the AU does not meet water quality standards for temperature. In addition, the PNV analysis indicated that the AU is subject to excess solar loads. The temperature criteria for two of the beneficial uses assigned to Threemile Creek are 22 °C daily maximum and 19 °C daily average for COLD and 13 °C daily maximum and 9 °C daily average for SS. The critical periods for COLD are June 21–September 21 (warmest time of year). For SS, the critical periods are March 1–July 15 and October 1–December 30 due to the observed presence of Yellowstone Cutthroat Trout, Brown Trout, Brook Trout, Rainbow Trout, and Rainbow x Cutthroat Trout hybrids in the Beaver-Camas subbasin during electrofishing over the years (DEQ 2005a; IDFG 2007; USFS 1997–2012). If Threemile Creek was to meet the temperature criteria during these critical times, temperature would not be considered an impairment to the AU.

Table 3. Selected numeric criteria supportive of designated beneficial uses in Idaho's water quality standards.

Parameter	Primary Contact Recreation (PCR)	Secondary Contact Recreation (SCR)	Cold Water Aquatic Life (COLD)	Salmonid Spawning[a] (SS)
Water Quality Standards: IDAPA 58.01.02.250–251				
Bacteria				
• Geometric mean	<126 *Escherichia coli* (*E. coli)* /100 mL[b]	<126 *E. coli* /100 mL	—	—
• Single sample	≤406 *E. coli* /100 mL	≤576 *E. coli* /100 mL	—	—
Temperature[c]	—	—	22 °C or less daily maximum; 19 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average

a During spawning and incubation periods for inhabiting species
b Escherichia coli per 100 milliliters
c Temperature exemption: Exceeding the temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the ninetieth percentile of the 7-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.
Notes: does not apply (—)

Table 4. Pollutant target during critical periods for the Beaver-Camas Subbasin.

Pollutant	Parameter	Narrative Target	Numeric Criteria	Critical Period
E. coli	Geometric mean	—	<126 *E. coli* /100 mL	Grazing season (Summer/Fall)
Temperature	Potential natural vegetation	Natural shade level: Channel width	COLD: 22 °C daily maximum; 19 °C daily average SS: 13 °C daily maximum	June 21–Sept 21 March 1–July 15 October 1–December 30
Sediment	Streambanks	80% streambank stability	—	Spring snowmelt and high runoff events

Notes: does not apply (—); cold water aquatic life (COLD); salmonid spawning (SS)

For AUs with potential sedimentation/siltation impairments in the Beaver-Camas subbasin, streambank erosion is usually the issue. As such, the 80% streambank stability target is year-round. The critical time for streambank erosion is during spring snowmelt and high runoff events. After reviewing results from previously collected BURP data including, Fine Sediment Biotic Index (FSBI) scores, percent fines, and Wolman pebble count data to determine if sediment was a likely impairment, streambank erosion inventories (SEIs) were conducted on six AUs: Ching Creek (ID17040214SK006_03), Crooked/Crab Creek (ID17040214SK008_03), Pass Creek (West Camas Creek ID17040214SK013_02), Rattlesnake Creek (ID17040214SK016_02), Threemile Creek (ID17040214SK017_02), and Van Noy Canyon Creek (Beaver Creek ID17040214SK018_02). SEI results indicated Van Noy Canyon Creek did not meet the streambank stability target of ≥80% streambank stability and ≤20% erosive banks, with an existing 76% bank stability and 24% erosive banks. Based on SEI calculations, the other five AUs

appeared to meet the streambank stability target. Appendix C provides the SEI data sheets for the AUs evaluated.

For AUs with *E. coli* impairment, numeric criteria apply year-round; however, the critical period occurs during the summer and fall, which coincides with grazing season and recreation season. Stream flows are also at their lowest during this time. Bacteria samples and geometric mean calculations completed during the critical period in 2012, 2013, and 2018 determined that seven AUs including Ching Creek (ID17040214SK006_03), East Camas Creek (ID17040214SK010_03), West Camas Creek (ID17040214SK013_03), Threemile Creek (ID17040214SK017_03), Beaver Creek (ID 17040214SK018_04), West Modoc Creek (Beaver Creek ID17040214SK021_02), and Pleasant Valley Creek (ID17040214SK023_02) were impaired by *E. coli*. Crooked/Crab Creek (ID17040214SK008_03), Warm Creek (ID17040214SK009_02) and Sheep Creek (Beaver Creek ID17040214SK020_02) were also sampled during the critical period but the geometric mean calculations indicated that they were not impaired by *E. coli*.

During the 2018 field season, several AUs that were investigated did not have sufficient water depth/flow or did not exhibit impairment as listed in Category 5. Crooked Creek (ID17040214SK008_02) was listed for combined biota/habitat bioassessments. During the initial field visit, the water depth was too low to deploy temperature data loggers. DEQ staff visited the stream several times during the season; however, the AU was completely dry in early July. Warm Creek (ID17040214SK009_02) was listed for combined biota/habitat bioassessments and fecal coliform. A logger was deployed and a PNV analysis was performed on the AU. Results from the logger determined that this AU was impaired by temperature and a PNV analysis identified an excess of solar load within the AU. However, a geometric mean calculated from bacteria samples taken during the critical period determined that a bacteria impairment did not exist. Pass Creek (West Camas Creek ID17040214SK013_02) was listed for sedimentation/siltation, and the SEI performed, determined that excess streambank erosion did not exist. Rattlesnake Creek (ID17040214SK016_03) was listed for combined biota/habitat bioassessments and was investigated in mid-July. Mature sagebrush had grown in the gravel streambed, and there was no evidence of flow in the channel, as it was completely dry. No evidence of recent flow was noticed further upstream or downstream of the survey point, so no monitoring occurred there. It was determined that this stream is intermittent and/or ephemeral and excludes it from assessment. Beaver Creek (ID17040214SK020_02) was listed for combined biota/habitat bioassessment and *E. coli*. Finding a stream within the Beaver Creek AU (ID17040214SK020_02) with adequate water depth or flow for a survey was challenging, and the tributaries visited did not contain enough depth to deploy a temperature data logger.

Idaho's water quality standards require that all waters "shall maintain a level of water quality at their pour point into downstream waters that provides for the attainment and maintenance of the water quality standards of those downstream waters, including waters of another state or tribe" (IDAPA 58.01.02.070.08).

Consistent with IDAPA 58.01.02.054.04, "there is no impairment of beneficial uses or violations of water quality standards where natural conditions exceed applicable water quality criteria." The temperature TMDL's load capacity estimates and load allocations are based on the concept

of Potential Natural Vegetation. The goal of PNV TMDLs is to attain shade conditions equivalent to natural conditions and achieve a temperature regime expected under "natural background conditions." Since this TMDL does not estimate "natural background temperatures" but uses shade as a surrogate, no numeric temperature target is established. Since natural background standards apply only "when natural background conditions exceed any applicable water quality criteria" (IDAPA 58.01.02.200.09), if stream temperatures are below numeric temperature criteria when natural conditions are achieved (i.e., TMDL is fully implemented), natural background standards would not apply; however, if stream temperatures do not exceed numeric criteria when PNV is achieved, there is no longer an impairment of beneficial uses due to temperature.

Narrative targets for sediment impaired waters are provided in Idaho's water quality standards: "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." (IDAPA 58.01.02.200.08). The allocations in the sediment TMDLs are developed to meet non-point source sediment targets which are protective of beneficial uses and would not contribute to downstream sediment impairments.

Pursuant to Idaho water quality standards (IDAPA 58.01.02.251.01), the following is numeric criteria for PCR and SCR beneficial uses: *E. coli* colonies may not exceed a geometric mean of 126 cfu/mL for five samples collected every 3 to 7 days within a 30-day period. The allocations in the *E. coli* TMDLs in this document are developed to be protective of beneficial uses and would not contribute to downstream bacteria impairments.

With exception of the *E.coli* TMDLs, AUs analyzed in these TMDLs are tributary to AUs analyzed for the same impairments. The waters of the Beaver-Camas subbasin empty to Beaver Creek (AU ID17040214SK018_04) and Camas Creek (AU ID17040214SK002_05). Both streams have temperature TDMLs. Camas Creek also has a sediment TMDL. Beneficial uses in Beaver Creek include the designated uses of DWS, COLD, SS, and PCR, whereas the beneficial uses in Camas Creek include the designated uses of COLD, SS, and PCR. Protecting beneficial uses upstream ensures beneficial use protection downstream. The subbasin is a closed drainage that has no connection to the Snake River. Instead, the surface water infiltrates into the Snake River Plain aquifer, or it is diverted for agricultural purposes.

2.3 Summary and Analysis of Existing Water Quality Data

Water quality data described below were collected to evaluate sediment, temperature, and bacteria impairments. Multiple government agencies have collected data in the Beaver-Camas subbasin. The United States Geological Survey (USGS) provided flow data. The Idaho Department of Fish and Game (IDFG) and United States Forest Service (USFS) provided fish data and restoration information. The Natural Resources Conservation Service (NRCS) provided restoration information, and the Idaho Department of Water Resources (IDWR) provided water rights data. DEQ collected and provided the following data: BURP, temperature, *E. coli*, SEI, PNV, and Solar Pathfinder. These data were analyzed to establish the current water quality

status of the water bodies and compared to water quality data gathered and analyzed in the Beaver-Camas subbasin TMDL (DEQ 2005a).

2.3.1 Beneficial Use Reconnaissance Program Data

The BURP monitoring protocol uses standardized procedures to collect aquatic insects, conduct fish surveys, measure water chemistry, and document habitat conditions in streams and rivers to determine support of beneficial uses. Aquatic insects and fish are very sensitive to changes in water quality, so their presence, abundance, and health indicate the overall quality of a water body. BURP data are evaluated against assessment thresholds using the *Water Body Assessment Guidance* (DEQ 2016a) to determine if the water body is meeting standards and supporting beneficial uses.

Table 5 provides the BURP data for the COLD and SS beneficial use support collected for this review. The BURP monitoring protocol provides data on three important stream quality indicators: macroinvertebrates, fish, and habitat. A stream macroinvertebrate index (SMI) is generated from six or seven metrics based on the benthic macroinvertebrate assemblages in reference streams and depending on stream site class [i.e., mountains, foothills, or plains, plateaus, or broad valleys (PPVB)]. A stream fish index (SFI) includes five to six metrics based on the species present, abundance of the different species, and abundance of tolerant/intolerant individuals. A stream habitat index (SHI) uses both quantitative and qualitative measures of stream habitat, including substrate composition, channel structure, streamside vegetation, and streambank condition. Index scores (condition ratings) from the monitoring samples are compared with statistical reference index scores and used along with available physical and chemical data to determine whether an AU supports its beneficial uses. A score <2 is considered not supporting and a score of ≥2 is considered fully supporting. Not Assessed (NA) or (-) indicates data for the index were not evaluated.

Establishing water quality trends within the Beaver-Camas subbasin using BURP data is a challenge due to intermittent dry conditions and infrequent BURP monitoring in previous years at the majority of the sites. Between 2005, when the last TMDL was approved, and 2016, six out of 24 AUs received a passing BURP score. The most recent calculated passing BURP score was for a portion of Beaver Creek (ID17040214SK018_04) in 2012.

Table 5. BURP scores for the Beaver-Camas subbasin (1995-2016).

AU Name	AU Number	Year	SMI	SFI	SHI	Average	2018/2020 Integrated Report Category
Camas Creek—Spring Creek to Beaver Creek	ID17040214SK002_05	2010	—	—	—	NA	4a
		2004	—	—	—	NA	
		1995	—	—	—	NA	
		1995	—	—	—	NA	
Ching Creek—source to mouth	ID17040214SK006_03	2013	3	1	1	1.67	5
		2003	3	1	1	1.67	
		1998	2	1	1	1.33	
		1996	3	1	1	1.67	
Crooked/Crab Creek—source to mouth	ID17040214SK008_02	2015	—	—	—	NA	5
		2003	—	—	—	NA	
		1998	1	1	1	1.00	
Crooked/Crab Creek—source to mouth	ID17040214SK008_03	2003	—	—	—	NA	5
		1998	1	0	1	0.00	
Warm Creek—Cottonwood Creek to Mouth and East Camas Creek	ID17040214SK009_02	2012	1	—	1	1.00	5
		2004	—	—	—	NA	
		1998	0	1	1	0.00	
East Camas Creek	ID17040214SK010_02	—	—	—	—	—	4a
East Camas Creek	ID17040214SK010_03	2012	3	1	1	1.67	4a, 5
		2001	3	1	2	2.00	
		1996	3	1	2	2.00	
East Camas Creek	ID17040214SK011_02	—	—	—	—	—	4a
East Camas Creek	ID17040214SK011_03	—	—	—	—	—	4a
West Camas Creek	ID17040214SK012_03	2005	—	—	—	NA	4a
		2005	3	0	1	0.00	
West Camas Creek—source to Targhee National Forest Boundary	ID17040214SK013_02	2008	2	—	3	2.50	4a, 5
		2003	—	—	—	NA	
		2003	—	—	1	1.00	
		2002	3	1	1	1.67	
		2002	3	—	2	2.50	
		2002	—	—	—	NA	
		2002	3	1	1	1.67	
		2002	2	—	1	1.50	
		2002	—	—	—	NA	
		2002	—	—	—	NA	
		2001	3	—	3	3.00	
		1996	2	—	1	1.50	
		1996	3	1	3	2.33	
		1996	3	—	3	3.00	
		1996	2	1	1	1.33	
		1996	3	—	1	2.00	
		1996	3	1	3	2.33	
		1996	2	1	3	2.00	
		1996	3	—	3	3.00	

AU Name	AU Number	Year	SMI	SFI	SHI	Average	2018/2020 Integrated Report Category
West Camas Creek—source to Targhee National Forest Boundary	ID17040214SK013_03	2013	2	1	2	1.67	4a, 5
		2012	2	1	1	1.33	
		2008	2	1	2	1.67	
		2007	3	1	2	2.00	
		2004	3	1	1	1.67	
		2003	3	1	2	2.00	
		2001	3	1	1	1.67	
Rattlesnake Creek—source to mouth	ID17040214SK016_02	2008	2	1	1	1.33	5
		2008	3	3	3	3.00	
		2003	—	—	—	NA	
		2003	—	—	—	NA	
		2003	—	—	1	1.00	
		1998	3	1	1	1.67	
		1998	3	1	1	1.67	
		1998	0	—	1	0.00	
		1998	1	—	3	2.00	
		1998	3	3	3	3.00	
		1998	3	2	1	2.00	
		1998	3	—	3	3.00	
		1998	1	1	1	1.00	
		1998	0	—	1	0.00	
Rattlesnake Creek—source to mouth	ID17040214SK016_03	2003	—	—	—	NA	5
		1998	0	—	1	0.00	
Threemile Creek—source to mouth	ID17040214SK017_02	2003	—	—	—	NA	4a, 5
		2003	—	—	1	1.00	
		2003	—	—	—	NA	
		1998	3	1	3	2.33	
		1998	3	1	2	2.00	
		1998	3	1	3	2.33	
		1998	0	1	3	0.00	
Threemile Creek—source to mouth	ID17040214SK017_03	2005	3	—	1	2.00	4a, 5
		2004	—	—	—	NA	
		1998	2	—	1	1.50	
Beaver Creek—Miner's Creek to Rattlesnake Creek	ID17040214SK018_02	2008	3	—	1	2.00	4a, 5
		2008	2	—	1	1.50	
		2008	1	2	1	1.33	
		2003	—	—	—	NA	
		2003	—	—	—	NA	
		2003	—	—	—	NA	
		2003	—	—	—	NA	
		1998	0	—	1	0.00	
		1998	2	2	3	2.33	
		1998	2	3	3	2.67	
		1996	1	—	1	1.00	
		1996	3	1	3	2.33	
Beaver Creek—Miner's Creek to Rattlesnake Creek	ID17040214SK018_04	2012	1	3	2	2.00	4a, 5
		1995	0	—	1	0.00	
Beaver Creek—Idaho Creek to Miner's Creek	ID17040214SK020_02	2013	—	—	—	NA	5
		2003	—	—	—	NA	
		1998	1	—	1	1.00	
		1996	—	—	—	NA	

AU Name	AU Number	Year	SMI	SFI	SHI	Average	2018/2020 Integrated Report Category
Beaver Creek—Idaho Creek to Miner's Creek	ID17040214SK020_03	2006	—	—	—	NA	4a
Beaver Creek—source to Idaho Creek	ID17040214SK021_02	2012	1	—	1	1.00	4a, 5
		2004	—	—	—	NA	
		2003	—	—	—	NA	
		2003	—	—	—	NA	
		2003	—	—	—	NA	
		2003	—	—	—	NA	
		2003	—	—	—	NA	
		2003	—	—	—	NA	
		1998	0	—	1	0.00	
		1998	0	—	3	0.00	
		1998	0	3	1	0.00	
		1998	3	1	1	1.67	
		1998	3	3	1	2.33	
		1998	1	—	1	1.00	
		1998	2	—	1	1.50	
Beaver Creek—source to Idaho Creek	ID17040214SK021_03	2013	—	—	—	NA	4a
		2007	—	—	—	NA	
Pleasant Valley Creek—source to mouth	ID17040214SK023_02	2013	2	1	1	1.33	5
		2013	1	1	2	1.33	
		2012	1	—	2	1.50	
		2003	—	—	—	NA	
		2003	—	—	—	NA	
		2003	—	—	1	1.00	
		2003	—	—	—	NA	
		2003	—	—	—	NA	
		2003	—	—	1	1.00	
		2002	2	3	1	2.00	
		2002	2	—	2	2.00	
		2002	3	—	1	2.00	
		2002	1	—	2	1.50	
		2001	3	—	1	2.00	
		1996	1	1	3	1.67	
		1996	—	3	1	2.00	
		1996	3	1	3	2.33	
		1996	3	1	3	2.33	
		1996	3	1	3	2.33	
Huntley Canyon Creek—source to mouth	ID17040214SK024_02	2001	2	1	2	1.67	4a

Notes: NA = not assessed. Site was either dry or inaccessible at the time of the monitoring.

2.3.2 United States Geological Survey Flow Data

Stream flows in the Beaver-Camas subbasin during the 2018 runoff season were normal to above normal through the fall, winter, and spring due to a large snowpack and a full reservoir system. This is consistent with the typical stream flow pattern that occurs in the Beaver-Camas subbasin. Increases and decreases in flow follow the weather pattern, with high flows during spring runoff lasting until mid-June. Low flows occur in the fall and last into mid-October.

Prior to September 30, 2019, the USGS maintained two continuous discharge gaging stations in the Beaver-Camas subbasin. USGS gage #13112000 is currently active and recording discharge data. It is located in the southern portion of the watershed on Camas Creek in Camas, Idaho. Data indicate flows in this location consistently reach 0 cubic feet per second (cfs) on a seasonal basis. Figure 3 shows the daily mean discharge from 1926–2019. The highest daily mean discharge recorded throughout the gage's period of activity was on 5/1/06 at 1,280 cfs. More recently, a discharge of increased capacity occurred on 3/24/18 at 517 cfs. May appears to be the high flow month during the year with a mean average flow over the years at 190 cfs, coinciding with spring runoff, while seasonal low flows typically occur during August (4.1 cfs), September (2.9 cfs), and October (4.8 cfs). Data are available from USGS at *https://waterdata.usgs.gov/id/nwis/dv?cb_00060=on&format=gif_default&site_no=13112000&referred_module=sw&period=&begin_date=1925-05-01&end_date=2019-12-02*.

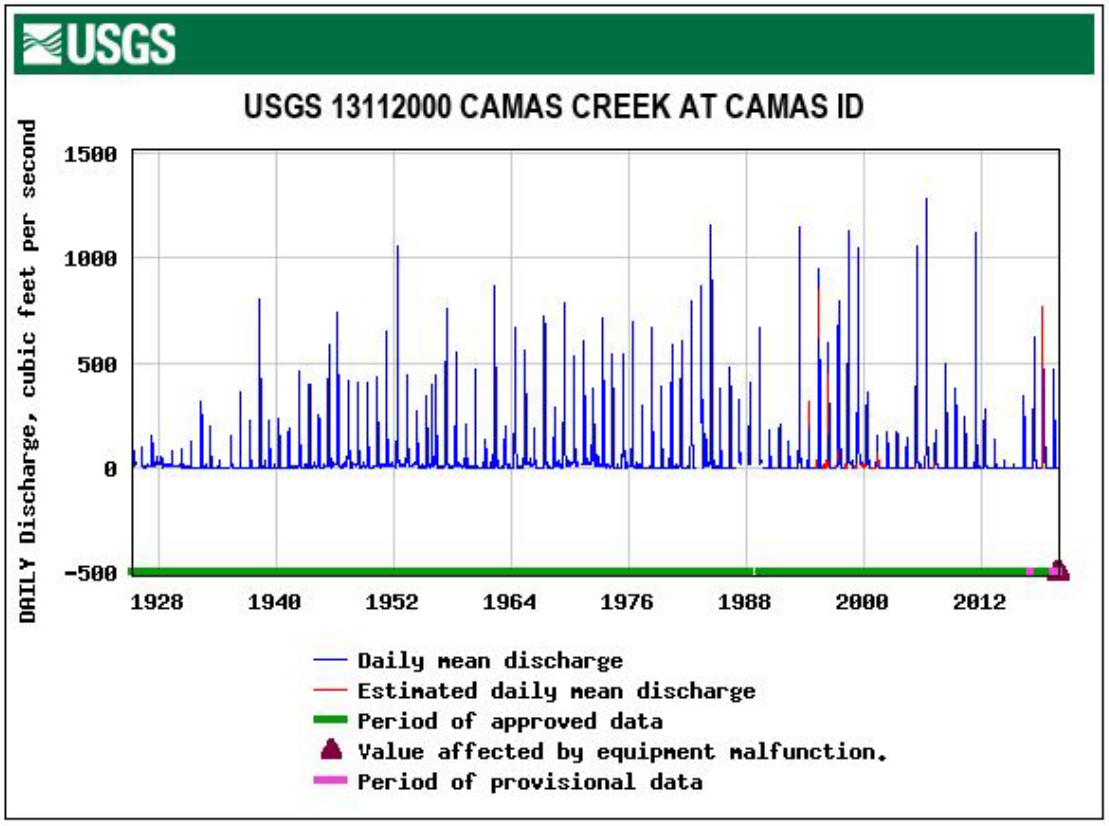


Figure 3. Daily mean discharge, Camas Creek at Camas, Idaho (USGS 2019a).

The second USGS gage, #13113000, was active on and off since 1938 but was discontinued in September 2019. The gage was located in the upper west half of the subbasin on Beaver Creek in Spencer, Idaho. Data recorded by this gage showed that Beaver Creek streamflow was perennial in this location. However, further south of Spencer, a sustained year-round flow does not occur and during 2018 field investigations, the portion of Beaver Creek flowing through Dubois was completely dry in July. Figure 4 shows the daily mean discharge from 1938–2019. The highest daily mean cubic feet per second (cfs) discharge recorded throughout the gage's period of activity was on 8/5/75 at 940 cfs. The highest discharge recorded since the Beaver-

Camas subbasin TMDL (DEQ 2005a) was approved occurred on 3/23/18 at 512 cfs. May appears to be the high flow month during the year with a mean average flow over the years of 108 cfs, coinciding with spring runoff, while seasonal low flows typically occur during August (14 cfs), September (13 cfs) and October (18 cfs). Data are available from USGS at *https://nwis.waterdata.usgs.gov/id/nwis/dv?cb_00060=on&format=gif_default&site_no=13113000&referred_module=sw&period=&begin_date=1938-12-06&end_date=2019-12-02*.

As shown by the graphs, the hydrology in the Beaver-Camas subbasin is diverse. An in-depth discussion of historical flow data in the Beaver-Camas subbasin can be found in the Beaver-Camas subbasin TMDL (DEQ 2005a).

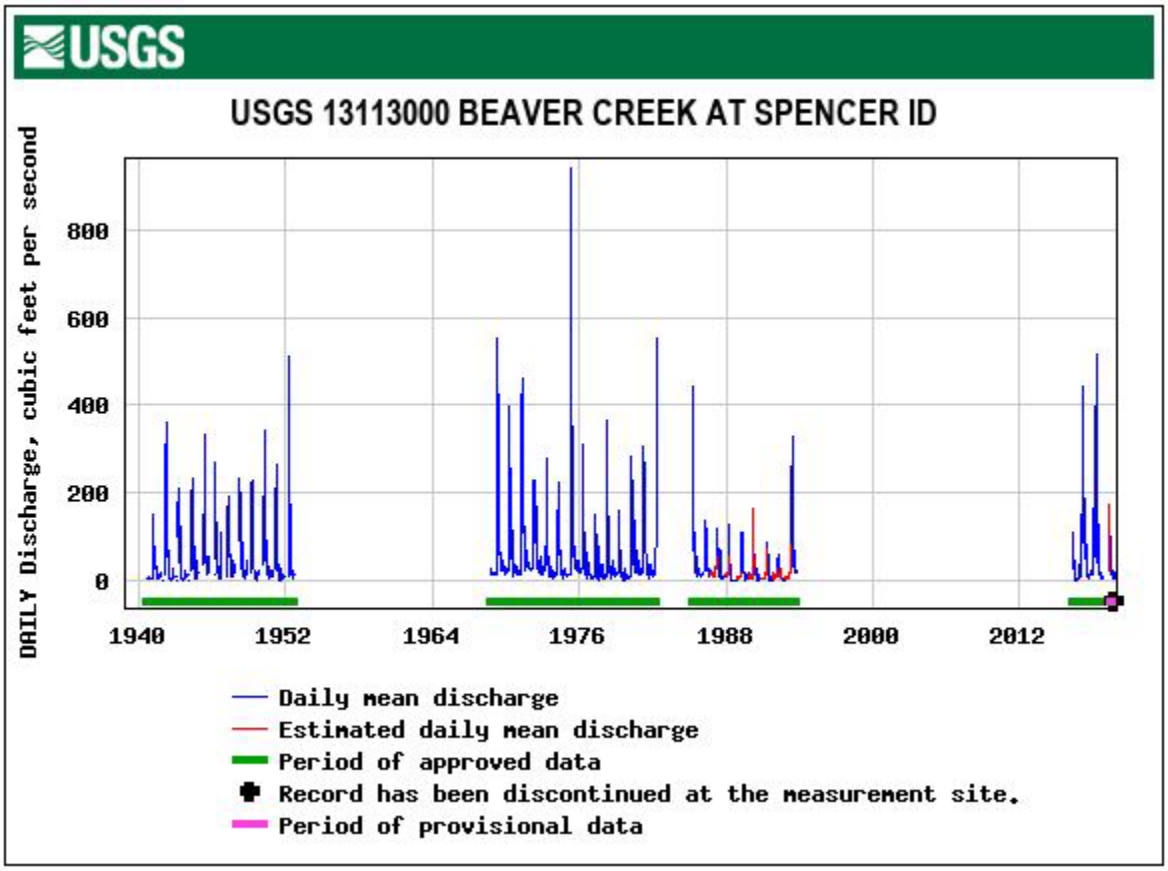


Figure 4. Daily mean discharge, Beaver Creek at Spencer, Idaho (USGS 2019b).

2.3.3 Water Column Data

This TMDL analysis uses data generated through DEQ's monitoring efforts, specifically *E. coli* sampling. The data are provided in Appendix C.

2.3.4 Temperature

Temperature data loggers were deployed in 15 AUs listed in Category 4a and 5 throughout the Beaver-Camas subbasin during the 2018 field season. Temperature logger data collected from 5/30/18–11/19/18 showed stream temperatures in these tributaries exceeded SS criteria. COLD

criteria were exceeded in four AUs (Appendix C, Table C2 and Figures C1–C15). Recent temperature data are consistent with data generated for the Beaver-Camas subbasin TMDL (DEQ 2005a), which resulted in 17 temperature TMDLs.

2.3.5 Potential Natural Vegetation for Temperature TMDLs

The PNV approach was applied to 20 AUs in the Beaver-Camas subbasin during the 2018 field season (section 5). A lack of shade or riparian vegetation along the streambanks can cause excess solar load on a water body and allow temperatures to exceed the water quality standards. PNV temperature TMDLs quantify nonpoint source solar heat load to streams. Idaho's water quality standards include a provision (IDAPA 58.01.02.200.09) establishing if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered a violation of water quality standards. In these situations, natural conditions essentially become the water quality standards, and the natural level of shade and channel width become the TMDL target. The instream temperature that results from attainment of these conditions is consistent with the water quality standards, although it may exceed numeric temperature criteria.

Using aerial interpretation, existing shade was estimated on representative reaches of the Category 4a- and 5-listed streams shown in Appendix C. A Solar Pathfinder is used to field verify these shade estimates. During a field survey, photos are taken of a Solar Pathfinder device, which is situated at bankfull level in the center of the stream. The Solar Pathfinder captures images of all existing shade-producing riparian communities on the streambanks. Once the riparian community types are identified and defined, a shade curve can be selected that models available shade for that riparian community at its potential. Existing shade measurements can then be compared to potential shade estimates, at the same stream widths, and the resulting shade deficit is interpreted as a temperature load reduction. The majority of streams surveyed in the Beaver-Camas subbasin exhibited a shade deficit when compared to potential shade targets. Three of the 20 AUs did not lack shade in the reaches examined.

2.3.6 *E. coli* Bacteria Monitoring

Idaho's water quality standards state *E. coli* bacteria are not to exceed 126 cfu/100 mL of a five sample, 30-day geometric mean. Single sample thresholds are 406 cfu/100 mL for PCR uses and 576 cfu/100 mL for SCR uses. Depending on the use, if the respective single sample maximum is exceeded, four additional samples must be taken every 3 to 7 days within a month's time to determine the geometric mean concentration for comparison to the standard (IDAPA 58.01.02.251.01 and 02).

Geometric mean concentrations were calculated from *E. coli* bacteria samples obtained from listed streams in 2012, 2013, and 2018. The resulting concentrations and geometric means show that reductions in *E. coli* are necessary to support PCR and SCR uses (Appendix B) for the seven AUs shown in Table 6: Ching Creek (ID17040214SK006_03), East Camas Creek (ID17040214SK010_03), West Camas Creek (ID17040214SK013_03), Threemile Creek

(ID17040214SK017_03), Beaver Creek (ID17040214SK018_04), West Modoc Creek (Beaver Creek ID17040214SK021_02), and Pleasant Valley Creek (ID17040214SK023_02).

Three additional AUs with calculated geometric mean concentrations from *E. coli* samples taken during the 2018 field season did not exceed 126 cfu/100 mL criteria: Crooked/Crab Creek (ID17040214SK008_03)—concentration of 124; Warm Creek (ID17040214SK009_02)—concentration of 90; and Sheep Creek (Beaver Creek ID17040214SK020_02)—concentration of 85. These AUs meet water quality standards and will not require a TMDL to reduce *E. coli.*

Table 6. *E. coli* geometric mean concentrations and resultant load allocations.

AU Name	AU Number	*E. coli* Concentration Geometric Mean[a] (cfu/100 mL)	TMDL Target (cfu/100 mL)	TMDL Required?
Ching Creek	ID17040214SK006_03	254	126	Yes
Crooked/Crab Creek	ID17040214SK008_03	124	126	No
Warm Creek	ID17040214SK009_02	90	126	No
East Camas Creek	ID17040214SK010_03	135	126	Yes
West Camas Creek	ID17040214SK013_03	283	126	Yes
Threemile Creek	ID17040214SK017_03	395	126	Yes
Beaver Creek	ID17040214SK018_04	334	126	Yes
Sheep Creek (Beaver Creek)	ID17040214SK020_02	85	126	No
Beaver Creek	ID17040214SK021_02	433	126	Yes
Pleasant Valley Creek	ID17040214SK023_02	1170	126	Yes

a. The geometric mean is calculated from five samples collected in a 30-day period every 3–7 days.

2.3.7 Sedimentation Monitoring

Six AUs listed in Category 5 of the 2018/2020 IR (DEQ 2020) were suspected of sediment or combined biota/habitat bioassessment impairment based on previous monitoring. There are a variety of metrics that DEQ uses to characterize the streams in Idaho. These metrics are calculated using data collected through BURP protocol, which helps determine the likely impairment of streams. In suspected sediment impairment cases, the BURP habitat score (SHI) is referenced. The SHI consists of the following habitat measures: instream cover, large organic debris, percent fines less than 2mm in wetted width, embeddedness, number of Wolman size classes, channel shape (undercut), percent bank cover, percent canopy cover, disruptive pressures, and zone of influence. Index scores generated from the measures are adjusted to a common scale using a 1, 2, 3 scoring system. The converted scores are then averaged to provide a single score. Average scores greater than or equal to 2 are fully supporting of aquatic life, while scores less than to 2 are not fully supporting. Additional detail regarding the BURP protocol is discussed in Section 2.3.1.

As a component of the SHI score, the Wolman pebble count can be helpful in determining whether a sediment issue exists. Overall, the data collected with the Wolman pebble count indicates the number of different particle sizes found in a survey sample. If a streambed has a

greater diversity in particle size and a higher Wolman score, this usually indicates that the stream is not likely impaired with sediment. The percent fines (< 2 mm) collected during the Wolman pebble count can also be evidence of a sediment impairment. If a streambed's composition contains particles < 2 mm, it is designated as "sand/silt". Typically, the greater the amount of sand/silt in a stream's substrate, the greater amount of percent fines.

The fine sediment biotic index (FSBI) index score is a component of the BURP macroinvertebrate (SMI) score. It assesses fine sediment (< 2 mm) impacts on macroinvertebrate communities. The FSBI score is the sum of the FSBI value of all taxa from four of the most sediment sensitive macroinvertebrate categories. Each taxon is assigned a fine sediment tolerance category based on a taxon's 75th percentile of occurrence. The more sensitive the taxa is to sediment, the higher the value it is assigned (Relyea et al 2010). Therefore, it is generally assumed that the higher the FSBI score (i.e., ≥ 100), the more sediment sensitive macroinvertebrates are present and the less likely the stream is to have a sediment impairment.

Table 7 presents the six AUs suspected of sediment or combined biota/habitat bioassessments impairment along with their average SHI scores and % fines. Referencing this data, it appears that Ching Creek has the highest FSBI score but a low habitat score. The Wolman score indicates a diverse size sample and the % fines is under the 28% fines target. With exception of the low average SHI score, data collected do not indicate a sediment impairment. However, an SEI was performed on this AU to further evaluate the potential for sediment impairment and add to the lines of evidence for or against sediment impairment, as stream conditions tend to change over time.

Table 7. BURP data for AUs with sediment or combined biota/habitat bioassessment impairments within the Beaver-Camas subbasin.

AU Name	AU Number (17040214SK)	% Bank Stability (Average)	FSBI Score (Average)	% Fines (Average)	Wolman Score (Average)	SHI Habitat Scores (Average)
Ching Creek	006_03	96	87	27	7	1
Crooked/Crab Creek	008_03	76	35	47	0	0
West Camas Creek (Pass Creek)	013_02	94	46	22	4	2
Rattlesnake Creek	016_02	72	57	18	5	2
Threemile Creek (East Threemile Creek)	017_02	82	59	18	5	2
Beaver Creek (Van Noy Canyon Creek)	018_02	68	34	39	3	2

Idaho currently does not have an established protocol or methodology to evaluate sediment metrics collected during BURP assessments to determine sediment caused impairments. In an effort to ascertain the likely cause of combined biota/habitat bioassessments listing, we compared sediment metrics from streams in the Beaver-Camas subbasin with a SHI of 3 to the average scores of the AUs. It is assumed that AUs with an SHI of 3 are the least impacted by anthropogenic sources of sediment. Table 8 shows the average sediment habitat metric score for all BURP sites in the Beaver-Camas subbasin with a SHI of 3, which amounts to a total of four BURP sites.

Table 8. Average scores of 4 streams in the Beaver-Camas subbasin with an SHI of 3.

Stream Habitat Score (SHI)	FSBI (score)	% Fines	Wolman (Score)	Bank Cover (%)
3	71	11	7	88

To further evaluate the impact of sediment on beneficial uses in the Beaver-Camas subbasin, we calculated the percent difference of sediment metrics between streams with an SHI of 3 (Table 9) and streams with combined biota/habitat bioassessment listings. On average, the AUs in Table 9 had FSBI scores that were 49% less than the FSBI scores of AUs with an SHI of 3. All AUs exhibited higher fractions of fine sediment when compared to streams with SHI 3 metrics. On average, the percent fines were 56% higher in the six AUs than in the SHI 3 metric streams. Similar patterns were observed with Wolman scores, where substrate size was 46% smaller (i.e., contained less diversity) in the six AUs than in streams with SHI 3 metrics. The stream bank cover metric from the AUs showed bank cover was greater than the SHI 3 metric for all AUs except Beaver Creek (Van Noy Canyon Creek). Percent differences are presented below in Table 9.

Table 9. Percent metric differences between SHI 3 streams and 2018/2020 IR sediment and/or combined biota/habitat bioassessment listed streams in the Beaver-Camas subbasin.

AU Name	AU Number (ID17040214)	FSBI (% Dif.)	% Fines (% Dif.)	Wolman Score (% Dif.)	Bank Cover (% Dif.)
Ching Creek	006_03	18%	59%	7%	2%
Crooked/Crab Creek	008_03	-103%	77%	—	3%
West Camas Creek (Pass Creek)	013_02	-54%	50%	-63%	8%
Rattlesnake Creek	016_02	-25%	39%	-30%	6%
Threemile Creek (East Threemile Creek)	017_02	-20%	39%	-30%	6%
Beaver Creek (Van Noy Canyon Creek)	018_02	-109%	72%	-117%	-21%

Because sediment issues are assumed to be caused by streambank erosion in the Beaver-Camas subbasin, SEIs were performed on the AUs. The SEI is used to measure streambank stability by estimating erosion rates in and sediment loads to streams. SEI is a qualitative evaluation of channel shape, streambank stability, and riparian vegetation developed using field methods outlined by the Natural Resources Conservation Service (NRCS) as a tool to evaluate erosion condition on streambanks, gullies, and roads (NRCS 1983). When an eroding streambank is identified in the field during an SEI, the streambank height and length are measured and

recorded. Six streambank characteristics are ranked in the field, and corresponding erosion rates and target erosion rates are calculated using a spreadsheet. Streambank erosion values obtained from the sample reach can be extrapolated to adjacent streambanks of similar condition with the same land uses to estimate direct annual sediment inputs from streambank erosion. Streambank erosion up to 20% is considered a natural phenomenon, so when streambank stability is at 80%, load capacity is considered met (Overton et al. 1995).

Ching Creek, Crooked/Crab Creek, Pass Creek (West Camas Creek ID17040214SK013_02), Rattlesnake Creek, East Threemile Creek, and Van Noy Canyon Creek (Beaver Creek ID17040214SK018_02) were all surveyed for bank stability. Of the six stream segments where surveys were completed, only Van Noy Canyon Creek showed streambank stability less than 80%. The SEI performed on Van Noy Canyon Creek measured 24% eroded banks, compared to a target value of 20%. The SEI TMDL methodology is only appropriate when the sources of sediment caused impairment are from in-channel processes. The analysis of FSBI, percent fines, and Wolman scores indicate these streams may be more impacted by sediment compared AUs with an SHI of 3; however, the high percentage of streambank cover does not make these AUs, other than Van Noy Canyon Creek, good candidates for SEI TMDLs. Future assessments of the Beaver-Camas subbasin should determine if other sources of sediment outside of in-channel processes are present or if other stressors are causing impairment. Appendix C presents the sediment load analyses completed for the Beaver-Camas subbasin.

As with most streams in the Beaver-Camas subbasin, Van Noy Canyon Creek is snowmelt and precipitation runoff driven. Van Noy Canyon Creek is a small low flow creek with undeveloped banks. Van Noy Canyon Creek did not exhibit highly erosive banks, so it is assumed widespread erosion throughout the AU does not exist. The SEI noted 20 trampled areas along a 0.38-mile reach. Sediment impacts to Van Noy Canyon Creek appear to result from trampling by wildlife and livestock while accessing the stream. Current sediment loads for all six AUs evaluated are shown in Table 10.

Table 10. Sediment loads from nonpoint sources within the Beaver-Camas subbasin.

AU Name	AU Number (ID17040214SK)	Current Load (tons)	Estimation Method	TMDL Required?
Ching Creek	006_03	25.0/year 0.068/day	Observed Bank Stability and Target Stability Score	No
Crooked/Crab Creek	008_03	18.6/year 0.051day		No
West Camas Creek (Pass Creek)	013_02	0.0/year 0.000/day		No
Rattlesnake Creek	016_02	63.7/year 0.175/day		No
Threemile Creek (East Threemile Creek)	017_02	27.9/year 0.076/day		No
Beaver Creek (Van Noy Canyon Creek)	018_02	313.2/year 0.858/day		Yes

2.3.8 Idaho Department of Fish and Game Fish Data

The IDFG *Fisheries Management Plan 2013-2018* describes the species present, habitat conditions, and fisheries management practices to be applied in the Beaver-Camas subbasin (IDFG 2013a):

> The Beaver/Camas Creek drainage includes Mud Lake, Beaver and Camas creeks as important waters. High density populations of wild cutthroat, rainbow and brook trout exist in most streams in the headwater areas. However, allopatric populations of native cutthroat trout (those without brook trout or rainbow trout) are limited. Despite the broad distribution of rainbow and brook trout, there are a limited number of streams where non-native species can likely be eradicated and subsequently prevented from recolonizing. IDFG will work to identify such candidate streams and work with stakeholders to restore native cutthroat trout populations where feasible and supported by the public. Water conditions limit trout populations in the lower ends of these streams.
>
> Because of the impacted nature of these drainages, the abundance of nonnative fish, and the inability to successfully eradicate nonnative fish and establish native fish, combined with input from our angling public, these drainages will be managed for both native and introduced species. Fish populations and interest in fishing Beaver Creek have declined during the 2000s as a result of the drought. Hatchery supplementation has continued annually through early summer, however, flows and water temperatures have limited the ability to stock throughout the season. Further, abundant willow complexes hamper attempts to fish from the shoreline. A naturally reproducing brook trout population is capable of supporting current fishing pressure in Beaver Creek. Based on these factors, the Department removed Beaver Creek from the stocking rotation, and will rely on natural reproduction to provide a fishery here. Paul Reservoir, which lies in the Beaver Creek drainage, is managed to provide easy access and high catch rates. The reservoir is stocked annually with fingerling cutthroat trout. The program continues to be very successful, with anglers reporting high catch rates and a quality fishing experience.

2.3.9 Status of Beneficial Uses

The majority of current beneficial use support status determinations in the Beaver-Camas subbasin show a lack of beneficial use support, whether those uses are designated or existing. The BURP data in section 2.3.1 show the number of surveys that could not be completed due to lack of access or dry stream conditions. It is difficult to determine the extent that current agricultural water supply withdrawals and natural infiltration of water into the basalt streambed exacerbate these low stream flow issues and contribute to higher stream temperatures resulting in a lack of beneficial use support.

2.3.10 Assessment Unit Summary

The data analysis, literature review, field investigations, and recommendations for changes to the AUs in Category 5 of the Integrated Report are provided below.

2.3.10.1 Assessment Units Addressed in TMDLs

ID17040214SK006_03, Ching Creek—Source to mouth

- Listed for *E. coli* and combined biota/habitat bioassessments in Category 5 of the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: Spring, Little, Ching, and Cottonwood Creeks.

- BURP data collected in 1996, 1998, 2003, and 2013 indicated high index scores for macroinvertebrates but low index scores for fish and habitat.
- SEI data collected in 2018 on Ching Creek indicated no excessive streambank erosion and no load reduction needed.
- Results from water samples collected for bacteria analysis indicated *E. coli* concentrations with a geometric mean of 254 cfu/100 mL. This value exceeds the water quality standards and geometric mean of 126 cfu/100 mL. A bacteria TMDL was developed for this AU.
- Once the TMDL is approved, move this AU to Category 4a for *E. coli*.
- AU should remain in Category 5 for combined biota/habitat biosassessments until additional BURP surveys or other data can determine a potential cause for impairment.

ID17040214SK008_02, Crooked/Crab Creek—Source to mouth

- Listed for combined biota/habitat bioassessments in Category 5 of the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: Crab, Crooked, and McGarry Canyon Creeks.
- BURP data were collected in 1998, 2003, and 2015. The year 1998 was the only year with enough water to capture BURP data, which resulted in low index scores.
- In 2018, the AU did not contain enough water depth to deploy a temperature logger so determining a temperature impairment was not possible.
- AU should remain in Category 5 for combined biota/habitat bioassessments until additional BURP surveys and other data can determine a potential cause for impairment.

ID17040214SK008_03 Crooked/Crab Creek—Source to mouth

- Listed for combined biota/habitat bioassessments and *E. coli* in Category 5 of the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: Crab and Crooked Creeks.
- BURP data collected in 1998 and 2003 resulted in low index scores or no scores.
- In 2018, SEI data on Crab Creek indicated no impairment from excessive streambank erosion and no load reduction needed.
- Temperature logger data recorded June 2018 through November 2018 showed stream temperatures exceeded SS criteria 16 out of 65 days. COLD criteria were exceeded 11 out of 82 days.
- PNV analysis showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths. A new PNV temperature TMDL was developed with this review (section 5).
- In 2018, water samples collected for bacteria analysis indicated *E. coli* concentrations with a geometric mean of 124 cfu/100 mL. This value does not exceed the water quality standards and geometric mean of 126 cfu/100 mL. No bacteria TMDL is needed.
- Delist the AU from Category 5 for *E. coli.*
- Once the TMDL is approved, move AU to Category 4a for temperature.

ID17040214SK009_02 Warm Creek—Cottonwood Creek to mouth and East Camas Creek

- Listed for combined biota/habitat bioassessments and fecal coliform in Category 5 of the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: Saw and Warm Creeks.
- BURP data collected in 1998, 2004, and 2012 resulted in low index scores or no score.
- Temperature logger data recorded June 2018 through November 2018 showed stream temperatures exceeded SS criteria 16 out of 65 days. COLD criteria were not exceeded.
- PNV analysis showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths. A new PNV temperature TMDL was developed with this review (section 5).
- In 2018, water samples collected for bacteria analysis resulted in *E. coli* concentrations with a geometric mean of 90 cfu/100 mL. This value does not exceed the water quality standards and geometric mean of 126 cfu/100 mL. No bacteria TMDL is needed.
- Delist AU from Category 5 for *E. coli.*
- Once the TMDL is approved, move AU to Category 4a for temperature.

ID17040214SK010_03 East Camas Creek

- Listed for *E.* coli in Category 5 of the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary stream, East Camas Creek.
- BURP data collected in 1996, 2001, and 2012 exhibited high index scores for macroinvertebrates and habitat, but fish index scores were low.
- Water samples collected for bacteria analysis indicated *E. coli* concentrations with a geometric mean of 135 cfu/100 mL. This value exceeds the water quality standards and geometric mean of 126 cfu/100 mL. A bacteria TMDL was developed with this review (section 5).
- Once the TMDL is approved, move AU to Category 4a for *E. coli*.

ID17040214SK013_02 West Camas Creek—Source to Targhee National Forest Boundary

- Listed for sedimentation/siltation in Category 5 of the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: Allen Canyon, Alex Draw, West Camas, Pete, Stump, Jug, Castle, Pass, Disaster, Steel, West Steel, and East Steel Creeks.
- Most streams in this AU have exhibited high index scores for macroinvertebrates. Over the years, habitat index scores varied, but fish index scores were consistently low.
- SEI data collected on Pass Creek indicated no impairment from excessive streambank erosion and no load reduction needed.
- AU should remain in Category 5 for sedimentation/siltation until additional BURP surveys or other data analyses can be performed to confirm that there is no sediment impairment within the AU.

ID17040214SK013_03 West Camas Creek—Source to Targhee National Forest Boundary

- Listed for *E. coli* in Category 5 of the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary stream, West Camas Creek.

- BURP data were collected seven times from 2001 through 2013. In 2003 and 2007, the data indicated high index scores for macroinvertebrates and habitat, which resulted in a passing average index score. BURP data collected in the other 5 years resulted in failing average scores regardless of high index scores for macroinvertebrates and habitat.
- Water samples collected for bacteria analysis resulted in *E. coli* concentrations with a geometric mean of 282 cfu/100 mL. This value exceeds the water quality standards and geometric mean of 126 cfu/100 mL. A bacteria TMDL was developed with this review (section 5).
- Once the TMDL is approved, move AU to Category 4a for *E. coli*.

ID17040214SK016_02 Rattlesnake Creek—Source to mouth

- Listed for combined biota/habitat bioassessments in Category 5 of the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: Corral, East Fork Rattlesnake, Spring, and West Fork Rattlesnake Creeks.
- BURP data collection was attempted 14 times (9 times in 1998; 3 times in 2003; and 2 times in 2008) in various tributaries. Approximately half of the index scores were passing and half were failing. Four of the attempts resulted in dry or inaccessible creeks so no scores were calculated.
- Temperature logger data recorded June 2018 through November 2018 showed stream temperatures exceeded SS criteria 16 out of 65 days. COLD criteria was not exceeded.
- PNV analysis in the AU showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths. A new PNV temperature TMDL was developed with this review (section 5).
- SEI data collected on West Fork Rattlesnake Creek indicated no impairment from excessive streambank erosion and no load reduction needed.
- Once the TMDL is approved, move AU to Category 4a for temperature.

ID17040214SK017_02 Threemile Creek—Source to mouth

- Listed for combined biota/habitat bioassessments in Category 5 of the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: East Threemile, West Threemile, Middle Threemile, and Threemile Creeks.
- Seven attempts were made to collect BURP data on this AU. With two attempts, the stream was dry or inaccessible, and no index scores were calculated. In 1998, macroinvertebrates and habitat received high index scores, a low fish index score, but. overall, the stream received a passing score. In 2003, a low index score for habitat and no scores for either macroinvertebrates or fish resulted in a failing average index score.
- SEI data were collected on East Threemile Creek and resulted in no impairment from excessive streambank erosion and no load reduction needed. Numerous beaver dams were observed downstream from the SEI location and older unoccupied beaver dams were observed upstream. Beaver presence may account for the lack of sediment impairment.

- The 2005 temperature TMDL was updated in this document as a result of the PNV analysis (section 5). The updated PNV analysis showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths. In 2018, a Solar Pathfinder survey completed on a stream segment found the AU is deficient in shade.
- This AU should be delisted from Category 5 for combined biota/habitat bioassessments, as temperature is the sole cause of impairment.

ID17040214SK017_03 Threemile Creek—Source to mouth

- Listed for fecal coliform in Category 5 of the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary stream, Threemile Creek.
- BURP data were collected on this AU in 1998, 2004, and 2005. In 1998, macroinvertebrates received a high index score, but low or no index scores for fish and habitat. The stream was dry or inaccessible in 2004 so no scores calculated, but in 2005, the AU received a passing overall score.
- Water samples collected for bacteria analysis in 2018 resulted in *E. coli* concentrations with a geometric mean of 395 cfu/100 mL. This value exceeds the water quality standards and geometric mean of 126 cfu/100 mL. A bacteria TMDL was developed with this review (section 5).
- Once the TMDL is approved, move AU to Category 4a for *E. coli*.

ID17040214SK018_02 Beaver Creek—Miner's Creek to Rattlesnake Creek

- Listed for combined biota/habitat bioassessments in Category 5 of the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: Beaver, Left Fork, Cobble, Picnic Hollow, Thomas Draw, Van Noy Canyon, Calf, Dairy, Telephone, Clay, and Stoddard Creeks.
- BURP data collection was attempted 12 times on this AU in a variety of tributaries. During four attempts, the creeks were dry or inaccessible. Four times the AU exhibited failing index scores, and four times the index scores were passing.
- SEI data collected from Van Noy Canyon Creek resulted in excessive sediment erosion. A sediment TMDL was developed with this review (section 5).
- Once the TMDL is approved, move AU to Category 4a for sedimentation/siltation.

ID17040214SK018_04 Beaver Creek—Miner's Creek to Rattlesnake Creek

- Listed for *E. coli* in Category 5 of the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary stream, Beaver Creek.
- BURP data were collected in 1995 and 2012. The 1995 data collection resulted in low or no index scores. High index scores and a passing average index score resulted in 2012 data collection.
- Water samples collected for bacteria analysis resulted in *E. coli* concentrations with a geometric mean of 334 cfu/100 mL. This value exceeds the water quality standards and geometric mean of 126 cfu/100 mL. A bacteria TMDL was developed with this review (section 5).

- Once the TMDL is approved, move AU to Category 4a for *E. coli.*

ID17040214SK020_02 Beaver Creek—Idaho Creek to Miner's Creek

- Listed for combined biota/habitat bioassessments and *E. coli* in Category 5 of the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: Sheep, Camp, and Flat Creeks.
- BURP data was collected four times on this AU, and in three attempts, flow was too low to sample or the stream was inaccessible. In 1998, all index scores for macroinvertebrates, fish, and habitat were low.
- Temperature loggers were planned for deployment in 2018 to examine the cause of the combined biota/habitat bioassessments listing, but water depth in three of the streams within this AU was too low to adequately monitor for temperature.
- Water samples collected for bacteria analysis in 2018 resulted in *E. coli* concentrations with a geometric mean of 85 cfu/100 mL. This value does not exceed the water quality standards and geometric mean of 126 cfu/100 mL. No bacteria TMDL is needed.
- Delist AU from Category 5 for *E. coli*.
- This AU should remain in Category 5 for combined biota/habitat bioassessments until additional BURP surveys or other data can determine a potential cause for impairment.
- **ID17040214SK021_02 Beaver Creek—Source to Idaho Creek**
- Listed for *E. coli* in Category 5 of the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: Beaver, Long Robbins, Chicken, Kettle, Berry, Horse, Tenpin Gulch, Modoc, West Modoc, East Modoc, and Middle Modoc Creeks.
- BURP data were collected in 1998, 2003, 2004, and 2012, with multiple collections in 1998 and 2003. Two passing average index scores were achieved in 1998 and 2012. All other BURP data collection attempts resulted in failing or no index scores.
- Water samples collected for bacteria analysis resulted in *E. coli* concentrations with a geometric mean of 433 cfu/100 mL. This value exceeds the water quality standards and geometric mean of 126 cfu/100 mL. A bacteria TMDL was developed with this review (section 5).
- Once the TMDL is approved, move AU to Category 4a for *E. coli.*

ID17040214SK023_02 Pleasant Valley Creek—Source to mouth

- Listed for *E. coli* and combined biota/habitat bioassessments in Category 5 of the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: Pleasant Valley, School Section, Headquarters, Ramshorn, Kite Canyon, White Pine Canyon, Swampy Draw, and Brooks Canyon Creeks.
- BURP data collection was conducted 19 times with the most recent in 2013. All index scores from 2002 to 2013 were failing.
- Results from the temperature logger deployed in Pleasant Valley Creek from June 2018 through November 2018 showed stream temperatures exceeded SS criteria 14 out of 66 days. COLD criteria was not exceeded.
- The 2005 temperature TMDL was updated in this document as a result of the PNV analysis (section 5). The updated PNV analysis showed a lack of available shade from

riparian vegetation when compared to shade targets for similar vegetation types and stream widths. In 2018, a Solar Pathfinder survey completed on a stream segment found the AU is deficient in shade.

- Water samples collected for bacteria analysis resulted in *E. coli* concentrations with a geometric mean of 1,170 cfu/100 mL. This value exceeds the water quality standards and geometric mean of 126 cfu/100 mL. A bacteria TMDL was developed with this review (section 5).
- Once the TMDL is approved, move AU to Category 4a for temperature and *E. coli.*

2.3.10.2 Assessment Units Proposed for Delisting

For the Integrated Report, DEQ refers to a delisting as any AU-pollutant combination that is removed from Category 4 or Category 5. A delisting must be supported by a detailed rationale. The following AUs are proposed for delisting in the next Integrated Report:

- **ID17040214SK016_03 Rattlesnake Creek—Source to mouth**
- Listed for combined biota/habitat bioassessments in Category 5 of the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: Corral, Rattlesnake, East Fork Rattlesnake, and Spring Creeks.
- USGS topographic maps (1:24,000k scale—Idmon and Gardner Lake Quadrangles) indicate this creek is intermittent. This AU was listed in error. The first attempt to collect BURP data on this AU occurred in 1998, which was one of the highest water years on record (100-year flood). The BURP results indicated macroinvertebrates, fish, and habitat index scores were low or nonexistent. Based on these low index scores, the AU was listed on the 2002 §303(d) list for combined biota/habitat bioassessments. In 2003, the stream was dry, and no BURP data were collected or index scores calculated.
- EPA approved the first Beaver-Camas subbasin TMDL in 2005. The primary water pollutant was elevated stream temperature. EPA approved temperature TMDLs for 17 AUs and a sediment TMDL for 1 AU. A TMDL was not developed for Rattlesnake Creek because the TMDL characterized the stream with intermittent flows.
- During the 2018, SEI data collection was attempted on Rattlesnake Creek, but evidence suggests the creek is intermittent and/or ephemeral. Photo documentation of the creek highlights rocks, mature sagebrush and other vegetation growing in the middle of a gravel creek bed. There was no evidence of water, flow or moisture in the creek bed and no noticeable visible deposition (Figure 5 and Figure 6).
- SCR beneficial use on this AU is fully supporting, but no BURP data have been collected justifying a fully supporting beneficial use attainment determination. This listing is in error, likely resulting from a time when creeks were designated as water quality-limited segments rather than separated into AUs.
- Due to the intermittent and/or ephemeral condition of this creek, DEQ recommends moving the AU to Category 3 based on insufficient data for use assessment.

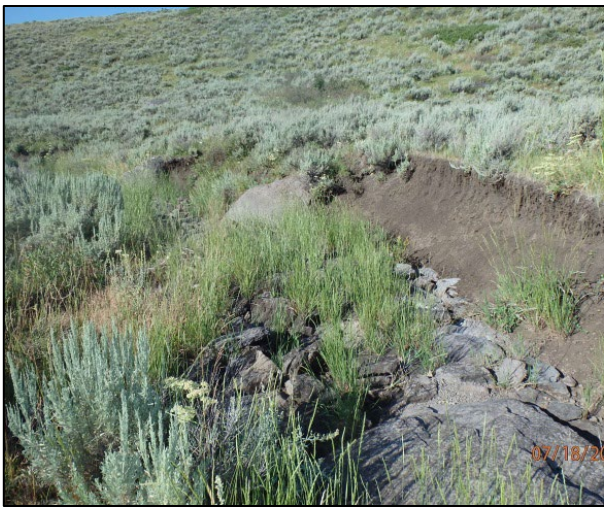


Figure 5. Rattlesnake Creek—Mature vegetation growing in the middle of the streambank.



Figure 6. Rattlesnake Creek—Dry gravel streambed of an intermittent and ephemeral stream.

3 Pollutant Source Inventory

Pollution within the Beaver-Camas subbasin is primarily from temperature, sediment, and bacteria. EPA approved the load allocations for temperature and sediment established in the original Beaver-Camas subbasin TMDL (DEQ 2005a).

3.1 Point Sources

The Beaver-Camas subbasin has no issued National Pollutant Discharge Elimination System (NPDES) or Idaho Pollutant Discharge System (IPDES) permits. No multisector general permits were found in EPA's database for an NPDES/IPDES permit. There are no known point sources, so no wasteload allocation will be developed.

3.2 Nonpoint Sources

Most land use in the Beaver-Camas subbasin adjacent to streams is agriculture. Rangeland makes up the highest percentage. Nonpoint sources of pollution associated with these land uses include increased temperature loading, sediment delivery, and in some cases, elevated bacteria.

The primary source of nonpoint source pollution to the majority of streams in the Beaver-Camas subbasin is solar radiation resulting from riparian habitat degradation. The lack of shade on portions of streams is a significant contributor to beneficial use impairment.

Sediment and *E. coli* also exist as nonpoint sources of pollution within the subbasin. As stabilizing vegetation is removed from streambanks, they become unstable and erode. Elevated *E. coli* levels are often associated with riparian grazing, related streambank erosion, and increased temperature loading.

3.3 Pollutant Transport

Pollutant transport refers to the pathway by which pollutants move from the pollutant source to cause a problem or water quality violation in the receiving water body.

Most temperature pollutant transport is in the form of solar radiation directly to the stream as a result of exposure. Temperature problems result from solar radiation due to a loss of streamside vegetation.

For sediment, transport is a function of particle size and characteristics of the stream channel, such as morphological type, gradient, and width/depth ratio. Smaller particles transport farther in the channel before coming to rest in depositional areas of the stream. Channel characteristics determine the velocity of streamflow. Higher velocities cause further scouring and deposition of particles farther downstream than would occur naturally.

Bacteria pollutant transport is facilitated by wet weather runoff, erosion, seepage, and direct impacts to the stream. Typical sources of bacteria pollution include failing septic systems; decaying matter; agriculture; and pet, livestock, and wildlife waste.

4 Summary of Five-Year Water Quality Monitoring and of Past and Present Pollution Control Efforts

In addition to developing new TMDLs for impaired streams within the Beaver-Camas subbasin, this document contains a 5-year review of previously developed Beaver-Camas subbasin TMDLs to comply with Idaho Code §39-3611(7). The 5-year review evaluates the current water quality status of the streams, for which TMDLs have already been developed and describes current water quality status and monitoring DEQ completed during the 2018 field season. Pollution control efforts that have occurred since the last developed TMDL will also be discussed in this section.

4.1 Five-Year Water Quality Monitoring

ID17040214SK002_05, Camas Creek—Spring Creek to Beaver Creek

- Listed for sedimentation/siltation and temperature in Category 4a (approved TMDLs) in the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary stream, Camas Creek.

- Temperature logger data recorded in Camas Creek from June to November 2018 showed temperatures were exceeded 34 out of 82 days for COLD beneficial use and 19 days out of 68 days for the SS beneficial use.
- The 2005 Beaver-Camas subbasin temperature TMDL was updated due to considerable changes in PNV methodology (section 5). The updated PNV analysis showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths.
- AU should remain in Category 4a for temperature.
- No SEIs were completed on this AU. Adequate stream lengths for SEIs were located on private property, but access was not granted.
- AU should remain in Category 4a for sedimentation/siltation. Additional BURP surveys and other data are needed to delist the AU from Category 5 for sedimentation/siltation.

ID17040214SK010_02, East Camas Creek

- Listed for temperature in Category 4a (approved TMDL) in the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary stream, Larkspur Creek.
- The 2005 Beaver-Camas subbasin temperature TMDL was updated due to considerable changes in PNV methodology (section 5). The updated PNV analysis showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths.
- AU should remain in Category 4a for temperature.

ID17040214SK010_03, East Camas Creek

- Listed for temperature in Category 4a (approved TMDL) in the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary stream, East Camas Creek.
- BURP data collected in 1996, 2001, and 2012 exhibited high index scores for macroinvertebrates and habitat, but fish index scores were low.
- Temperature logger data recorded May 2018 through November 2018 showed stream temperatures exceeded SS criteria 28 out of 98 days. COLD criteria were not exceeded.
- The 2005 Beaver-Camas subbasin temperature TMDL was updated due to considerable changes in PNV methodology (section 5). The updated PNV analysis showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths. In 2018, a Solar Pathfinder survey completed on a stream segment found the AU deficient in shade.
- AU should remain in Category 4a for temperature.

ID17040214SK011_02, East Camas Creek—Source to Larkspur Creek

- Listed for temperature in Category 4a (approved TMDL) in the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: East Camas, Mule Meadows, and Spruce Creeks.

- Temperature logger data recorded June 2018 through November 2018 showed stream temperatures exceeded SS criteria 16 out of 81 days. COLD criteria were not exceeded.
- The 2005 Beaver-Camas subbasin temperature TMDL was updated due to considerable changes in PNV methodology (section 5). The updated PNV analysis showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths. In 2018, a Solar Pathfinder survey completed on a stream segment found the AU deficient in shade.
- AU should remain in Category 4a for temperature.

ID17040214SK011_03, East Camas Creek—Source to Larkspur Creek

- Listed for temperature in Category 4a (approved TMDL) in the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary stream, East Camas Creek.
- Temperature logger data recorded June 2018 through November 2018 showed stream temperatures exceeded SS criteria 10 out of 80 days. COLD criteria were not exceeded.
- The 2005 Beaver-Camas subbasin temperature TMDL was updated due to considerable changes in PNV methodology (section 5). The updated PNV analysis showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths. In 2018, a Solar Pathfinder survey completed on a stream segment confirmed the AU is deficient in shade.
- AU should remain in Category 4a for temperature.

ID17040214SK012_03, West Camas Creek

- Listed for temperature in Category 4a (approved TMDL) in the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary stream, West Camas Creek.
- Temperature logger data recorded May 2018 through November 2018 showed stream temperatures exceeded SS criteria 46 out of 94 days. COLD criteria were exceeded 1 out of 90 days.
- The 2005 Beaver-Camas subbasin temperature TMDL was updated due to considerable changes in PNV methodology (section 5). The updated PNV analysis showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths.
- AU should remain in Category 4a for temperature.

ID17040214SK013_02, West Camas Creek—Source to Targhee National Forest Boundary

- Listed for temperature in Category 4a (approved TMDL) in the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: Allen Canyon, Alex Draw, West Camas, Pete, Stump, Jug, Castle, Pass, Disaster, Steel, West Steel, and East Steel Creeks.
- Streams in this AU exhibited high index scores for macroinvertebrates. Over the years, habitat index scores varied, but fish index scores were consistently low.

- The 2005 Beaver-Camas subbasin temperature TMDL was updated due to considerable changes in PNV methodology (section 5). The updated PNV analysis showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths. In 2018, a Solar Pathfinder survey completed on a stream segment found the AU deficient in shade.
- AU should remain in Category 4a for temperature.

ID17040214SK013_03, West Camas Creek—Source to Targhee National Forest Boundary

- Listed for temperature in Category 4a (approved TMDL) in the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary stream, West Camas Creek.
- BURP data were collected seven times from 2001 through 2013. In 2003 and 2007, the data collected resulted in high index scores for macroinvertebrates and habitat. These high index scores resulted in a passing average index score. BURP data collected in the other 5 years resulted in failing average scores regardless of high index scores for macroinvertebrates and habitat.
- Temperature logger data recorded in West Camas Creek from May to November 2018 showed temperature for the COLD beneficial use was not exceeded. Temperatures for the SS beneficial use were exceeded 41 out of 95 days.
- The 2005 Beaver-Camas subbasin temperature TMDL was updated due to considerable changes in PNV methodology (section 5). The updated PNV analysis showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths. In 2018, a Solar Pathfinder survey completed on a stream segment found the AU deficient in shade.
- AU should remain in Category 4a for temperature.

ID17040214SK017_02, Threemile Creek—Source to Mouth

- Listed for temperature in Category 4a (approved TMDL) in the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: East Threemile, West Threemile, Middle Threemile, and Threemile Creeks.
- Seven attempts to collect BURP data on the AU occurred; two attempts resulted in no index scores due to an inaccessible or dry stream. In 1998, macroinvertebrates and habitat received high index scores; the fish index score was low, but the stream received a passing score. In 2003, there was a low index score for habitat and no scores for either macroinvertebrates or fish resulting in a failing average index score.
- Temperature logger data recorded June 2018 through November 2018 showed stream temperatures exceeded SS criteria 17 out of 66 days. COLD criteria were not exceeded.
- The 2005 Beaver-Camas subbasin temperature TMDL was updated due to considerable changes in PNV methodology (section 5). The updated PNV analysis showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths. In 2018, a Solar Pathfinder survey completed on a stream segment found the AU deficient in shade.

- AU should remain in Category 4a for temperature.

ID17040214SK017_03, Threemile Creek—Source to Mouth

- Listed for temperature in Category 4a (approved TMDL) in the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary stream, Threemile Creek.
- BURP data were collected in 1998, 2004, and 2005. In 1998, macroinvertebrates received a high index score but low or no index scores for fish and habitat. The stream was dry or inaccessible in 2004 so no scores were calculated, but the AU received a passing overall score in 2005.
- Temperature logger data recorded in Threemile Creek from May 2018 to November 2018 showed temperatures were exceeded 6 out of 90 days for COLD beneficial use and 47 days out of 94 days for the SS beneficial use.
- The 2005 Beaver-Camas subbasin temperature TMDL was updated due to considerable changes in PNV methodology (section 5). The updated PNV analysis showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths.
- AU should remain in Category 4a for temperature.

ID17040214SK018_02, Beaver Creek—Miner's Creek to Rattlesnake Creek

- Listed for temperature in Category 4a (approved TMDL) in the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: Beaver, Left Fork, Cobble, Picnic Hollow, Thomas Draw, Van Noy Canyon, Calf, Dairy, Telephone, Clay, and Stoddard Creeks.
- BURP data collection was attempted 12 times on this AU in a variety of creeks. In four attempts, the creeks were dry or inaccessible, four times the creeks had failing index scores, and four times the index scores were passing.
- The 2005 Beaver-Camas subbasin temperature TMDL was updated due to considerable changes in PNV methodology (section 5). The updated PNV analysis showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths. In 2018, a Solar Pathfinder survey completed on a stream segment found the AU deficient in shade.
- AU should remain in Category 4a for temperature.

ID17040214SK018_04, Beaver Creek—Miner's Creek to Rattlesnake Creek

- Listed for temperature in Category 4a (approved TMDL) in the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary stream, Beaver Creek.
- BURP data were collected in 1995 and 2012. In 1995, BURP data resulted in low or no index scores, and in 2012, the AU resulted in high index scores and a passing average index score.
- The 2005 Beaver-Camas subbasin temperature TMDL was updated due to considerable changes in PNV methodology (section 5). The updated PNV analysis did not show a lack

of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths. In 2018, a Solar Pathfinder survey completed on a stream segment found the AU is not deficient in shade on the segment surveyed. Although the PNV analysis did not identify a shade deficit, additional monitoring is needed to delist this AU.

- AU should remain in Category 4a for temperature until further investigations show full support of beneficial uses.

ID17040214SK020_03, Beaver Creek—Idaho Creek to Miner's Creek

- Listed for temperature in Category 4a (approved TMDL) in the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary stream, Beaver Creek.
- Temperature logger data recorded in Beaver Creek from June 2018 to November 2018 showed stream temperatures exceeded SS criteria 30 out of 75 days. COLD criteria were not exceeded.
- The 2005 Beaver-Camas subbasin temperature TMDL was updated due to considerable changes in PNV methodology (section 5). The updated PNV analysis did not show a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths. In 2018, a Solar Pathfinder survey completed on a stream segment confirmed the AU is not deficient in shade on the segment surveyed. Although the PNV analysis did not identify a shade deficit, additional monitoring is needed to delist this AU.
- AU should remain in Category 4a for temperature until further investigations show full support of beneficial uses.

ID17040214SK021_02, Beaver Creek—Source to Idaho Creek

- Listed for temperature in Category 4a (approved TMDL) in the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary streams: Beaver, Long, Robbins, Chicken, Kettle, Berry, Horse, Tenpin Gulch, Modoc, West Modoc, East Modoc, and Middle Modoc Creeks.
- BURP data were collected in 1998, 2003, 2004, and 2012, with multiple collections in 1998 and 2003. Two passing average index scores were achieved in 1998 and 2012. All other BURP data collection attempts resulted in low or no index scores.
- The 2005 Beaver-Camas subbasin temperature TMDL was updated due to considerable changes in PNV methodology (section 5). The updated PNV analysis showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths. In 2018, a Solar Pathfinder survey completed on a stream segment found the AU deficient in shade.
- AU should remain in Category 4a for temperature.

ID17040214SK021_03, Beaver Creek—Source to Idaho Creek

- Listed for temperature in Category 4a (approved TMDL) in the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of tributary stream, Beaver Creek.

- Temperature logger data recorded May 30, 2018, through November 19, 2018, showed stream temperatures exceeded SS criteria 44 out of 95 days. COLD criteria were not exceeded.
- The 2005 Beaver-Camas subbasin temperature TMDL was updated due to considerable changes in PNV methodology (section 5). The updated PNV analysis did not show a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths. Although the PNV analysis did not identify a shade deficit, additional monitoring is needed to delist this AU.
- AU should remain in Category 4a for temperature until further investigations show full support of beneficial uses.

ID17040214SK024_02, Huntley Canyon Creek—Source to Mouth

- Listed for temperature in Category 4a (approved TMDL) in the 2018/2020 Integrated Report (DEQ 2020).
- AU consists of the tributary stream: Huntley Canyon Creek.
- Temperature logger data recorded May 2018 through November 2018 showed stream temperatures exceeded SS criteria 31 out of 91 days. COLD criteria were not exceeded.
- The 2005 Beaver-Camas subbasin temperature TMDL was updated due to considerable changes in PNV methodology (section 5). The updated PNV analysis showed a lack of available shade from riparian vegetation when compared to shade targets for similar vegetation types and stream widths.
- AU should remain in Category 4a for temperature.

4.2 Past and Present Pollution Control Efforts

Since completing the Beaver-Camas subbasin TMDL (DEQ 2005a), DEQ has regularly monitored the stream water and habitat quality in the subbasin. As described in Table 11, numerous research and restoration activities have been completed or are currently being implemented by local, state, private, and federal agencies. Further details and information regarding these activities can be acquired from the managing agency or responsible group.

Table 11. Best Management Practices implemented with the Beaver-Camas subbasin from 2003 to 2019.

Best Management Practice	BMP Number	Units	Total
Access Control	472	Acre	298.7
Brush Management	314	Acre	973.0
Aquatic Organism Passage	396	—	2
Fence	382	Feet	47,228.0
Heavy Use Area Protection	561	Acre	3.0
Pipeline	516	Feet	21,871.0
Prescribed Grazing	528	Acre	3,177.6
Pumping Plant	533	—	2.0
Riparian Forest Buffer	391	Acre	57.0
Road/Trail/Landing Closure and Treatment	654	Feet	100,320.0
Streambank and Shoreline Protection	580	Feet	400.0
Stream Crossing	578	—	7.0
Stream Habitat Improvement and Management	395	Acre	19.0
Structure for Water Control	587	—	1.0
Tree/Shrub Establishment	612	Acre	23.0
Water Well	642	—	1.0
Watering Facility	614	—	9.0

4.2.1 United States Forest Service Projects—Caribou-Targhee National Forest

Cottonwood Creek Willow Planting (2017)—Willows were planted, and tree branches were used to stabilize an eroding cutbank (Figure 7 and Figure 8).



Figure 7. Cottonwood Creek (before)—Eroded cutbank located at a bend (Source: USFS).



Figure 8. Cottonwood Creek (after)—Willows planted and tree branches placed on eroded bank for stabilization (Source: USFS).

Modoc Creek Beaver Dam Analogues (2017/2018)—The USFS and IDFG explored ways to reestablish beaver to aid in rehabilitating degraded streams and prolong water retention. Streams with historic beaver habitat and plentiful willow were targeted. Beaver dam analogues and a starter lodge were built on Modoc Creek in 2017 and 2018 to create ponds or cover to encourage transplanted nuisance beavers to remain in the areas where they are relocated (Figure 9).



Figure 9. Modoc Creek—Completed beaver dam analogue for relocated beavers to maintain and improve the structure.

Stoddard Creek Dispersed Camping and Off-Highway Vehicles Control (2016)—This project resulted in approximately 3 acres of improvement and included dispersed camping management in a popular area along Stoddard Creek. Boulders were placed between several of

the dispersed camping areas and the stream to provide a buffer. Willows were transplanted along 200 feet of Stoddard Creek to improve aquatic habitat (Figure 10). Several unauthorized user-created all-terrain vehicle trails/roads were also obliterated.



Figure 10. Stoddard Creek—Willows installed along the creek banks (Source: USFS).

Corral Creek Dam Removal and Rehabilitation Project (2012)—Located approximately 8 miles east of Spencer, Idaho, in Clark County, the Caribou-Targhee National Forest implemented the Corral Creek dam and rehabilitation project in 2012 to facilitate natural stream function, improve dam stabilization, and provide fish passage. Before rehabilitation, the dam had been nonfunctional for nearly 50 years and eventually failed in 1967 causing excessive environmental damage.

The Corral Creek dam was roughly 162 feet long x 6 feet wide with a slope length of 45 feet from the top to the base on each side (Figure 11). The side slopes were measured at 46% (24.7°). The culvert was roughly 18 inches deep and approximately 88 feet long. The culvert outlet was considered a fish barrier because the culvert was perched 6–10 inches above the water surface. The slope of the culvert was not measured; however, due to the 88-foot length and continuous high water velocities though the culvert, this condition added to the fish and aquatics barrier.

At the inlet, a control structure below water level appeared partially plugged or partially closed. The plug caused water to backup into the pond upstream. Due to changes in inflow, the size of the pond changed throughout the year causing a reservoir effect around the margins, demonstrated by a lack of waterside vegetation.

In 2012, the dam was removed, and the water impoundment was converted to a naturalized lake feature and channel outlet (Figure 12). The project removed most of the upper portions of the dam, including the culvert, and reconstructed the old spillway to become the new stream channel. Boulders on site were used to create a series of steps or plunges to mimic natural channel morphology of a Rosgen “B” type channel at the outlet. This design connected to the

existing channel and provided long-term stability, aquatic passage, and public safety without maintenance.



Figure 11. Corral Creek before dam removal (Source: USFS).



Figure 12. Corral Creek—5 years after dam removal and rehabilitation (Source: USFS).

Kay Creek and Cottonwood Creek Crossing Upgrades (2011)—This project was completed in partnership with Trout Unlimited and was one component of a larger project focused on improving road and watershed conditions on the Cottonwood Loop Road in the Cottonwood drainage of the East Camas subwatershed. In 2003, increased runoff became a concern when the Winslow Fire burned in the drainage. Postfire investigations revealed undersized structures and aquatic barriers of the stream crossings on Kay and Cottonwood Creeks. Efforts to improve these conditions using stimulus funding began in 2009 with postfire restoration. The restoration focused on graveling 8.9 miles of the Cottonwood Loop Road (FS 026) in cooperation with Clark County. Graveling was completed in 2010 and improved road drainage conditions, reduced unnecessary erosion, and protected water quality. Kay Creek is a heavily braided channel across an alluvial fan. At one point, the creek had abandoned the channel leading to the bridge and created a secondary channel that drained to a 2-foot diameter culvert. The culvert was replaced

with a new 28-foot bridge exceeding the 11.5-foot bankfull width (Figure 13–Figure 16). The old bridge is now used as an overflow channel.

Located on an alluvial fan, the original 12-foot Cottonwood Bridge was installed in 1961 over a 22-foot bankfull width channel. The undersized bridge restricted flow and frequently backed up spring runoff causing flooding and washing out of various portions of the road. The undersized bridge was replaced with a 28-foot bridge to alleviate restricted flow (Figure 17–Figure 22). Above and below both bridges, four acres of stream improvements were needed to restore stream function and aquatic passage and improve water quality.



Figure 13. Kay Creek (before)—2-foot diameter culvert inlet (Source: USFS).



Figure 14. Kay Creek (after)—28-foot bridge with restored stream function and aquatic passage (i.e., inlet) (Source: USFS).



Figure 15. Kay Creek (before)—2-foot diameter culvert outlet showing the aquatic barrier that was removed (Source: USFS).



Figure 16. Kay Creek (after)—28-foot bridge with restored stream function and aquatic passage (i.e., outlet) (Source: USFS).



Figure 17. Cottonwood Creek (before)—12-foot-long failing bridge during a high flow with limited freeboard (Source: USFS).



Figure 18. Cottonwood Creek (after)—28-foot-long bridge with restored stream function and aquatic passage (i.e., outlet) (Source: USFS).



Figure 19. Cottonwood Creek (before)—High spring runoff with extensive bank erosion on the inlet that jeopardized the road (Source: USFS).



Figure 20. Cottonwood Creek (after)—Stream upgrades restored channel dimensions and stability, which improved water quality (Source: USFS).



Figure 21. Cottonwood Creek (before)—Road condition (Source: USFS).



Figure 22. Cottonwood Creek (after)—Road condition (Source: USFS).

Stoddard Creek Road Crossing Improvement and Historic Channel Reactivation (2009)—The Stoddard Creek road/stream ford was improved by armoring the ford and elevating the road approach with gravel. This improvement reduced the risk of water flooding the road during spring runoff when creek overflows the streambanks (Figure 23 and Figure 24). Stream flow was restored to a historic channel of Stoddard Creek to improve streambank stability, willow/overhanging cover, and aquatic habitat. In the past, the stream was straightened downstream of the road crossing. Willows and riparian habitat were limited. Reactivating the historic channel increased the overall available aquatic habitat. The stream was directed back into a natural channel containing abundant riparian vegetation and enhanced stream habitat (e.g., riffle/pool complex), and the old channel was filled in (Figure 25 and Figure 26).



Figure 23. Stoddard Creek (before)—Original approach and road crossing grade (Source: USFS).



Figure 24. Stoddard Creek (after)—Stream ford was armored and graveled to elevate the road approach (Source: USFS).



Figure 25. Stoddard Creek (before)—Straightened reach downstream of the road crossing. Note lack of willows (Source: USFS).



Figure 26. Stoddard Creek (after)—Streamflow restored to the right channel containing willows. Old channel filled in (Source: USFS).

Miner's Creek Stream Restoration (2008)—Miners Creek changed significantly in the 1950s. Before 1951, the stream was diverted from its willow-dominated channel onto the valley floor. A second diversion occurred between 1951 and 1960 immediately downstream of an old road crossing. In both cases, a relatively straight and deep gully developed parallel to the original stream channel. In 2008, two gully plugs were constructed to elevate the stream flow back into the original stream channel. Several grade control structures, made of boulders, were also installed where the existing and original channels joined back together. The gully was converted into an overflow channel with several small ponds and wetlands to dissipate energy during high flow events. A number of headcuts and streambanks were also established by placing rock, reshaping, and adding large woody debris to the streambanks. The culvert located just downstream of the channel restoration site was a barrier to aquatic passage due to a long drop (Figure 27). The stream channel at the culvert outlet was raised with boulders and gravels to

eliminate the large drop and allow aquatic organism passage (Figure 28). Approximately 15 acres were improved with this project.



Figure 27. Miner's Creek (before)—Culvert outlet had a several foot drop (Source: USFS).



Figure 28. Miner's Creek (after)—Gravel and boulders fill in the eroded area under the outlet (Source: USFS).

Stoddard Creek Stream Crossing Improvements (2008)—This project improved travel management and watershed conditions in the Stoddard Creek area by improving two stream crossings, obliterating four user-created stream crossings, placing boulders to provide a stream buffer at several dispersed camping areas along the stream, and closing over 3 miles of unauthorized trails with boulder placement (Figure 29 and Figure 30). The stream crossing on Forest Service Road 002 at Stoddard Creek was improved by armoring a crossing and obliterating two user-created crossings (Figure 31 and Figure 32).



Figure 29. Stoddard Creek (before)—Unauthorized trail denigraded the stream banks causing the stream to flood Picnic Hollow Road (Source: USFS).



Figure 30. Stoddard Creek (after)—Boulder placement raised and armored the stream and keeps the water inside the banks (Source: USFS).



Figure 31. Stoddard Creek (before)—Unauthorized trail through a wetland and on a hillside in the Picnic Hollow area (Source: USFS).



Figure 32. Stoddard Creek (after)—Trail and wetland area were restored when all-terrain vehicle access was removed (Source: USFS).

West Indian Creek Beaver Relocation (2007)—Two beavers, a male and a pregnant female, were captured and transported from the Island Park Ranger District to West Indian Creek on May 23, 2007 (Figure 33). One month later, it was discovered the beavers built a dam less than 0.25 miles from where they were released. After several years of monitoring, the beaver's activity began to restore the creek's channel complexity by raising the water table, storing water and sediment behind the beaver dam and throughout the floodplain.



Figure 33. West Indian Creek—Relocated beavers (Source: USFS).

West Indian and West Rattlesnake Creeks Fish Ladders (2007)—A West Indian Creek culvert was retrofitted with a "fish ladder" to assist the passage of Yellowstone Cutthroat Trout and improve and expand their usable habitat (Figure 34 and Figure 35). The same operation, on a slightly larger scale, was completed on West Rattlesnake Creek.



Figure 34. West Indian Creek (before)—Culvert with fish barrier (Source: USFS).



Figure 35. West Indian Creek (after)—Retrofitted culvert with fish ladder (Source: USFS).

West Indian Creek Livestock Bumper Rails (2007)—A livestock "bumper rail" was constructed along West Indian Creek in June 2007 to force cattle to avoid a cutbank that needed restored (Figure 36). A similar project was completed on West Camas Creek 10 years prior, and it was very successful.



Figure 36. West Indian Creek—Bumper rail installation (Source: USFS).

Allan Canyon Road Improvement and Stream Restoration (2007)—Allan Canyon Creek, tributary to West Camas Creek, had eroded and each year was sending increasingly larger spring flows down an old road bed (Figure 37). This excessive erosion increased sediment to West Camas Creek. Before Allan Canyon Creek entered West Camas Creek, the diverted water

overwhelmed several undersized culverts resulting in more erosion as it traveled along a ditch for 300–400 feet until intersecting with a larger culvert. The high flows on the old road had eroded approximately 200–300 cubic yards of material and transported it downstream. This project restored channel function in Allan Canyon Creek by keeping the stream in the natural channel and prevented the water from further eroding the old road bed (Figure 38). Three of four culverts were replaced with larger culverts to handle spring flows on the Clark County jurisdiction road (FDR 006). One of the four culverts that conveyed flows for Allan Canyon Creek was also enlarged to handle flows and aquatic passage (Figure 39).



Figure 37. Allan Canyon Creek (before)— In 2006 spring high flow event, floodwaters from Allan Canyon were captured by an old road. High flows caused a gully to erode and floodwaters traveled to the main road (FDR 006), overwhelming undersized culverts.



Figure 38. Allan Canyon Creek (after)— Natural floodplain topography was reconstructed, and the gully was filled with over 60 cubic yards of material. Barrier boulders were repositioned to exclude future motorized travels and disperse recreation down the old road. Wood-straw was also spread on the ground as groundcover to aid in site recovery (Source: USFS).



Figure 39. Allan Canyon Creek—A new 64- x 43-inch arched pipe replaced the undersized 36-inch round pipe (Source: USFS).

Crooked and Corral Creeks Road Barriers (2007)—Closure fencing was constructed to prevent vehicles from accessing unauthorized roads and trails to and through Crooked and Corral Creeks (Figure 40). Over 16 miles of unauthorized roads were closed as a result of the project.



Figure 40. Crooked and Corral Creeks—Closure fence construction (Source: USFS).

West Camas Creek Soil Stabilization (2007)—This seeding project to encourage soil stabilization was located in the West Camas Creek drainage, near Stump Creek (Figure 41).



Figure 41. West Camas Creek—Preparing the soil to plant seeds (Source: USFS).

4.2.2 United States Bureau of Land Management

Unnamed Spring Exclosure–West Monida Allotment (2019)—This upcoming project will construct a new exclosure on an unnamed spring in the West Monida Allotment to keep livestock from the spring area (0.2 miles and 0.24 riparian-wetland acres) (Figure 42).

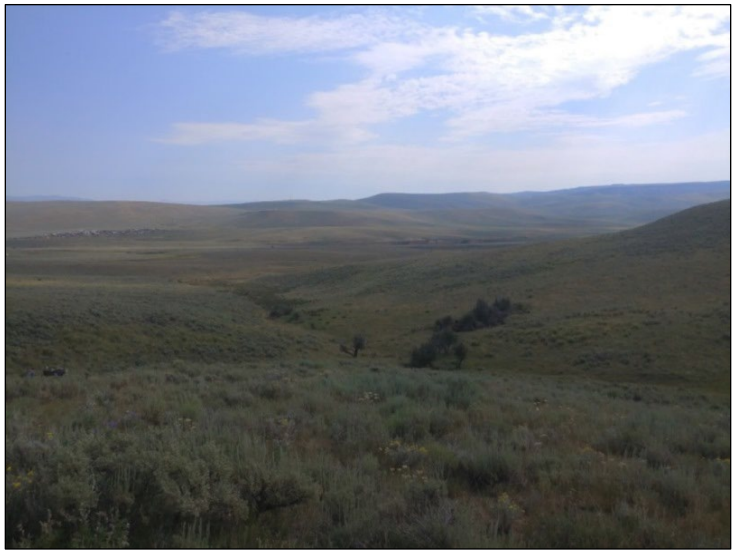


Figure 42. Unnamed Spring (West Monida Allotment)—Riparian area, from the top of the reach, looking east (Source: BLM).

Camas Creek Exclosure–East Dubois Allotment (2015)—A livestock exclosure was constructed on an 0.15-mile section of Camas Creek to protect approximately 0.55 acres of riparian wetland vegetation in the East Dubois grazing allotment (Figure 43).



Figure 43. Camas Creek (East Dubois Allotment)—Upper end of the reach looking upstream (Source: BLM).

Beaver Creek Exclosure Expansion–West Monida Allotment (2009)—This project expanded an existing livestock exclosure located at the headwaters of Beaver Creek in the West Monida Allotment. Built in the early 1990s, the original exclosure protected approximately 0.83 miles of stream (9.75 riparian wetland acres) (Figure 44). The expansion excluded an additional 0.34 miles on an unnamed tributary to Beaver Creek (1.3 riparian wetland acres) from livestock grazing (Figure 45).



Figure 44. Beaver Creek (West Monida Allotment)—Original exclosure, middle of the Beaver Creek reach (below major spring complex area), looking upstream (Source: BLM).



Figure 45. Unnamed tributary to Beaver Creek (West Monida Allotment)—Exclosure expansion, lower end, upper extent of flow, looking downstream (Source: BLM).

4.2.3 Natural Resources Conservation Service

Camas Creek Conservation Plan (2001–2008)—Two projects were implemented on Camas Creek. The first project, completed in January 2003, implemented the grazed range and wildlife conservation elements. Grazed range conservation practices included installing fencing (13,059 feet), pipeline (19,871 feet), and six troughs and implementing brush management (973 acres) and prescribed grazing (3,116 acres). Wildlife conservation practices included installing a well and pumping plant, fencing (18,426 feet), riparian forest buffers (57 acres), and planting trees and/or shrubs (20 acres). Use exclusion practices were implemented on 232 acres and on 3 acres of heavy use area. The second project included a continuous conservation reserve program that implemented the grazed range conservation element on an additional 61.6 acres. This phase installed a pumping plant, fencing (15,743 feet), pipeline (2,000 feet), and three troughs. Use exclusion was implemented on 61.6 acres. This phase was completed in January 2008, and by October 2008, the riparian recovery effort was well underway due to the presence of beaver in the area. A 2016 site visit revealed the riparian forest buffer and trees that had been planted were fully established and thriving (Figure 46).

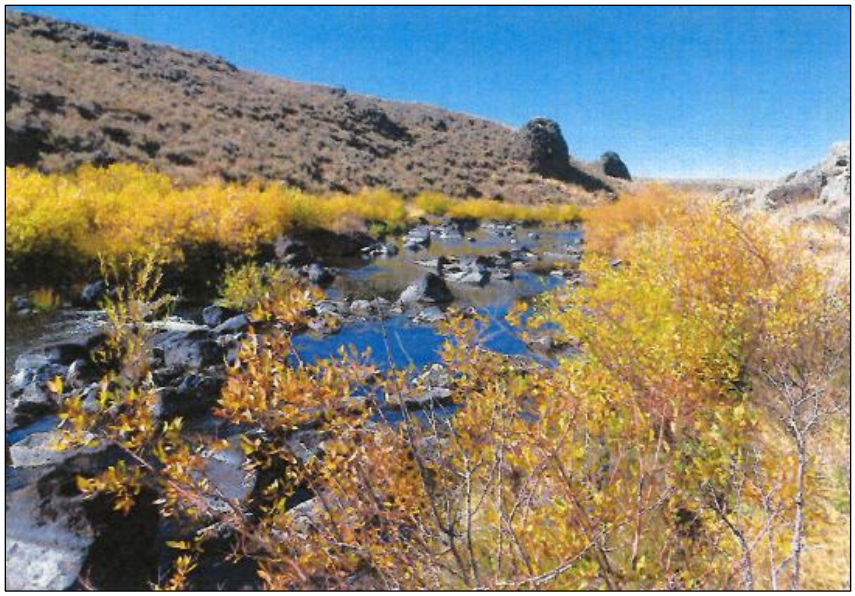


Figure 46. Camas Creek—Healthy riparian forest buffer along the streambank (2016) (Source: NRCS).

5 Total Maximum Daily Loads

A TMDL prescribes an upper limit (i.e., load capacity) on discharge of a pollutant from all sources to ensure water quality standards are met. It further allocates this load capacity among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation, and nonpoint sources, each of which receives a load allocation. Natural background contributions, when present, are considered part of the load allocation but are often treated separately because they represent a part of the load not subject to control. Because of uncertainties about quantifying loads and the relation of specific loads to attaining water quality standards, the rules regarding TMDLs (40 CFR 130) require a margin of safety (MOS) be included in the TMDL. Practically, the MOS and natural background are both reductions in the load capacity available for allocation to pollutant sources.

Load capacity can be summarized by the following equation:

LC = MOS + NB + LA + WLA = TMDL

Where:

LC = load capacity
MOS = margin of safety
NB = natural background
LA = load allocation
WLA = wasteload allocation

The equation is written in this order because it represents the logical order in which a load analysis is conducted. First, the load capacity is determined. Then the load capacity is broken

down into its components. After the necessary MOS and natural background, if relevant, are quantified, the remainder is allocated among pollutant sources (i.e., the load allocation and wasteload allocation). When the breakdown and allocation are complete, the result is a TMDL, which must equal the load capacity.

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, determining critical conditions can be more complicated than it may initially appear.

Another step in a load analysis is quantifying current pollutant loads by source. This step allows for the specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary for pollutant trading to occur. A load is fundamentally a quantity of 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 (40 CFR 130.2). These other measures must still be quantifiable and relate to water quality standards, but they allow flexibility to deal with pollutant load 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.

5.1 Temperature TMDL

5.1.1 Instream Water Quality Targets

For the Beaver-Camas subbasin temperature TMDLs, DEQ used a PNV approach. Idaho's water quality standards include a provision (IDAPA 58.01.02.200.09) that if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered a violation of water quality standards. In these situations, natural conditions essentially become the water quality standard, and for temperature TMDLs, the natural level of shade and channel width become the TMDL target. The instream temperature that results from attaining these conditions is consistent with the water quality standards, even if it exceeds numeric temperature criteria. Appendix B further discusses the water quality standards and natural background provisions.

The PNV approach is described briefly below. The procedures and methodologies to develop PNV target shade levels and to estimate existing shade levels are described in detail in *The Potential Natural Vegetation (PNV) Temperature Total Maximum Daily Load (TMDL) Procedures Manual* (Shumar and de Varona 2009). The manual also provides a more complete discussion of shade and its effects on stream water temperature.

5.1.1.1 Factors Controlling Water Temperature in Streams

Several important factors contribute heat to a stream: ground water temperature, air temperature, and direct solar radiation (Poole and Berman 2001). Of these, direct solar radiation is the source of heat that is most controllable. The parameters that affect the amount of solar radiation hitting a stream throughout its length 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 (i.e., structure) affects riparian vegetation density and water storage in the alluvial aquifer. Riparian vegetation and channel morphology are the factors influencing shade that are most likely to have been influenced by anthropogenic activities and can be most readily corrected and addressed by a TMDL.

Riparian vegetation provides a substantial amount of shade on a stream by virtue of its proximity. However, depending on how much vertical elevation surrounds the stream, vegetation further away from the riparian corridor can also provide shade. We can measure the amount of shade that a stream receives in a number of ways. Effective shade (i.e., that shade provided by all objects that intercept the sun as it makes its way across the sky) can be measured in a given location with a Solar Pathfinder or with other 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 stream 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 can be measured using a densiometer or estimated visually either on site or using aerial photography. All of these methods provide information about how much of the stream surface is shaded and how much is exposed to direct solar radiation.

5.1.1.2 Potential Natural Vegetation for Temperature TMDLs

PNV along a stream is the riparian plant community that could grow to an overall mature state, although some level of natural disturbance is usually included in the development and use of shade targets. Vegetation can be removed by disturbance either naturally (e.g., wildfire, disease/old age, wind damage, wildlife grazing) or anthropogenically (e.g., domestic livestock grazing, vegetation removal, and erosion). The idea behind PNV as targets for temperature TMDLs is that PNV provides a natural level of solar load to the stream without any anthropogenic removal of shade-producing vegetation. Vegetation levels less than PNV (except for natural levels of disturbance and age distribution) result in the stream heating up from anthropogenically created additional solar inputs.

DEQ can estimate PNV (and target shade) from models of plant community structure (shade curves for specific riparian plant communities), and we can measure or estimate existing canopy cover or shade. Comparing the two (target and existing shade) tells us how much excess solar load the stream is receiving and what potential exists to decrease solar gain. Streams disturbed by wildfire, flood, or some other natural disturbance will be at less than PNV and require time to recover. Streams that have been disturbed by human activity may require additional restoration above and beyond natural recovery.

Existing and PNV shade was converted to solar loads from data collected on flat-plate collectors at the nearest National Renewable Energy Laboratory (NREL) weather stations collecting these data. In this case, we used a combination of the Pocatello, Idaho, and Helena, Montana, stations. The difference between existing and target solar loads, assuming existing load is higher, is the load reduction necessary to bring the stream back into compliance with water quality standards (Appendix B).

PNV shade and the associated solar loads are assumed to be the natural condition; thus, stream temperatures under PNV conditions are assumed to be natural (so long as no point sources or other anthropogenic sources of heat exist in the watershed) and are considered to be consistent with Idaho's water quality standards, even if they exceed numeric criteria.

5.1.1.2.1 Existing Shade Estimates

Existing shade was estimated for 20 AUs from visual interpretation of aerial photos and field observations. Sixteen of the 20 AUs examined have existing temperature TMDLs from the previous Beaver-Camas subbasin TMDL (DEQ 2005a) and are listed in Category 4a for temperature. Six of the 20 AUs are listed in Category 5 of the 2018/2020 Integrated Report (DEQ 2020) for combined biota/habitat bioassessments. Since the Beaver-Camas subbasin TMDL was approved, PNV methodology has changed. Updated shade curves, specific to Idaho riparian communities, were applied to all 20 AUs evaluated in this document. Three of the 20 AUs were found not lacking in shade along sections of the streams; however, updated TMDLs were still developed for all 20 AUs. Additional BURP surveys and other data is needed to delist the three AUs from Category 4a for temperature.

Estimates of existing shade based on plant type and density were marked out as stream segments on a 1:100,000 or 1:250,000 hydrography, taking into account natural breaks in vegetation density. Stream segment length for each estimate of existing shade varies depending on the land use or landscape that has affected that shade level. Each segment was assigned a single value representing the bottom of a 10% shade class (adapted from the cumulative watershed effects process, IDL 2000). For example, if shade for a particular stream segment was estimated somewhere between 50% and 59%, we assigned a 50% shade class to that segment. The estimate is based on a general intuitive observation about the kind of vegetation present, its density, and stream width. Streams where the banks and water are clearly visible are usually in low shade classes (10%, 20%, or 30%). Streams with dense forest or heavy brush where no portion of the stream is visible are usually in high shade classes (70%, 80%, or 90%). More open canopies where portions of the stream may be visible usually fall into moderate shade classes (40%, 50%, or 60%).

Visual estimates made from aerial photos are strongly influenced by canopy cover and do not always take into account topography or any shading that may occur from physical features other than vegetation. It is not always possible to visualize or anticipate shade characteristics resulting from topography and landform. However, research has shown that shade and canopy cover measurements are remarkably similar (OWEB 2001), reinforcing the idea that riparian vegetation and objects proximal to the stream provide the most shade. The visual estimates of

shade in this TMDL were partially field verified with a Solar Pathfinder, which measures effective shade and considers other physical features that block the sun from hitting the stream surface (e.g., hillsides, canyon walls, terraces, and man-made structures).

5.1.1.2.2 Solar Pathfinder Field Verification

The accuracy of the aerial photo interpretations was field verified with a Solar Pathfinder. The Solar Pathfinder is a device that traces 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 location where the tracing is made. To adequately characterize the effective shade on a stream segment, 20 traces are taken at systematic or random intervals along the length of the stream in question. Solar Pathfinder surveys were conducted on the following AUs in 2018: East Camas Creek (ID17040214SK010_03, ID17040214SK011_02, and ID17040214SK011_03), West Camas Creek (ID17040214SK013_02 and ID17040214SK013_03), Threemile Creek (ID17040214SK017_02), Beaver Creek (ID17040214SK018_02, ID17040214SK018_04, ID17040214SK020_03, and ID17040214SK021_02), and Pleasant Valley Creek (ID17040214SK023_02).

At each sampling location, the Solar Pathfinder was placed in the middle of the stream at about the bankfull water level. Twenty traces were taken following the manufacturer's instructions (i.e., orient to the south and level). Systematic sampling was used because it is easiest to accomplish without biasing the sampling location. For each sampled segment, the sampler started at a unique location, such as 25 to 50 meters from a bridge or fence line, and proceeded upstream or downstream taking additional traces at fixed intervals (e.g., every 25 meters, 25 paces, etc.). Alternatively, one can randomly locate points of measurement by generating random numbers to be used as interval distances.

When possible, the sampler also measured bankfull widths, took notes, and photographed the landscape of the stream at several unique locations while taking traces. Special attention was given to changes in riparian plant communities and the types of plant species (the large, dominant, shade-producing ones) were present. One can also 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.

In Table 12, the Solar Pathfinder data shows the aerial interpretations were reasonably accurate with a mean overestimation of 0.60 ± 0.80 (average ± 95% C.I.). At one site, aerial interpretation was overestimated by three classes. At two sites, aerial interpretation was overestimated by two classes. Three sites were overestimated by one class. The correct shade class was identified at two sites and a shade class was underestimated by one class at three sites. These data were used to correct interpretations in those locations and to "calibrate our eyes" for further evaluation in other areas of the shade analysis.

Table 12. Solar Pathfinder field verification results for 11 Beaver-Camas subbasin sites.

Pathfinder Site	AU Number	Aerial Shade Classification	Pathfinder Measurement	Pathfinder Shade Classification	Shade Classification Difference
East Camas Creek	ID17040214DK010_03	50	67	60	-1
	ID17040214DK011_02	60	38	30	3
	ID17040214DK011_03	80	73	70	1
West Camas Creek	ID17040214DK013_02	0	6	0	0
	ID17040214DK013_03	30	19	10	2
Threemile Creek	ID17040214DK017_02	50	61	60	-1
Beaver Creek	ID17040214DK018_02	30	35	30	0
	ID17040214DK018_04	40	33	30	1
	ID17040214DK020_03	30	25	20	1
	ID17040214DK021_02	10	21	20	-1
Pleasant Valley Creek	ID17040214DK023_02	70	50	50	2
				Mean	0.60
				Standard Deviation	1.30
				Confidence Level (95.0%)	0.80

5.1.1.2.3 Target Shade Determination

PNV targets were determined from an analysis of probable vegetation at the streams and comparing that to shade curves developed for similar vegetation communities in Idaho (Shumar and de Varona 2009). A shade curve shows the relationship between effective shade and stream width. As a stream gets wider, shade decreases as vegetation has less ability to shade the center of wide streams. As the vegetation gets taller, the more shade the plant community is able to provide at any given channel width.

5.1.1.2.4 Natural Bankfull Widths

Stream width must be known to calculate target shade since the width of a stream affects the amount of shade the stream receives. Bankfull width is used because it best approximates the width between the points on either side of the stream where riparian vegetation starts. Measures of current bankfull width may not reflect widths present under PNV (i.e., natural widths). As impacts to streams and riparian areas occur, width-to-depth ratios tend to increase so streams become wider and shallower. Shade 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 eroded away.

Since existing bankfull width may not be discernible from aerial photo interpretation and may not reflect natural bankfull widths, this parameter must be estimated from available information. We used regional curves for the major basins in Idaho—developed from data compiled by Diane Hopster of the Idaho Department of Lands—to estimate natural bankfull width (Figure 47).

For each stream evaluated in the load analysis, natural bankfull width was estimated based on the drainage area of the Upper Snake Basin curve from Figure 48. Although estimates from other curves were examined (i.e., Salmon, Payette/Weiser), the Upper Snake Basin curve was chosen because of its proximity to the Beaver-Camas watershed and similarity of the geology and climate. Existing width data should also be evaluated and compared to these curve estimates if data are available. In the Beaver-Camas watershed, only a few BURP sites exist, and bankfull width data from those sites represent only spot data (e.g., three measured widths in a reach just several hundred meters long) that do not always represent the stream as a whole.

We found BURP bankfull width data to agree with natural bankfull width estimates from the Upper Snake Basin regional curve and chose not to make natural widths any different from the Beaver-Camas basin estimates. Natural bankfull width estimates for each stream in this analysis are presented in Appendix C, Table C3. These BURP data are consistent with the hydrologic data used to generate the Upper Snake Basin curve. The load analysis tables contain a natural bankfull width and an existing bankfull width for every stream segment in the analysis based on the bankfull width results presented in Table C3. Existing widths and natural widths are the same in load tables when no data exist to support making them differ.

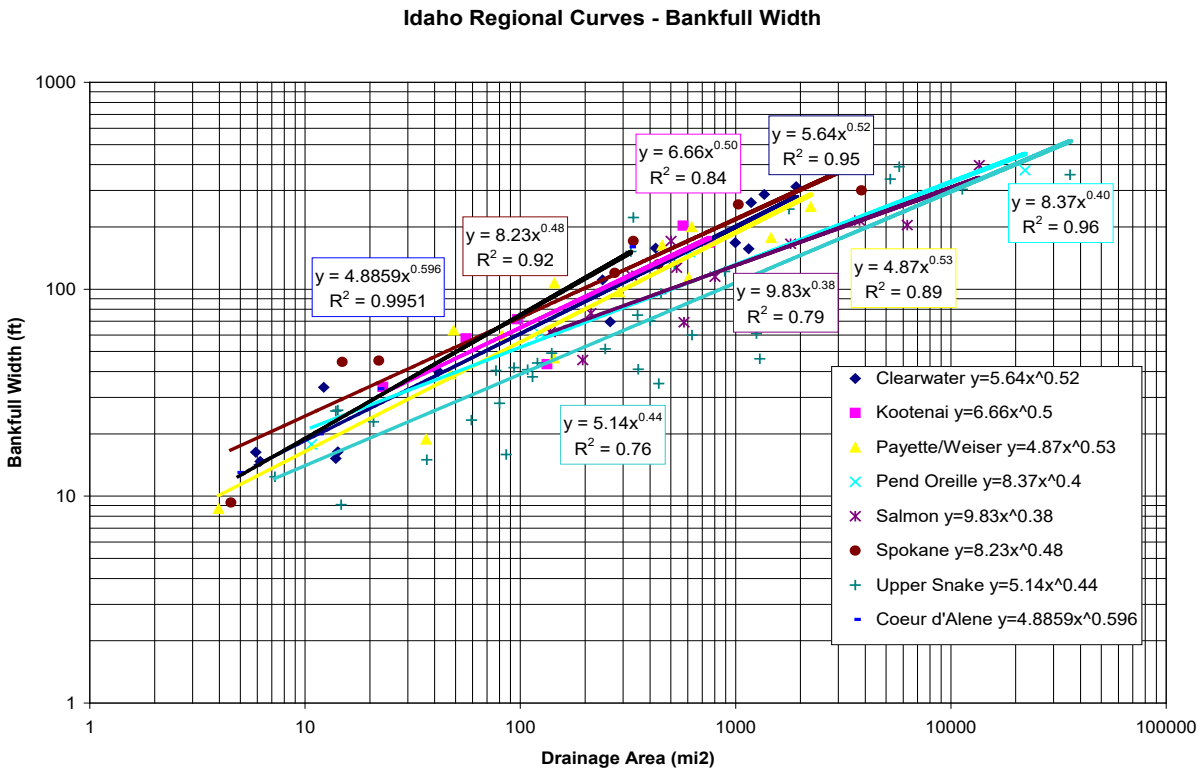


Figure 47. Bankfull width as a function of drainage area.

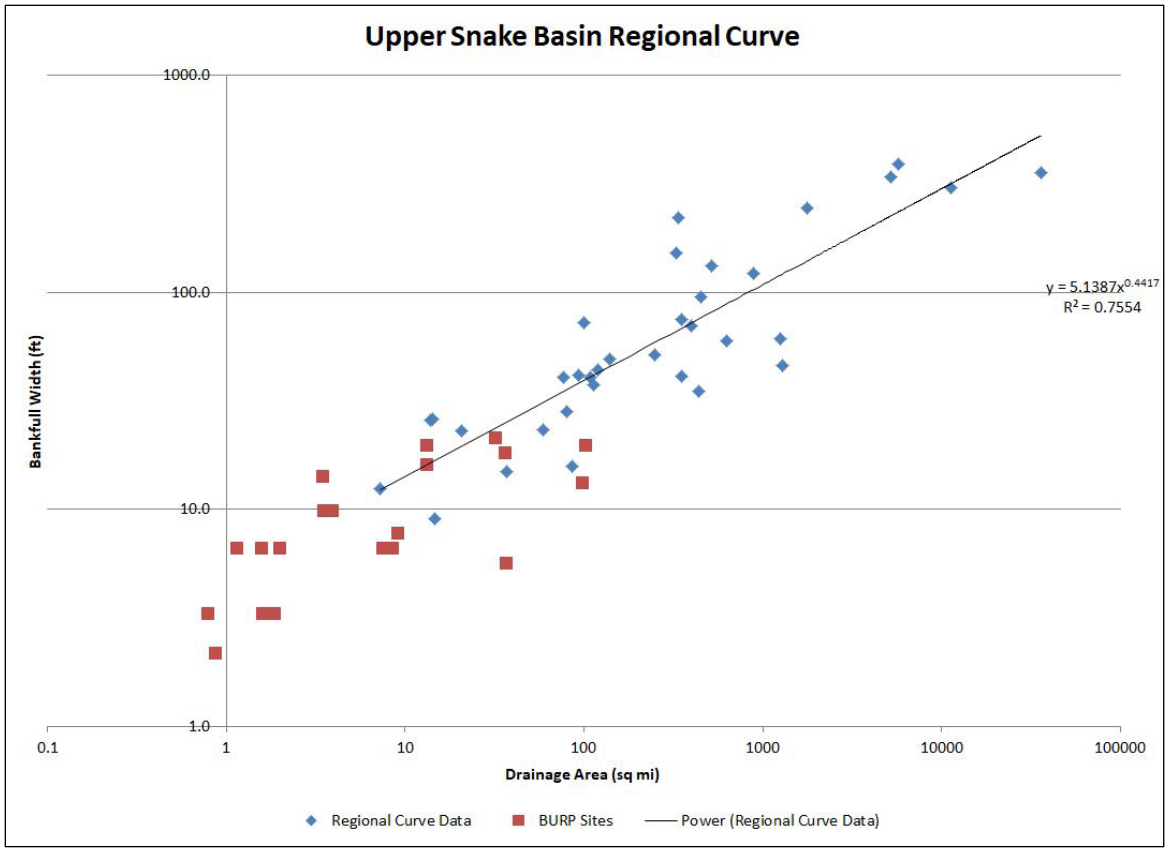


Figure 48. BURP bankfull width as a function of drainage area.

5.1.1.3 Design Conditions

The Beaver and Camas Creeks are the two main drainages that form the subbasin. Both drainages receive spring runoff flows from the northern mountainous region in the upper watershed. Beaver Creek receives perennial flows from Modoc, Idaho, Pleasant Valley, Miners, Stoddard, and Dairy Creeks, which are located north of Spencer, Idaho. Below Spencer, occasional intermittent flows from Rattlesnake and Dry Creeks are introduced to Beaver Creek. Any remaining flow in the lower two-thirds of the subbasin is either diverted for irrigation or naturally infiltrates into the basalt streambed (DEQ 2005a).

The entire length of Camas Creek is a losing reach through porous basalt streambed. Similar to Beaver Creek, flows are spring runoff and precipitation driven. Flows to Camas Creek are initiated at the eastern edge of the subbasin along the continental divide and then supplied by Crooked/Crab, West Camas, East Camas, Warm, Cottonwood, Ching, and Spring Creeks. These creeks drain to wetlands starting at Kilgore and extend down to Eighteen Mile Creek where the creeks converge and become the headwaters of Camas Creek. A few miles below the headwaters, surface flows are diverted for irrigation purposes. The hydrologic end of the subbasin is Mud Lake, located in the most southern portion of the Beaver-Camas subbasin (DEQ 2005a).

The Beaver-Camas subbasin is classified in the Middle Rockies and Snake River Plain Level III ecoregions with the Middle Rockies ecoregion occupying the forested hills and the Snake River Plain ecoregion found in lower elevation flatlands. Level IV ecoregions in the Middle Rockies include 17ab, (Dry Gneissic-Schistose-Volcanic Hills), and 17e, (Barren Mountains), which characterize the two major land types found in the forested hills of the Beaver-Camas subbasin. The semiarid Dry Gneissic-Schistose-Volcanic Hills are predominately grass and shrub dominated. These hills are less rugged and drier than the higher elevation Barren Mountains ecoregion but are more rugged and receive more precipitation than the Dry Intermontane Sagebrush Valleys. The predominance of grasses and shrubs contrasts with the elevational mosaic of open canopy forest-shrubland-grassland of the Barren Mountain ecoregion. The Barren Mountain ecoregion occurs from 6,800 to 10,000 feet; supports open-canopied forests comprised of Douglas fir, lodgepole pine, aspen groves, sagebrush, mountain brush, and grasses. Forests are usually found in a narrow elevation band and most widespread on north slopes (McGrath et al. 2001).

The Snake River Plains ecoregion in the Beaver-Camas subbasin occupies the flatlands of Beaver and Camas Creeks and is made up of the Eastern Snake River Basalt Plains Level IV ecoregion. This ecoregion generally has shallow, stony soils that make cultivation difficult outside of the small areas that have soils deep enough to support farming under sprinkler irrigation. Rangeland is common and the potential natural vegetation is generally sagebrush and bunchgrass (McGrath et al. 2001).

5.1.1.4 Shade Curve Selection

To determine PNV shade targets for the Beaver-Camas subbasin, effective shade curves from the Targhee National Forest group and the southern Idaho nonforest group were examined, as shown in Table 13 (Shumar and de Varona 2009) These curves were produced using vegetation community modeling of Idaho plant communities (Appendix C, Figures C16–C27). Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis. For the Beaver-Camas subbasin, curves for the most similar vegetation type were selected for shade target determinations. Shade curves for forest patches on headwater streams were selected from maps of the Targhee National Forest Ecological Unit Inventory (Bowerman et al. 1999). In some cases, no shade curves were developed for the specific ecological unit described, and an attempt was made to create the most accurate shade curve based on the vegetation compositions described in Bowerman et al. (1999). Ecological units encountered along the streams examined include forest types in the higher elevation headwaters and a willow-dominated type on midelevation stream segments. Most shrub-dominated riparian areas outside of the national forest were placed in a riparian vegetation type comprised of several willow species with components of conifers and other shrubs present at varying levels. Higher elevation areas were identified with components of subalpine fir, lodgepole pine, with Douglas fir types most commonly recognized. Some areas were identified that could contain some populations of Rocky Mountain juniper, limber pine, and whitebark pine. Ecological Unit Groups in Bowerman et al. (1999) are numbered and may contain similar names. Differences of vegetation population densities account for the makeup of the unit group and while named similarly could have larger components of one forest community compared to another.

Detailed analysis of the shade-producing features of similarly named forest types had large effects on the amount of shade each forest type could produce and required developing accurate shade curves. The shade investigation identified one ephemeral drainage that was clearly a dry channel. In aerial photos, established vegetation is seen growing down the center of the channel, which was confirmed by field visits.

Table 13. Shade curves used as targets for streams (Shumar and de Varona 2009; Bowerman et al. 1999).

Targhee National Forest Ecological Unit Group	Southern Idaho Nonforest Group
1140 - Cool Forest	1145-1146 - Cool Moist Shrub
1149 - Cool Forest	1204-1250 - Forest/Shrub Steppe_Foothills
1150 - Cool Forest	1760 - Forest/Shrub Steppe_Flatlands
1154 - Dry Forest	2606 - Riparian
1270 - Cold, Moist Forest	
1316 - Mid Forest	
1576 - Cool Forest / Alpine	
1597 - Cool Forest	

5.1.1.5 Water Quality Monitoring Points

Numeric monitoring in any of the temperature-impaired or shade-deficient AUs should be based on the statewide protocols. A robust riparian canopy aimed at preventing excess solar loads to streams is essential to the successful implementation of the PNV temperature TMDLs presented in this document. DEQ staff examined data and aerial photos to estimate existing shade percentages along the AUs. In the field, DEQ conducts shade monitoring by collecting Solar Pathfinder data to verify the amount of existing shade on a stream estimated by the aerial interpretation. Target shade is estimated with data and software, which is compared to the estimated existing shade. The difference between existing and target shade is used to determine the locations along the AU where restoration activities should be focused. In the next 5-year review cycle, aerial interpretations of the existing shade conditions and shade monitoring along any AU segment by collecting Solar Pathfinder data will confirm progress made toward maintaining or achieving the shade targets provided in the TMDLs. DEQ's existing methods and quality assurance programs outline required elements for both the monitoring plans and beneficial use assessments.

5.1.2 Load Capacity

The load capacity, also referred to as target load in this document, for a stream under PNV is essentially the solar loading allowed under the shade targets specified for the segments within that stream. These loads are determined by multiplying the solar load measured by a flat-plate collector (under full sun) for a given period of time by the fraction of the solar radiation that is not blocked by shade (i.e., the percent open or 100% minus percent shade). In other words, if a shade target is 60% (or 0.6), the solar load hitting the stream under that target is 40% of the load hitting the flat-plate collector under full sun. The target solar load for each segment

identified is then summed to determine the target solar load for the entire AU. The target solar load can be summarized with the following equation:

$$\sum seg = seg_1 + seg_2 + seg_3 + \cdots + seg_n$$

Where:

$$\text{seg} = NREL\ Collector\ kWh/m^2/day \times\ (1\ - Target\ Shade\ Percentage)$$

Solar load data were collected from flat-plate collectors at the NREL weather stations in Pocatello, Idaho, and Helena, Montana. The solar load data used in this TMDL analysis are spring/summer averages (i.e., an average load for the 6-month period from April through September). Load capacity calculations are also based on this 6-month period, coinciding with the time of year when stream temperatures are increasing, deciduous vegetation is in leaf, and fall spawning occurs (Table 14). During this period, temperatures may affect beneficial uses such as spring and fall SS and COLD criteria, which may be exceeded during summer months. Late July and early August typically represent the period of highest stream temperatures. Solar gains can begin early in the spring and affect not only the highest temperatures reached later in the summer but also SS temperatures in spring and fall.

Table 14. Load capacity versus current solar loads from nonpoint sources in the Beaver-Camas subbasin.

AU Name	AU Number	Load Capacity (Target Load) (kWh/day)	Current Load (kWh/day)	Estimation Method	TMDL Required
Camas Creek—Spring Creek to Beaver Creek	ID17040214SK002_05	6,500,000	6,700,000	Existing shade analysis	Yes
Crooked/Crab Creek—source to mouth	ID17040214SK008_03	200,000	260,000	Existing shade analysis	Yes
Warm Creek—Cottonwood Creek to mouth and East Camas Creek	ID17040214SK009_02	100,000	160,000	Existing shade analysis	Yes
East Camas Creek	ID17040214SK010_02	6,300	8,000	Existing shade analysis	Yes
East Camas Creek	ID17040214SK010_03	71,000	88,000	Existing shade analysis	Yes
East Camas Creek—source to Larkspur Creek	ID17040214SK011_02	39,000	84,000	Existing shade analysis	Yes
East Camas Creek—source to Larkspur Creek	ID17040214SK011_03	26,000	30,000	Existing shade analysis	Yes
West Camas Creek	ID17040214SK012_03	580,000	650,000	Existing shade analysis	Yes
West Camas Creek—source to Targhee National Forest Boundary	ID17040214SK013_02	360,000	460,000	Existing shade analysis	Yes

AU Name	AU Number	Load Capacity (Target Load) (kWh/day)	Current Load (kWh/day)	Estimation Method	TMDL Required
West Camas Creek—source to Targhee National Forest Boundary	ID17040214SK013_03	240,000	250,000	Existing shade analysis	Yes
Rattlesnake Creek—source to mouth	ID17040214SK016_02	340,000	570,000	Existing shade analysis	Yes
Threemile Creek—source to mouth	ID17040214SK017_02	180,000	210,000	Existing shade analysis	Yes
Threemile Creek—source to mouth	ID17040214SK017_03	55,000	65,000	Existing shade analysis	Yes
Beaver Creek—Miners Creek to Rattlesnake Creek	ID17040214SK018_02	290,000	400,000	Existing shade analysis	Yes
Beaver Creek—Miners Creek to Rattlesnake Creek	ID17040214SK018_04	730,000[a]	540,000	Existing shade analysis	Yes
Beaver Creek—Idaho Creek to Miners Creek[a]	ID17040214SK020_03	220,000[a]	170,000	Existing shade analysis	Yes
Beaver Creek—source to Idaho Creek	ID17040214SK021_02	520,000	910,000	Existing shade analysis	Yes
Beaver Creek—source to Idaho Creek[a]	ID17040214SK021_03	170,000[a]	170,000	Existing shade analysis	Yes
Pleasant Valley Creek—source to mouth	ID17040214SK023_02	180,000	250,000	Existing shade analysis	Yes
Huntley Canyon Creek—source to mouth	ID17040214SK024_02	25,000	53,000	Existing shade analysis	Yes

a. PNV analyses and/or Solar Pathfinder data indicated these AUs were are meeting shade targets consistet with natural conditions (i.e. no shade deficits) in the segments surveyed. The existing TMDLs were updated to reflect current shade curves applied to the AUs. Additional investigations are needed to confirm fully supporting beneficial uses.

In Appendix C, Tables C5–C24 show corresponding target summer loads (in kilowatt-hours per square meter per day [kWh/m^2/day] and kWh/day) that serve as the load capacities for the streams. Existing and target loads in kWh/day can be summed for the entire stream or portion of stream examined in a single load analysis table. These total loads are shown at the bottom of their respective columns in each table. Because load calculations involve stream segment area calculations, the channel width of the segment, which typically only has one or two significant figures, dictates the level of significance of the corresponding loads. One significant figure in the resulting load can create rounding errors when existing and target loads are subtracted. The totals row of each load table represents total loads with two significant figures in an attempt to reduce apparent rounding errors.

The AU with the largest target load (i.e., load capacity) was Camas Creek (ID17040214SK002_05) with 6,500,000 kWh/day (Table C5). The smallest target load was in East Camas Creek (ID17040214SK010_02) with 6,300 kWh/day (Table C8). Target shade figures are provided in Figures C29, C32, and C35.

For assessment units where PNV analyses show no excess solar load (i.e., no shade deficit), additional assessments are needed to demonstrate beneficial uses are supported and stream temperatures are consistent with natural background temperatures. Alternatively, AUs meeting shade targets may be candidates for future site-specific temperature criteria.

5.1.3 Estimates of Existing Pollutant Loads

Regulations allow that loads "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading" (40 CFR 130.2(g)). The existing solar load for each segment identified is then summed to determine the existing solar load for the entire AU. The existing solar load can be summarized with the following equation:

$$\sum seg = seg_1 + seg_2 + seg_3 + \cdots + seg_n$$

Where:

$$\text{seg} = NREL\ Collector\ kWh/m^2/day \times\ (1\ -\ Existing\ Shade\ Percentage)$$

Existing loads in this temperature TMDL come from estimates of existing shade as determined from aerial photo interpretations. There are currently no permitted point sources in the affected AUs. 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 in Pocatello, Idaho, and Helena, Montana. Existing shade data are presented in Appendix C, Tables C5–C24. Like load capacities (target loads), existing loads in Tables C5–C24 are presented on an area basis (kWh/m^2/day) and as a total load (kWh/day). Existing loads in kWh/day are also summed for the entire stream or portion of stream examined in a single load analysis table. The difference between target and existing load is also summed for the entire table. If existing load exceeds target load, this difference becomes the excess load (i.e., lack of shade) (section 5.1.4 and Figures C30, C33, and C36).

The AU with the largest existing load was Camas Creek (ID 17040214SK002_05) with 6,700,000 kWh/day (Table C-5). The smallest existing load was in East Camas Creek (ID 17040214SK010_02) with 8,000 kWh/day (Table C10). Existing shade figures are provided in Figures C28, C31, and C34.

5.1.4 Load Allocation

Because this TMDL is based on PNV, which is equivalent to natural background load, the load allocation is essentially the desire to achieve natural background conditions. However, in order to reach that objective, load allocations are assigned to nonpoint source activities that have affected or may affect riparian vegetation and shade as a whole. Therefore, load allocations are stream segment specific and dependent upon the target load for a given segment. Appendix C, Tables C5–C24 show the target shade and corresponding target summer load. This target load (i.e., load capacity) is necessary to achieve natural background conditions. There is no opportunity to further remove shade from the stream by any activity without exceeding its load

capacity. Additionally, because this TMDL depends upon natural background conditions for achieving water quality standards, all tributaries to the waters examined here need to be in natural conditions to prevent excess heat loads to the system.

Table 15 shows the total existing, target, and excess loads and the average lack of shade for each water body examined. 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 and thus greater surface area. However, 2nd-order AUs tend to be conglomerations of many individual 1st- and 2nd-order streams, making the total loads large as well.

Although this TMDL analysis focuses on total solar loads, the differences between existing and target shade are key to successfully restoring these waters to achieving water quality standards. The shade deficit figures are provided in Appendix C, Figures C30, C33, and C36.

Table 15. Total solar loads and average lack of shade for all waters.

Water Body Name	AU Number	Total Target Load	Total Existing Load (kWh/day)	Excess Load (Necessary % Reduction)	Average Shade Deficit (%)
Camas Creek—Spring Creek to Beaver Creek	ID17040214SK002_05	6,500,000	6,700,000	250,000 (4)	2
Crooked/Crab Creek—source to mouth	ID17040214SK008_03	200,000	260,000	65,000 (25)	-22
Warm Creek—Cottonwood Creek to mouth and East Camas Creek	ID17040214SK009_02	100,000	160,000	57,000 (36)	-26
East Camas Creek	ID17040214SK010_02	6,300	8,000	1,700 (21)	-17
East Camas Creek	ID17040214SK010_03	71,000	88,000	17,000 (19)	-16
East Camas Creek—source to Larkspur Creek	ID17040214SK011_02	39,000	84,000	41,000 (49)	-40
East Camas Creek—source to Larkspur Creek	ID17040214SK011_03	26,000	30,000	4,000 (13)	-9
West Camas Creek	ID17040214SK012_03	580,000	650,000	65,000 (10)	-12
West Camas Creek—source to Targhee National Forest Boundary	ID17040214SK013_02	360,000	460,000	110,000 (24)	-21
West Camas Creek—source to Targhee National Forest Boundary	ID17040214SK013_03	240,000	250,000	11,000 (4)	1
Rattlesnake Creek—source to mouth	ID17040214SK016_02	340,000	570,000	230,000 (40)	-29
Threemile Creek—source to mouth	ID17040214SK017_02	180,000	210,000	36,000 (17)	-18
Threemile Creek—source to mouth	ID17040214SK017_03	55,000	65,000	10,000 (15)	-12
Beaver Creek—Miners Creek to Rattlesnake Creek	ID17040214SK018_02	290,000	400,000	110,000 (28)	-23
Beaver Creek—Miners Creek to Rattlesnake Creek	ID17040214SK018_04	730,000[a]	540,000	0 (0)	12
Beaver Creek—Idaho Creek to Miners Creek	ID17040214SK020_03	220,000[a]	170,000	0 (0)	17
Beaver Creek—source to Idaho Creek	ID17040214SK021_02	520,000	910,000	390,000 (43)	-44
Beaver Creek—source to Idaho Creek	ID17040214SK021_03	170,000[a]	170,000	0 (0)	-3
Pleasant Valley Creek—source to mouth	ID17040214SK023_02	180,000	250,000	73,000 (29)	-20
Huntley Canyon Creek—source to mouth	ID17040214SK024_02	25,000	53,000	27,000 (51)	-44

a. PNV analyses and/or Solar Pathfinder data indicated these AUs are meeting shade targets consistent with natrual conditions (i.e., not shade deficits) in the segments surveyed. The existing TMDLs were updated to reflect current shade curves applied to the AUs. Additional investigations are needed to confirm fully supporting beneficial uses.
Notes: Load data are rounded to two significant figures, which may present rounding errors.

Target shade levels for individual reaches should be the goal managers strive for with future implementation plans. Managers should focus on the largest differences between existing and target shade as locations to prioritize implementation efforts. Each load analysis table contains a column that lists the lack of shade on the stream segment. This value is derived from subtracting target shade from existing shade for each segment. Stream segments with the largest lack of shade are in the worst shape. The average lack of shade derived from the last column in each load analysis table (Appendix C, Tables C5–C24) provides a general level of comparison among streams.

Based on Tables C5–C24, the 2nd-order tributaries requiring the largest solar load percentage reduction are East Camas (ID17040214SK011_02), Beaver (ID17040214SK021_02), Warm (ID17040214SK009_02), Rattlesnake (ID17040214SK016_02), Threemile (ID17040214SK017_02), and Huntley Canyon (ID17040214SK024_02) Creeks. The solar load on these creeks could be due to the land use changes occurring along the streams as they leave the forested headwaters and run to lower gradient agricultural and grazing lands. Riparian vegetation has been removed via water diversions, damming, and channelization to enhance grazing and agricultural opportunities on the bottomlands, subjecting the modified streams to increased solar loads.

The 5th-order of Camas Creek (ID17040214SK002_05) and 3rd-order of West Camas Creek (ID17040214SK013_03) require significantly lower load reductions. This result is likely due to a decrease in target shade as the bankfull widths of these AUs widen. Because the target or potential shade percentage is expected to be lower at wider bankfull widths, the difference between the existing and target shade on these AUs is not as great.

The Beaver Creek 3rd-and 4th-order AUs (ID17040214SK018_04), (ID17040214SK020_03), and (ID17040214SK021_03) have adequate shade and no excess loads. These AUs are adjoining streams located east of the I-15 freeway between the railroad and mountains. Access to these AUs is limited, allowing the vegetation along the streambanks to remain largely undisturbed.

The Rattlesnake Creek AU (ID17040214SK016_03) is an intermittent and ephemeral stream, and no load calculations were performed.

A certain amount of excess load is potentially created by the existing shade/target shade difference inherent in the load analysis. Because existing shade is reported as a 10% shade class and target shade a unique integer between 0% and 100%, there is usually a difference between the two. For example, say a particular stream segment has a target shade of 86% based on its vegetation type and natural bankfull width. If existing shade on that segment were at target level, it would be recorded as 80% in the load analysis because it falls into the 80% existing shade class. There is an automatic difference of 6%, which could be attributed to the MOS.

5.1.4.1 Water Diversion

Stream temperature may be affected by diversions of water for water rights purposes. Diversion of flow reduces the amount of water exposed to a given level of solar radiation in the stream channel, which can result in increased water temperature in that channel. Loss of flow

in the channel also affects the ability of the near-stream environment to support shade-producing vegetation, resulting in an increase in solar load to the channel.

Although these water temperature effects may occur, nothing in this TMDL supersedes any water appropriation in the affected watershed. Section 101(g), the Wallop Amendment, was added to the CWA as part of the 1977 amendments to address water rights.

> It is the policy of Congress that the authority of each State to allocate quantities of water within its jurisdiction shall not be superseded, abrogated or otherwise impaired by this chapter. It is the further policy of Congress that nothing in this chapter shall be construed to supersede or abrogate rights to quantities of water which have been established by any State. Federal agencies shall co-operate with State and local agencies to develop comprehensive solutions to prevent, reduce and eliminate pollution in concert with programs for managing water resources.

Additionally, Idaho's water quality standards indicate the following:

> The adoption of WQSs and the enforcement of such standards is not intended to…interfere with the rights of Idaho appropriators, either now or in the future, in the utilization of the water appropriations which have been granted to them under the statutory procedure… (IDAPA 58.01.02.050.01)

In this TMDL, we have not quantified what impact, if any, diversions are having on stream temperature. Water diversions are allowed for in state statute, and it is possible for a water body to be 100% allocated. Diversions notwithstanding, reaching shade targets as discussed in the TMDL will protect what water remains in the channel and allow the stream to meet water quality standards for temperature. This TMDL will lead to cooler water by achieving shade that would be expected under natural conditions and water temperatures resulting from that shade. DEQ encourages local landowners and holders of water rights to voluntarily do whatever they can to help instream flow to keep channel water cooler for aquatic life.

As shown in Figure 49, the Beaver-Camas subbasin contains 2,701 ground water rights with decreed, licensed, or statutory claims dating from 1891 to 2006 and 1,670 surface water rights with decreed, licensed, or statutory claims dating from 1864 to 2015. The standard headgate volume for the Beaver-Camas subbasin is 3.5-acre feet per acre. This information, provided and maintained by the IDWR through their website water rights search tool, is subject to change. IDWR should be contacted for questions about updated water rights activities and appropriations: *https://www.idwr.idaho.gov/.*

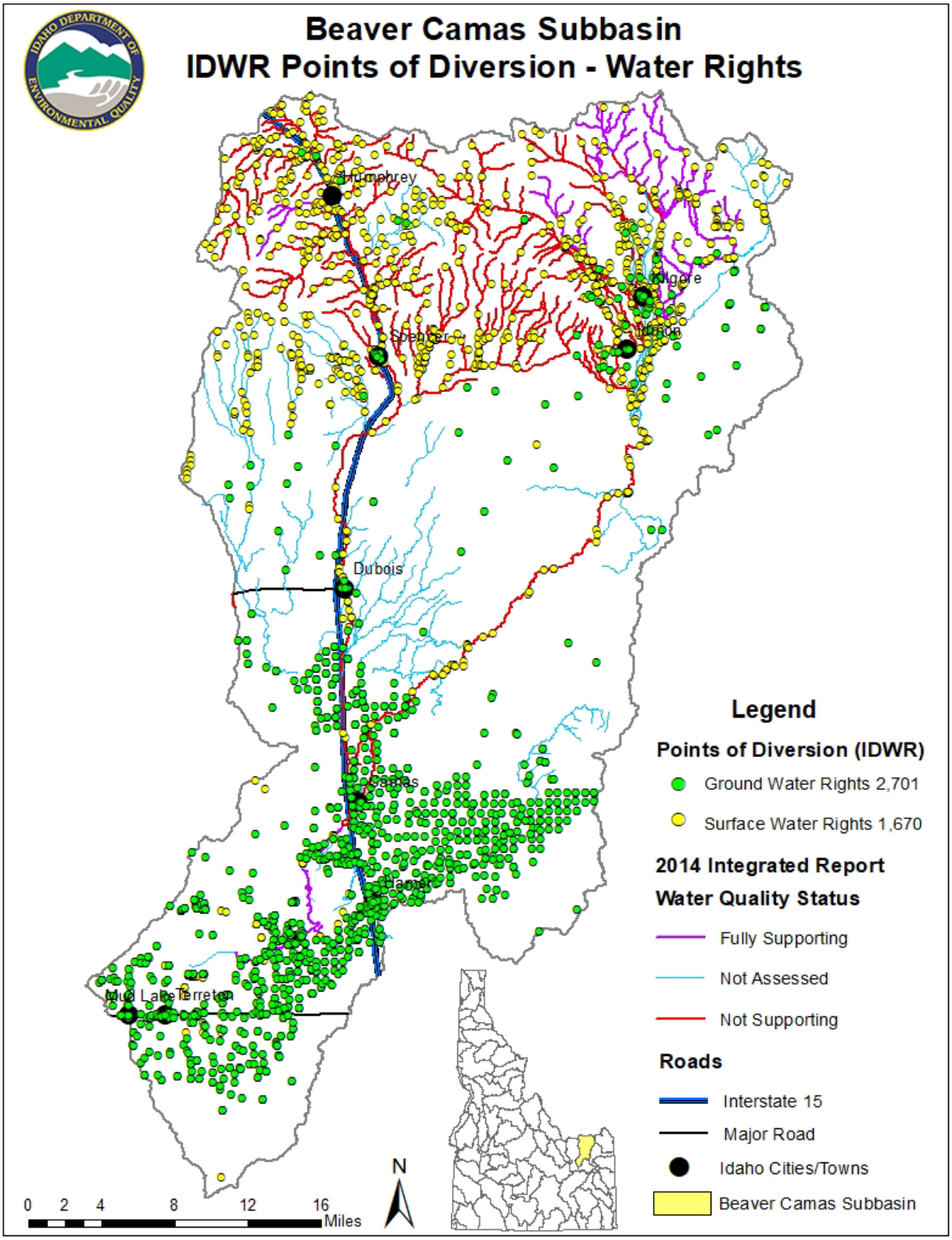


Figure 49. Beaver-Camas subbasin IDWR points of diversion–water rights (IDWR 2018).

5.1.4.2 Margin of Safety

The MOS in this TMDL is considered implicit in the design as described above. 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% shade class, which likely underestimates actual shade in the load analysis. Although the load analysis used in this TMDL involves gross estimations that are likely to have large variances, load allocations are applied to the stream and its riparian vegetation rather than specific nonpoint source activities and can be adjusted as more information is gathered from the stream environment.

5.1.4.3 Seasonal Variation

All loads in this TMDL have been calculated to include the 6-month period from April through September. This time period is when the combination of increasing air and water temperatures coincide with increasing solar inputs and vegetative shade. This time period coincides with the critical time periods of April through June when spring SS occurs, July and August when maximum temperatures may exceed COLD criteria, and September when fall SS is most likely to be affected by higher temperatures. Water temperature is not likely to be a problem for beneficial uses outside of this time period because of cooler weather and lower sun angle.

5.1.4.4 Natural Background

For PNV temperature TMDLs, it is assumed that natural temperatures may exceed these criteria during certain time periods. If PNV targets are achieved yet stream temperatures are warmer than these criteria, it is assumed that the stream's temperature is natural (provided there are no point sources or human-induced ground water sources of heat) and natural background provisions of Idaho's water quality standards apply:

> 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. (IDAPA 58.01.02.200.09)

5.2 *E. coli* Bacteria TMDL

5.2.1 Instream Water Quality Targets

Idaho's water quality standards set instream water quality targets for the bacteria-impaired waters in the Beaver-Camas subbasin and prescribe *E. coli* numeric criteria for both PCR and SCR uses. To support the recreation beneficial uses, the number of *E. coli* colonies may not exceed a geometric mean of 126 cfu/mL for five samples collected every 3 to 7 days within a 30-day period (IDAPA 58.01.02.251.01). For PCR, an instantaneous sample of 406 cfu/100 mL

triggers the need for additional sampling to calculate the geometric mean for comparison to the criterion. For SCR, the trigger for an instantaneous sample is 576 cfu/100 mL.

Design Conditions

Monthly sampling, conducted to determine the critical time period for *E. coli* load to these streams, shows that the summer months during low flow periods will require concentrated efforts to reduce direct access to these streams by livestock, if owners, operators, and land managers intend to meet these load reductions. Because it is unknown which tributaries in the AUs are actively grazed, or at what specific time of year grazing will occur, TMDL load reductions for *E. coli* will apply to the entire AU throughout the year.

5.2.2 Target Selection

The number of *E. coli* colonies may not exceed a geometric mean of 126 cfu/100 mL for five samples collected every 3 to 7 days within a 30-day period.

5.2.3 Water Quality Monitoring Points

Ten AUs in the Beaver-Camas subbasin were listed as impaired by *E. coli* bacteria in Category 5 of the 2018/2020 Integrated Report (§303(d) list) (DEQ 2020). Geometric mean *E. coli* sampling was conducted on the AUs in 2012, 2013, and 2018 for compliance with the *E. coli* bacteria PCR and SCR criteria. Monitoring locations are listed in Table 16.

Table 16. *E. coli* sampling locations in the Beaver-Camas subbasin.

AU Name	AU Number	Dates Sampled	Latitude	Longitude
Ching Creek	ID17040214SK006_03	Unknown[a]	44.468340	-112.006976
Crooked/Crab Creek	ID17040214SK008_03	Sept - Oct. 2018	44.423141	-111.952019
Warm Creek	ID17040214SK009_02	Sept - Oct. 2018	44.389680	-111.893510
East Camas Creek	ID17040214SK010_03	Aug. – Sept. 2012	44.473688	-111.917370
West Camas Creek	ID17040214SK013_03	Aug. – Sept. 2012	44.461619	-111.996550
Threemile Creek	ID17040214SK017_03	Sept - Oct. 2018	44.349920	-112.143540
Beaver Creek	ID17040214SK018_04	Aug. – Sept. 2012	44.412925	-112.196078
Beaver Creek (Sheep Creek)	ID17040214SK020_02	Sept - Oct. 2018	44.481460	-112.192720
Beaver Creek (West Modoc Creek)	ID17040214SK021_02	Aug. – Sept. 2012	44.461823	-112.354135
Pleasant Valley Creek	ID17040214SK023_02	Aug. – Sept. 2013	44.431116	-112.259112

Notes: a. Ching Creek was listed in Category 5 for E. coli the 2010 Integrated Report based on collected samples and geomean number; however individual sample dates and results are not available.

The resulting concentrations and geometric means show that reductions in *E. coli* are necessary in seven of the 10 AUs sampled (Table 17). Geometric mean sampling was conducted in 2018 on Crooked/Crab Creek (ID17040214SK008_03) resulting in a geometric mean concentration of 124.3 cfu/100 mL, Warm Creek (ID17040214SK009_02) resulting in a geometric mean concentration of 90.0 cfu/100 mL, and Sheep Creek (Beaver Creek ID17040214SK020_02)

resulting in a geometric mean concentration of 84.7 cfu/100 mL. All concentrations meet water quality standards and will not require TMDLs to reduce *E. coli*.

Table 17. *E. coli* geometric mean concentrations and resultant load allocations.

AU Name	AU Number	*E. coli* Concentration Geometric Mean[a] (cfu/100 mL)	TMDL Target (cfu/100 mL)
Ching Creek	ID17040214SK006_03	254	126
East Camas Creek	ID17040214SK010_03	135	126
West Camas Creek	ID17040214SK013_03	283	126
Threemile Creek	ID17040214SK017_03	395	126
Beaver Creek	ID17040214SK018_04	334	126
Beaver Creek	ID17040214SK021_02	433	126
Pleasant Valley Creek	ID17040214SK023_02	1170	126

5.2.4 Load Capacity

In bacteria TMDLs, PCR criterion is used as the concentration target. The concentration target, critical stream flow, volume conversion factor, and time conversion factor are used to estimate the load capacity of a system as shown in the formula below:

$$Load\ capacity\ \left(\frac{\text{cfu}}{day}\right) = flow\left(\frac{ft^3}{second}\right) * target\ \left(\frac{cfu}{100\ mL}\right) * 28{,}316.8\left(\frac{mL}{ft^3}\right) * 86{,}400\left(\frac{second}{day}\right)$$

Where:

- Critical low flow is cubic feet per second (cfs)
- 126 colony forming units (cfu)/100 milliliters (mL) is the *E. coli* target
- 28,316.8 mL per cubic foot is the volume conversion
- 86,400 seconds per day is the time conversion

As documented above, the load capacity is calculated by multiplying stream flow by the target concentration. The load capacity depends on stream flow. Flow varies throughout the year, so load capacity values also vary throughout the year. Because the load capacities are flow-dependent, and the TMDL target is applied year-round (i.e., to all flow conditions), the load capacities are protective year-round, including during critical flow conditions.

Load capacity was calculated using flow rates generated by StreamStats (USGS 2019c) for each stream. StreamStats is an application that delineates drainage basins, measures basin characteristics, and estimates streamflow statistics for ungaged sites. Flow rates were estimated for Low Flow (7-day 10-year), Peak Flow (10-year), and September Flows (50% or median) to show comparisons. Ultimately, September flow rates were used to calculate loads because it is the month flow rates are consistently the lowest according to StreamStats and September is the month that *E. coli* samples were collected. Multiple flow statistics were used for each AU to demonstrate the loading capacity is dependent on flow and is thus considered flow variable. Load capacity for each AU with *E. coli* TMDLs is displayed in Table 18.

Table 18. *E. coli* load capacity for Beaver-Camas subbin (based on TMDL target of 126 cfu/100mL).

AU	Flow Stat	Q (cfs)	Load Capacity (cfu/day)
Ching Creek ID17040214SK006_03	September Median	0.71	2.19E+09
	7Q10	3.34	1.03E+10
	10 Year Peak	255	7.86E+11
East Camas Creek ID17040214SK010_03	September Median	0.94	2.90E+09
	7Q10	2.29	7.06E+09
	10 Year Peak	304	9.37E+11
West Camas Creek ID17040214SK013_03	September Median	2.4	7.40E+09
	7Q10	5.54	1.71E+10
	10 Year Peak	508	1.57E+12
Threemile Creek ID17040214SK017_03	September Median	0.52	1.60E+09
	7Q10	1.05	3.24E+09
	10 Year Peak	173	5.33E+11
Beaver Creek ID17040214SK018_04	September Median	5.59	1.72E+10
	7Q10	7.71	2.38E+10
	10 Year Peak	603	1.86E+12
Beaver Creek ID17040214SK021_02	September Median	1.18	3.64E+09
	7Q10	1.08	3.33E+09
	10 Year Peak	151	4.65E+11
Pleasant Valley Creek ID17040214SK023_02	September Median	1.68	5.18E+09
	7Q10	0.94	2.90E+09
	10 Year Peak	151	4.65E+11

5.2.5 Estimates of Existing Pollutant Loads

The subbasin consists primarily of rural Clark and Jefferson counties with a population that has remained consistently low over the years. The estimated 2018 population in the subbasin was 1,130 with the largest population of 588 residing in the town of Dubois (US Census Bureau 2018). There are no permitted confined animal feeding operations or known failing septic systems in the subbasin. With a low population, livestock and wildlife are the most likely contributing sources of *E. coli* bacteria found in the listed water bodies. Natural background sources of *E. coli* present in the streams are from wildlife species using the riparian and stream corridors. The percentage of the load contribution coming from each nonpoint source cannot be determined from the available data. Existing loads are based on collecting samples during the critical low flow (i.e., September median flows) and the geometric mean of five samples collected over a 30-day period. The five sample geometric means sampling dates also correspond with the September median flows used to estimate current *E. coli* loads.

Regulations allow that loads "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading" (40 CFR 130.2(g)). Current *E. coli* loads are calculated using the below formula:

$$Existing\ load\left(\frac{cfu}{day}\right) = flow\left(\frac{ft^3}{second}\right) * geometric\ mean\left(\frac{cfu}{100\ mL}\right) * 28{,}316.8\left(\frac{mL}{ft^3}\right) * 86{,}400\left(\frac{second}{day}\right)$$

Where:

a. Critical low flow is cubic feet per second (cfs)
b. Geometric mean in colony forming units (cfu)/100 milliliters (mL) is the *E. coli* concentration
c. 28,316.8 mL per cubic foot is the volume conversion
d. 86,400 seconds per day is the time conversion

An *E. coli* TMDL is needed where a geometric mean *E. coli* concentration exceeds the *E. coli* criterion of 126 cfu/100 mL. If the geometric mean exceeds the criterion, the existing load also exceeds the load capacity. The geometric mean from each AU depicted in Table 18 exceeded the *E. coli* criterion, so the load capacity is also exceeded.

The percent of *E. coli* load reduction required to meet water quality standards was also calculated for the seven AUs (Table 19). Six of the seven AUs exceeded water quality standards by more than 50%. The most significant *E. coli* load reduction required is Pleasant Valley Creek (ID17040214SK023_02) at 89%. The least significant *E. coli* load reduction required is East Camas Creek (ID17040214SK010_03) at 7%.

Table 19. Current *E. coli* loads and percent reduction in current loads needed to achieve the load capacity based on a concentration target (126 cfu/100mL).

AU Name	AU Number	*E. coli* Concentration (cfu/100 mL)	Flow Rate (cfs)	Load Capacity (cfu/day)	Current Load (cfu/day)	Excess Load (cfu/day)	Required Reduction (%)
Ching Creek	ID17040214SK006_03	254	0.71	2.19E+09	4.41E+09	2.22E+09	50
East Camas Creek	ID17040214SK010_03	135	0.94	2.90E+09	3.10E+09	2.07E+08	7
West Camas Creek	ID17040214SK013_03	283	2.4	7.40E+09	1.66E+10	9.22E+09	56
Threemile Creek	ID17040214SK017_03	395	0.52	1.60E+09	5.03E+09	3.42E+09	68
Beaver Creek	ID17040214SK018_04	334	5.59	1.72E+10	4.57E+10	2.84E+10	62
Beaver Creek	ID17040214SK021_02	433	1.18	3.64E+09	1.25E+10	8.86E+10	71
Pleasant Valley Creek	ID17040214SK023_02	1170	1.68	5.18E+09	4.81E+10	4.29E+10	89

5.2.6 Load Allocation and Wasteload Allocation

A wasteload allocation is the pollutant load allocated to point sources. A load allocation is the pollutant load allocated to nonpoint sources. For the AUs addressed in this TMDL, there are no known *E. coli* point sources. Creeks in the Beaver-Camas subbasin are believed to be affected primarily by wildlife access to the stream and livestock grazing during the summer months, when bacteria sampling typically occurs. During the 2018 *E. coli* sampling, livestock was observed at most of the locations. Due to the nonpoint source nature of *E. coli* in the subbasin, all allowable pollutant loads are allocated to nonpoint sources through an *E. coli* load allocation.

Using the example of Ching Creek, the load allocation was calculated by allocating 90% of the load capacity to the nonpoint sources and reserving 10% of the load capacity for an explicit margin of safety. Load allocations for the seven AUs are shown in Table 20.

$$Load\ Allocation\ \left(\frac{cfu}{day}\right) = 126\ \left(\frac{cfu}{100\ mL}\right) * 0.71\ \left(\frac{\text{-}ft^3}{second}\right) * 28{,}316.8\left(\frac{mL}{ft^3}\right) * 86{,}400\left(\frac{second}{day}\right) * 0.9$$
$$= 1.97\ x\ 10^9\ \left(\frac{cfu}{day}\right)$$

Where:

- Critical low flow is cubic feet per second (cfs)
- 126 colony forming units (cfu)/100 milliliters (mL) is the *E. coli* target
- 28,316.8 mL per cubic foot is the volume conversion
- 86,400 seconds per day is the time conversion
- 0.9 accounts for the 10% Margin of Safety

Table 20. Beaver-Camas subbasin *E. coli* TMDL load allocations.

AU	Flow Stat	Q (cfs)	Load Capacity (cfu/day)	Load Allocation (cfu/day)	Margin of Safety (cfu/day)
Ching Creek ID17040214SK006_03	September Median	0.71	2.19E+09	1.97E+09	2.19E+08
	7Q10	3.34	1.03E+10	9.27E+09	1.03E+09
	10 Year Peak	255	7.86E+11	7.07E+11	7.86E+10
East Camas Creek ID17040214SK010_03	September Median	0.94	2.90E+09	2.61E+09	2.90E+08
	7Q10	2.29	7.06E+09	6.35E+09	7.06E+08
	10 Year Peak	304	9.37E+11	8.43E+11	9.37E+10
West Camas Creek ID17040214SK013_03	September Median	2.4	7.40E+09	6.66E+09	7.40E+08
	7Q10	5.54	1.71E+10	1.54E+10	1.71E+09
	10 Year Peak	508	1.57E+12	1.41E+12	1.57E+11
Threemile Creek ID17040214SK017_03	September Median	0.52	1.60E+09	1.44E+09	1.60E+08
	7Q10	1.05	3.24E+09	2.91E+09	3.24E+08
	10 Year Peak	173	5.33E+11	4.80E+11	5.33E+10
Beaver Creek ID17040214SK018_04	September Median	5.59	1.72E+10	1.55E+10	1.72E+09
	7Q10	7.71	2.38E+10	2.14E+10	2.38E+09
	10 Year Peak	603	1.86E+12	1.67E+12	1.86E+11
Beaver Creek ID17040214SK021_02	September Median	1.18	3.64E+09	3.27E+09	3.64E+08
	7Q10	1.08	3.33E+09	3.00E+09	3.33E+08
	10 Year Peak	151	4.65E+11	4.19E+11	4.65E+10
Pleasant Valley Creek ID17040214SK023_02	September Median	1.68	5.18E+09	4.66E+09	5.18E+08
	7Q10	0.94	2.90E+09	2.61E+09	2.90E+08
	10 Year Peak	169	5.21E+11	4.69E+11	5.21E+10

5.2.6.1 Margin of Safety

A MOS accounts for uncertainties that may affect the protectiveness of a TMDL. It reduces the pollutant load available for allocation to nonpoint and point sources. An MOS can be implicit or explicit. DEQ selected a 10% explicit MOS based on uncertainty associated with *E. coli* field duplicate measurements. Field duplicates are two samples collected at the same site and time following the same sampling and analytical procedures. Based on data available in DEQ's *E. coli*

database at the time this TMDL was developed, the arithmetic mean absolute difference in concentration between field duplicate samples (|original – duplicate|) for cases where the original sample result was less than the *E. coli* criterion (126 cfu/100 mL) was 10.7 cfu/100 mL (based on 39 duplicate pairs collected across Idaho from 2016 to 2019). This value represents the average *E. coli* measurement uncertainty for individual sample results below the criterion and corresponds to 8.5% of 126 cfu/100 mL. A 10% MOS was selected to be conservative (protective) considering the limited data available for this

5.2.6.2 Seasonal Variation

The highest concentrations of bacteria in streams are typically found during the summer when flow is low and water is the warmest. Agricultural diversions, livestock grazing, and wildlife use all lower stream flow in this area. Seasonal variation for this TMDL is addressed by ensuring that loads are reduced during the critical period (when beneficial uses are impaired and loads are controllable). The required *E. coli* load reductions presented in this TMDL are calculated using measured *E. coli* concentrations and low flows that correspond to critical conditions in the Beaver-Camas subbasin. While the reductions are estimated using inputs that represent critical conditions, the concentration target of 126 cfu/100 mL is expected to be met year-round.

Since the *E. coli* TMDLs are flow variable the effects of seasonal variations are also accounted for with estimates of load capacity that vary as flow varies throughout the seasons. The seasonal load capacity can be estimated using observed seasonal flow statistics. The corresponding required reductions can be estimated using measured *E. coli* concentrations for the corresponding season.

5.2.6.3 Natural Background

A geometric mean of 126 cfu/100 mL for five samples, collected every 3 to 7 days, within 30 days is protective of beneficial uses and meets water quality standards. This determination depends on identifying changes in the source load and pathways that led to exceedances of the water quality standards. Natural background loads in the Beaver-Camas subbasin are unknown and cannot be quantified, so individual allocations are not included in the TMDLs; however, natural background sources, including *E. coli* contributions from wildlife and livestock using the riparian and stream corridors are accounted for in the load allocations.

5.2.6.4 E. coli TMDL Summary

A summary of the *E. coli* TMDL is provided in Table 21.

Table 21. The *E. coli* load allocations for the Beaver-Camas subbasin based on September flow.

AU Name	Flow Rate (cfs)	Load Capacity (cfu/day)	Load Allocation (cfu/day)	MOS (cfu/day)	Current Load (cfu/day)	Excess Load (cfu/day)	Required Reduction (%)
Ching Creek ID17040214SK006_03	0.71	2.19E+09	1.97E+09	2.19E+08	4.41E+09	2.22E+09	50
East Camas Creek ID17040214SK010_03	0.94	2.90E+09	2.61E+09	2.90E+08	3.10E+09	2.07E+08	7
West Camas Creek ID17040214SK013_03	2.4	7.40E+09	6.66E+09	7.40E+08	1.66E+10	9.22E+09	56
Threemile Creek ID17040214SK017_03	0.52	1.60E+09	1.44E+09	1.60E+08	5.03E+09	3.42E+09	68
Beaver Creek ID17040214SK018_04	5.59	1.72E+10	1.55E+10	1.72E+09	4.57E+10	2.84E+10	62
Beaver Creek ID17040214SK021_02	1.18	3.64E+09	3.27E+09	3.64E+08	1.25E+10	8.86E+10	71
Pleasant Valley Creek ID17040214SK023_02	1.68	5.18E+09	4.66E+09	5.18E+08	4.81E+10	4.29E+10	89

5.3 Sediment TMDL

5.3.1 Instream Water Quality Targets

The SEI process involves collecting streambank stability data and measurements to determine TMDL load allocations with the goal of full support of designated beneficial uses. When eroding streambanks are identified in the field during the SEI process, streambank height and length are measured and six additional streambank characteristics are ranked. Corresponding erosion rates and target rates are then calculated using these parameters. DEQ collected data and measurements for six AUs in 2018. SEI worksheets containing calculations, measurements, and photos for the six AUs are in Appendix C (Tables C25–C30).

Design Conditions

Sediment erosion can vary seasonally and annually with climate and hydrology, resulting in a year-round critical period, with sediment transport and deposition largely occurring during wetter years. In the Beaver-Camas subbasin, streambank erosion is most prevalent in the spring during bankfull conditions when runoff is at its peak. Based on the historical record of Camas Creek and Beaver Creek USGS gages, May and June tend to be the highest flow months. Low flow conditions usually occur in August and September.

5.3.2 Target Selection

Sediment targets selected for this TMDL are based on streambank stability equated to quantitative allocations of streambank erosion expressed in tons of sediment per year. Natural or background conditions for streambank sediment load is a ≥ 80% stable streambank with ≤ 20% eroding banks. The 80% stability level is identified in the "User's Guide to Fish Habitat: Descriptions that Represent Natural Conditions in the Salmon River Basin, Idaho" and is deemed protective of stream habitat (Overton et al. 1995). It is presumed that beneficial uses

are supported at these load rates. Streambank erosion above 20% is considered detrimental to beneficial uses and would require a load reduction. The SEI is used to estimate long-term streambank lateral recession rates. The inventory results in corresponding erosion rates and target erosion rates and consists of fieldwork, measurements and calculations to estimate streambank and channel stability, length of eroding banks, and bank geometry. The SEI method is based on modified NRCS methods, Rosgen stream classification systems, and other applicable literature (Pfankuch 1975; Lohrey 1989; Rosgen 1996).

5.3.3 Water Quality Monitoring Points

SEI monitoring locations were selected along AUs listed in Category 5 of the 2018/2020 Integrated Report (DEQ 2020) as sediment or combined biota/habitat bioassessments impaired. Existing bioassessment data and aerial photos were examined to identify locations along the AU with similar channel, streambank vegetation, and adjacent land use characteristics. At these identified locations, indicators of unstable streambanks were noted. Indicators may include evidence of active erosion and/or slumping, tension fractures evident on the ground surface behind undercuts, banks absent of vegetation and cobbles, presence of culverts, rip rap, livestock, or trails through the stream, and evidence of flooding or recent fires. The length and height of the erosive and stable streambanks were measured. Bank conditions were then evaluated and lateral recession rates of the eroding streambanks were determined according to their condition rating. Once the SEI was completed along a homogeneous reach of an AU, the observed and measured data were then extrapolated to the entire length of the AU. Extrapolating erosion and erosion rates to similar stream segments within the AU helps identify locations where remediation and restoration activities may be the most productive in reducing sediment loads.

DEQ manages sediment through narrative rather than numeric criteria. To provide a numeric target, the SEI (NRCS 1983) was used to estimate the erosion rates and sediment load into streams. SEIs were conducted at six locations (Table 22). None of the AUs exhibited stream bank stability ratings that were inconsistent with natural conditions (i.e., 80% cover) except for Beaver Creek (Van Noy Canyon Creek), which was listed in Category 5 of the 2018/2020 Integrated Report (DEQ 2020) for combined biota/habitat bioassessments. Beaver Creek (Van Noy Canyon Creek) received a TMDL and load allocation with this document. Ching, Crooked/Crab, West Camas (Pass), Rattlesnake, and Threemile Creeks were examined to determine if sediment could be limiting beneficial uses, but there did not appear to be excess streambank erosion based on the results from the field observations and calculations.

Beaver Creek (Van Noy Canyon Creek) should be monitored as watershed improvement projects proceed to confirm that streambanks are becoming more stable and beneficial uses are improving. The SEI data are provided in Appendix C.

Table 22. 2018 SEI monitoring locations.

Stream Name	AU Number	Downstream Latitude	Downstream Longitude	Upstream Latitude	Upstream Longitude
Ching Creek	ID17040214SK006_03	44.44590	-111.87365	44.45267	-111.87152
Crooked/Crab Creek	ID17040214SK008_03	44.42120	-111.94828	44.42161	-111.95043
West Camas Creek (Pass Creek)	ID17040214SK013_02	44.48470	-112.10790	44.48404	-112.11164
Rattlesnake Creek	ID17040214SK016_02	44.40229	-112.07328	44.40517	-112.07159
Threemile Creek	ID17040214SK017_02	44.38350	-112.11359	44.38675	-112.11034
Beaver Creek (Van Noy Canyon Creek)	ID17040214SK018_02	44.41100	-112.21716	44.40969	-112.21977

5.3.4 Load Capacity

The sediment load capacity is the sediment loading rate at which beneficial uses are supported. Load capacity estimates are developed for SEI TMDLs using streambank cover and lateral recession rates that are equivalent to natural background conditions. Streambanks with 80% streambank cover are considered to be equivalent to natural conditions (Overton et al. 1995). The natural level of lateral recession is determined on a case-by-case basis and is specific to each AU where an SEI assessment is completed. After an SEI assessment is completed, the assessor calculates a Field Stability Score. Six factors are rated to produce a Field Stability Score. These factors include bank erosion evidence, bank stability condition, bank cover/vegetation, lateral channel stability, channel bottom stability, and in-channel deposition. The Field Stability Score can range from 0 to 15 with a higher score representing higher lateral recession rates. Field Stability Scores between 0 and 4 are considered slight, 4 to 8 are moderate, and above 8 are severe. Once the Field Stability Score is estimated, the assessor uses details from the SEI field investigation and best professional judgement to determine Target Stability Score. The Target Stability Score and corresponding recession rate is assumed to represent erosion rates that normally occur in streams under natural conditions. The Target Stability Score is never greater than the Field Stability Score; however, if the Field Stability Score is low, the Target Stability Score may equal the Field Stability Score. The SEI method generates load capacity estimates using 80% streambank stability lateral recession rate estimated by the Target Stability Score. For more information on the Stream Bank Erosion Inventory please refer to Appendix D.

Since it is often not feasible to conduct SEI surveys for the entire length of an AU, a representative section of the AU is surveyed and the results are applied to the entire AU. The average percent stability (i.e., area) and Field/Target Stability Scores (i.e., erosion rates) from the surveyed subsection are then extrapolated to create estimates of the AU's load capacity and current load. The load capacity is calculated using the following equation:

$$Load\ Capacity\ \left(\frac{tons}{day}\right) = \frac{[\text{ Eroding Area } (sq\ ft)\ *\ 80\%\ \text{Bank Stability Factor}] *\ \text{Target Recession Rate } \left(\frac{\text{ft}}{yr}\right)\ *\ \text{bulk density}\ *\ 0.0005\ \left(\frac{tons}{lbs}\right)}{\text{Total Surveyed Length (ft)}} * Total\ AU\ Length\ (ft) * 0.0027\left(\frac{yr}{day}\right)$$

Where:

- Eroding Area is measured from SEI survey
- 80% stability factor is a conversion to estimate load at 80% stable streambanks
- Target Recession Rate is estimated from Target Stability Score
- Bulk Density is estimated from soil texture observed during survey which was 80 lbs/ft^3

The SEI load capacity estimates are dependent on the amount of eroding area measured during the SEI survey so changes in eroding area also changes load capacity estimates. In future reviews of this TMDL, the reviewers should focus on improvement in bank stability percentages and any changes observed in the Target Stability Score. The TMDL review should also focus on other habitat metrics (i.e., percent fines and substrate diversity) as well as biologic metrics, including FSBI numbers to gauge sediment improvements.

As shown in Table 23 below, the load capacity for Beaver Creek (Van Noy Canyon Creek) was calculated using a target bank stability of 80% and a target lateral recession rate of 0.0175ft/year.

Table 23. Sediment load capacity within the Beaver-Camas subbasin.

AU Name	AU Number	Eroding Area (ft^2)	80% Stability Factor	Total Surveyed Length (ft)	Total AU Length (ft)	Target Lateral Recession Rate (ft/year)	Load Capacity (tons/day)
Beaver Creek (Van Noy Canyon Creek)	018_02	1,206.08	0.8368	1,064	212, 520	0.0175	0.3866

5.3.5 Estimates of Existing Pollutant Loads

To the extent possible, background loads should be distinguished from human-caused increases in nonpoint loads. Federal regulations allow that loads "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading" [40 CFR 130.2(g)]. The volume of an eroding streambank at bankfull condition was calculated by measuring eroding bank height and length and evaluating the bank condition to estimate the lateral recession rate during periods of high discharge, taking erodibility of the soil type into consideration. Current load is calculated using the equation below:

$$Current\ Load\ \left(\frac{tons}{day}\right) = \frac{\text{Eroding Area } (sq\ ft)\ *\ \text{Field Recession Rate } \left(\frac{\text{ft}}{yr}\right) * \text{bulk density} * 0.0005\ \left(\frac{tons}{lbs}\right)}{\text{Total Surveyed Length } (ft)} *$$

$$\text{Total AU length } (ft) * 0.0027 \left(\frac{yr}{day}\right)$$

Where:

- Eroding Area is measured from SEI survey

- Field Recession Rate is estimated from Field Stability Score
- Bulk Density is estimated from soil texture observed during survey which was 80 lbs/ft^3

A current estimate of sediment load for Beaver Creek (Van Noy Canyon Creek) was generated using a streambank stability of 76% and a lateral recession rate of 0.0325 ft/year. The lateral recession rates used in the current load estimate differs slightly from the lateral recession rate used in the load capacity calculations. Table 24 shows the results of the current loads estimated for the Beaver-Camas subbasin. If a current load does not exceed the load capacity for an AU, a TMDL was not developed. Detailed results are provided in Appendix C.

Based on results from the field observations and calculations, a 56.9% or 0.5101 tons/day load reduction is necessary to move from the current condition to the natural background load capacity of the system for restoration of beneficial uses.

Table 24. Current sediment loads within the Beaver-Camas subbasin.

AU Name	AU Number	Field Recession Rate (ft/year)	Load Capacity (tons/day)	Current Load (tons/day)	Required Reduction (%)	Estimation Method
Beaver Creek (Van Noy Canyon Creek)	018_02	0.0325	0.3866	0.8581	56.9	Observed erosion rate volume extrapolated to total length of AU

5.3.6 Load Allocation

There are no point sources that discharge into the Beaver-Camas subbasin, so no wasteload allocations are necessary. Sediment impaired streams in the Beaver-Camas subbasin are impaired from nonpoint sources. (i.e., streambank erosion). At higher flows, greater sediment loads can be expected. During low flow periods, significantly less erosion is expected.

The load allocation is the portion of the load capacity that is allocated to nonpoint sources. Sediment load allocations are estimated targets to improve water quality so the beneficial uses will be fully supported. The load allocation includes natural background and reserves 10% of the load capacity for an explicit margin of safety, as shown by the below equation. Table 23 details the load allocation, current load and the sediment reduction necessary to achieve Van Noy Canyon Creek's load capacity.

$$Load\ Allocation\left(\frac{tons}{day}\right) = \frac{[\text{Eroding Area}\ (sq\ ft) * 80\%\ \text{Bank Stability Factor}] * \text{Target Recession Rate}\left(\frac{\text{ft}}{yr}\right) * \text{bulk density} * 0.0005\left(\frac{tons}{lbs}\right)}{\text{Total Surveyed Length (ft)}} * Total\ AU\ Length\ (ft) * 0.0027\left(\frac{yr}{day}\right) * 0.9$$

Where:

a. Eroding Area is measured from SEI survey
b. 80% stability factor is a conversion to estimate load at 80% stable streambanks
c. Target Recession Rate is estimated from Target Stability Score

d. Bulk Density is estimated from soil texture observed during survey which was 80 lbs/ft^3
e. 0.9 is the 10% Margin of Safety

5.3.6.1 Margin of Safety

A 10% MOS is applied to ensure that beneficial uses will be restored. This MOS is applied by determining 10% of the load capacity. The load reduction is determined by subtracting the load capacity from the current load inclusive of the 10% MOS (Table 23).

5.3.6.2 Seasonal Variation

Most of the total annual sediment load erodes from the streambanks during the spring high flow caused by snowmelt or rain-on-snow events when the streams are at or near bankfull levels. Throughout most of the year during base flow conditions, stream discharge is usually too low to create large amounts of scour or to transport high volumes of sediment. High flows create the greatest scour and have the greatest capability of carrying high bed and suspended loads (Allan 1995). The SEI measures eroded streambanks at their bankfull level to account for this sediment load. Monitoring streambank erosion is done during base flow conditions to more accurately measure erodible banks.

5.3.6.3 Natural Background

Sediment load allocations are estimated targets to improve water quality to support COLD and SS beneficial uses. The load capacity is the natural, minimally eroded state in a vegetated and stable streambank. The load capacity is the natural background condition, currently targeted to be 80% stable streambanks, with the lateral recession rate of the respective stream. Sediment may be the causal factor for impairment, but until the stream meets the designated beneficial uses, typically determined by passing BURP scores, any implementation and load reduction cannot be deemed successful.

5.3.6.4 Sediment TMDL Summary

A summary of the Sediment TMDL is provided in Table 25. Based on results from the field observations and calculations, a 56.9% or 0.5101 tons/day load reduction is necessary to move from the current condition to the natural background load capacity of the system for restoration of beneficial uses.

Table 25. Nonpoint source sediment load allocations for the Beaver-Camas subbasin.

AU Name	AU Number	Current Load (tons/day)	Load Capacity (tons/day)	Margin of safety (tons/day)	Load Allocation (tons/day)	Necessary Load Reduction (tons/day)	Necessary Percent Reduction (%)
Beaver Creek (Van Noy Canyon Creek)	018_02	0.8581	0.3866	0.0387	0.3479	0.5101	56.9

5.4 Reasonable Assurance

CWA §319 requires each state to develop and submit a nonpoint source management plan. The *Idaho Nonpoint Source Management Plan* was approved by EPA in March 2015 (DEQ 2015). The plan identifies programs to achieve implementation of nonpoint source best management practices (BMPs), includes a schedule for program milestones, outlines key agencies and agency roles, is certified by the state attorney general to ensure that adequate authorities exist to implement the plan, and identifies available funding sources.

Idaho's nonpoint source management program describes many of the voluntary and regulatory approaches the state will take to abate nonpoint pollution sources. One of the prominent programs described in the plan is the provision for public involvement, including basin advisory groups and WAGs. The Clark Soil Conservation District acts as the WAG for the Beaver-Camas subbasin because there is no official group.

Idaho's water quality standards refer to existing authorities to control nonpoint pollution sources in Idaho. Some of these authorities and responsible agencies are listed in Table 26.

Table 26. State of Idaho's regulatory authority for nonpoint pollution sources.

Authority	Water Quality Standard	Responsible Agency
Rules Pertaining to the Idaho Forest Practices Act (IDAPA 20.02.01)	58.01.02.350.03(a)	Idaho Department of Lands
Solid Waste Management Rules and Standards (IDAPA 58.01.06)	58.01.02.350.03(b)	Idaho Department of Environmental Quality
Individual/Subsurface Sewage Disposal Rules (IDAPA 58.01.03)	58.01.02.350.03(c)	Idaho Department of Environmental Quality
Stream channel Alteration Rules (IDAPA 37.03.07)	58.01.02.350.03(d)	Idaho Department of Water Resources
Rathdrum Prairie Sewage Disposal Regulations (Panhandle District Health Department)	58.01.02.350.03(e)	Idaho Department of Environmental Quality/ Panhandle District Health Department
Rules Governing Exploration, Surface Mining and Closure of Cyanidation Facilities (IDAPA 20.03.02)	58.01.02.350.03(f)	Idaho Department of Lands
Dredge and Placer Mining Operations in Idaho (IDAPA 20.03.01)	58.01.02.350.03(g)	Idaho Department of Lands
Rules Governing Dairy Waste (IDAPA 02.04.14)	58.01.02.350.03(h)	Idaho State Department of Agriculture

After TMDL approval by DEQ, EPA, and stakeholders, the next step of Idaho's water body management process is implementation. Idaho's water quality standards identify designated agencies that are responsible for evaluating and modifying BMPs to protect impaired water bodies. DEQ is committed to developing implementation plans within 18 months of EPA approval of a TMDL document. The WAG, DEQ, and other agencies will develop implementation plans, and DEQ will incorporate them into the state's water quality management plan.

Ongoing assessment of the support status of the water bodies with TMDLs will be reported in a 5-year review of the TMDL. If full support status has not been achieved, further implementation

will be necessary and further assessment performed until full support status is reached. Monitoring will be done at least every 5 years. If full support status is reached, the requirements of the TMDL will be considered complete.

5.5 Stormwater and Wasteload Allocationst

There are no known NPDES-permitted point sources in the affected watersheds and no wasteload allocations. Restoration projects have been implemented in the Beaver-Camas subbasin (section 4.2). The majority of these projects did not disturb 1 or more acres and did not qualify for Construction General Permit (CGP) coverage. The projects that disturbed 1 or more acres obtained nationwide 404 permits, 401 certifications, and stream channel alteration permits.

If a point source is proposed that would have thermal consequences on these waters, background provisions in Idaho's water quality standards addressing such discharges (IDAPA 58.01.02.200.09; IDAPA 58.01.02.401.01) should be involved (Appendix B).

Stormwater runoff is water from rain or snowmelt that does not immediately infiltrate into the ground and flows over or through natural or man-made storage or conveyance systems. When undeveloped areas are converted to land uses with impervious surfaces—such as buildings, parking lots, and roads—the natural hydrology of the land is altered and can result in increased surface runoff rates, volumes, and pollutant loads. Certain types of stormwater runoff are considered point source discharges for CWA purposes, including stormwater associated with municipal separate storm sewer systems, industrial stormwater covered under the Multi-Sector General Permit, and construction stormwater covered under the CGP.

The Beaver-Camas subbasin is rural with small towns. The largest town in the subbasin is Dubois, with an estimated 2018 population of 588 (US Census Bureau 2018). Due to the rural location, small population, and land use characteristics of the Beaver-Camas subbasin, there are no point source discharges associated with any of the different stormwater runoff permits. For more information about these permits and managing stormwater, see 201Appendix E.

5.6 Reserve for Growth

There are no point sources in the watershed so no wasteload allocations are included in this TMDL. Although new point sources introduced into the subbasin would receive a wasteload allocation in a future TMDL revision, it is unlikely that there will be a need for a reserve for growth due to the rural location, small population, and land use characteristics of the Beaver-Camas subbasin.

The load capacity has been allocated to existing sources in the watershed. There is no nonpoint reserve for growth for sediment or temperature TMDLs. The allocation for a temperature TMDL is based on meeting natural background riparian canopy conditions. Allocations for sediment TMDLs are based on meeting non-point source sediment targets.

E. coli TMDL allocations are based on a target concentration. Therefore, growth can occur provided that any point source discharge is less than or equal to the water quality criteria for *E. coli*.

5.7 Implementation Strategies

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that TMDL goals are not being met or significant progress is not being made toward achieving the goals. Reasonable assurance (section 5.5) for the TMDL to meet water quality standards is based on the implementation strategy.

Implementation strategies for TMDLs produced using PNV-based shade and solar loads should incorporate the load analysis tables presented in this TMDL (Appendix C, Tables C5–C24). These tables need to be updated, first to field verify the remaining existing shade levels and second to monitor progress toward achieving reductions and TMDL goals. 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 load analysis tables. Implementation strategies should include Solar Pathfinder monitoring to simultaneously field verify the TMDL and mark progress toward achieving desired load reductions.

Streambank restoration projects can be beneficial in eliminating multiple pollutants. Projects that have been implemented to improve temperature impairments have also improved sediment and *E. coli* impairments. The establishment of riparian communities along a stream helps shade the stream and prevent excess solar load. Exclusionary fencing installed to protect the plants while they are maturing, can reduce *E. coli* input into the stream by preventing access to the stream. As the riparian communities become established and anchor their roots into the soil, streambank stabilization also occurs. Excess sediment load into the stream can be reduced or eliminated, once the streambank stabilizes.

There may be a variety of reasons that individual stream segments do not meet shade targets, including natural phenomena (e.g., beaver ponds, springs, wet meadows, and past natural disturbances) and/or historic land-use activities (e.g., logging, grazing, and mining). Existing shade for each stream segment should be field verified to determine if shade differences are real and result from activities that are controllable. The maps and load analysis tables in this TMDL should be used to guide and prioritize implementation investigations. The information in this TMDL may need further adjustment to reflect new information and conditions in the future.

5.7.1 Time Frame

Once BMPs are in place, a time frame of 5–10 years is required to begin the process of streambank stabilization and initial identification of diminished volumes of fine sediment. Given their smaller bankfull widths, smaller streams may reach targets sooner than larger streams. It

is estimated that without new sediment inputs, the removing fines on the substrate and redeveloping the thalweg will take approximately 5 years.

Implementing the temperature TMDL relies on riparian area management practices that will provide a mature canopy cover to shade the stream and prevent excess solar load. Because implementation depends on mature riparian communities to substantially improve stream temperatures, DEQ believes 10–20 years may be a reasonable amount time for achieving water quality standards. Shade targets will not be achieved all at once. Given their smaller bankfull widths, smaller streams may reach targets sooner than larger streams.

If range or pasture management practices are suspected to be a source of bacteria impairment, substantial water quality improvements will not take as long to realize as temperature or sediment improvements. Although there may still be bacteria input by wildlife and other sources; improvements based on changes in range management practices can be realized almost immediately.

5.7.2 Approach

Full support of beneficial uses is the goal of any strategy implemented to increase shade on a stream, increase streambank stability or eliminate bacteria impairment. The same techniques described in this document that were used for temperature, streambank stability, and bacteria monitoring can be implemented at the same locations to determine whether strategy implementation is successful or whether alternative strategies are necessary to achieve the goal of beneficial use attainment.

The *Beaver-Camas Subbasin 17040214 Total Maximum Daily Load Implementation Plan for Agriculture* (ISWCC 2010) was developed several years following the Beaver-Camas subbasin TMDL (DEQ 2005a). The plan was developed to identify BMPs for implementation on agricultural lands. These BMPs were intended to help meet the requirements of the TMDL load allocations by reducing the amount of agricultural pollutants entering water bodies. A number of projects were implemented in the Beaver-Camas subbasin based on BMPs developed. The Clark Soil Conservation District continues to work with landowners to implement appropriate BMPs in the subbasin. The USFS, IDFG, NRCS, and BLM identified and implemented restoration and other water quality improvement projects in the Beaver-Camas subbasin. Section 4 includes examples of these projects.

Funding provided under CWA §319 and other funds will be used to encourage voluntary projects to reduce nonpoint source pollution.

5.7.3 Responsible Parties

DEQ and the designated management agencies in Idaho have primary responsibility for overseeing implementation in cooperation with landowners and managers. In Idaho, these agencies, and their federal and state partners, are charged by the CWA to lend available technical assistance and other appropriate support to local efforts for water quality

improvements. Designated state agencies assist with preparing specific implementation plans for resources they have regulatory authority or programmatic responsibility:

- Idaho Department of Lands for timber harvest, oil and gas exploration and development, and mining
- Idaho Soil and Water Conservation Commission for grazing and agricultural activities
- Idaho Transportation Department for public road construction
- Idaho Department of Water Resources for stream channel alteration activities
- Idaho State Department of Agriculture for aquaculture and animal feeding operations
- DEQ for all other activities

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

5.7.4 Implementation Monitoring Strategy

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

Monitoring will provide information on progress made toward achieving TMDL allocations and water quality standards and will help in the interim evaluation of progress, including in the development of 5-year reviews and future TMDLs.

BURP monitoring, as prescribed in the *Water Body Assessment Guidance* (DEQ 2016a), is used to collect data on AUs and to determine the support status of an AU's beneficial uses. BURP monitoring, in conjunction with temperature, sediment, and bacteria monitoring, provide comprehensive tracking of the water quality in the Beaver-Camas subbasin.

Effective shade monitoring can take place on any segment throughout the Beaver-Camas subbasin and be compared to existing shade estimates (Appendix C, Tables C5–C24 and Figures C28, C31, and C34). Those areas with the largest disparity between existing and target shade should be monitored with Solar Pathfinders to verify existing shade levels and determine progress toward meeting shade targets. Many existing shade estimates have not been field verified, so they may require adjustment during the implementation process. Stream segment length for each estimate of existing shade varies depending on the 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 toward target levels. Ten equally spaced

Solar Pathfinder measurements averaged together within that segment should suffice to determine new shade levels in the future.

Sediment monitoring can either take place at the same location where a previous SEI identified a sediment impairment or a location representative of an AU where a sediment impairment has been confirmed. Results of this SEI monitoring can be compared to previous SEI monitoring to evaluate whether sedimentation problems are improving and if implementation measures have succeeded.

Bacteria monitoring can take place in the same locations where bacteria sampling occurred in an AU that has a bacteria TMDL. Samples should be taken during the critical time of the year (May–October) and compared to Idaho's water quality standards to determine if the implemented BMPs have been effective.

The implementation plan will be tracked by accounting for the numbers, types, and locations of projects, BMPs, educational activities, or other actions taken to improve or protect water quality. Implementation plan monitoring will include watershed monitoring and BMP monitoring.

6 Conclusions

Effective shade targets were established for 20 AUs based on the concept of maximum shading under updated PNV techniques resulting in natural background temperature levels. Shade targets were derived from effective shade curves developed for similar vegetation types in Idaho. Existing shade was determined from aerial photo interpretation and partially field verified with Solar Pathfinder data. Target and existing shade levels were compared to determine the amount of shade needed to bring water bodies into compliance with temperature criteria in Idaho's "Water Quality Standards" (IDAPA 58.01.02). PNV analyses of three AUs on Beaver Creek (ID17040214SK018_04, ID17040214SK020_03, and ID17040214SK021_03) did not result in shade deficiencies, but TMDLs were developed for the AUs due to changes in PNV methodology that occurred since the Beaver-Camas subbasin TMDL (DEQ 2005a) was approved.

E. coli was sampled and geometric mean concentrations were calculated for 10 AUs. Seven of the 10 AUs exceeded the water quality criteria for *E. coli* and required bacteria TMDLs. Reductions in *E. coli* concentrations are required in the following AUs:

- Ching Creek (ID17040214SK006_03)—50%
- East Camas Creek (ID17040214SK010_02)—7%
- West Camas Creek (ID17040214SK013_03)—56%
- Threemile Creek (ID17040214SK017_03)—68%
- Beaver Creek (ID17040214SK018_04)—62%
- Beaver Creek (ID17040214SK021_02)—71%
- Pleasant Valley Creek (ID17040214SK023_02)—89%

SEIs were conducted on six AUs in 2018. Results from SEIs conducted on five AUs did not identify sedimentation impacts. Van Noy Canyon Creek, a stream in the Beaver Creek AU (ID17040214SK018_02) exceeded streambank erosion targets, and a sediment TMDL was developed.

The primary goal that managers should strive for with future implementation plans are (1) reduce sediment and *E*. *coli* from entering streams by limiting wildlife and livestock points of access to the streams; and (2) meet target shade levels for individual stream segments. Managers should focus on the largest differences between existing and target shade as locations to prioritize implementation efforts.

Table 27 lists the temperature, sediment, and bacteria TMDLs developed with this document. A summary of assessment outcomes for Category 5 and Category 4a AUs and recommended changes to listing status in the next Integrated Report is presented in Table 28 and Table 29.

Table 27. Water bodies and pollutants for which temperature, sediment, or bacteria TMDLs were developed.

Water Body	AU Number	Confirmed Impairments
Camas Creek—Spring Creek to Beaver Creek	ID17040214SK002_05	Temperature—Updated
Ching Creek—source to mouth	ID17040214SK006_03	*E. coli*
Crooked/Crab Creek—source to mouth	ID17040214SK008_03	Temperature
Warm Creek—Cottonwood Creek to mouth and East Camas Creek	ID17040214SK009_02	Temperature
East Camas Creek	ID17040214SK010_02	Temperature—Updated
East Camas Creek	ID17040214SK010_03	Temperature—Updated *E. coli*
East Camas Creek—source to Larkspur Creek	ID17040214SK011_02	Temperature—Updated
East Camas Creek—source to Larkspur Creek	ID17040214SK011_03	Temperature—Updated
West Camas Creek	ID17040214SK012_03	Temperature—Updated
West Camas Creek—source to Targhee National Forest Boundary	ID17040214SK013_02	Temperature—Updated
West Camas Creek—source to Targhee National Forest Boundary	ID17040214SK013_03	Temperature—Updated *E. coli*
Rattlesnake Creek—source to mouth	ID17040214SK016_02	Temperature
Threemile Creek—source to mouth	ID17040214SK017_02	Temperature—Updated
Threemile Creek—source to mouth	ID17040214SK017_03	Temperature—Updated *E. coli*
Beaver Creek)—Miner's Creek to Rattlesnake Creek	ID17040214SK018_02	Sedimentation/siltation Temperature—Updated
Beaver Creek—Miner's Creek to Rattlesnake Creek	ID17040214SK018_04	Temperature—Updated *E. coli*
Beaver Creek —Idaho Creek to Miner's Creek	ID17040214SK020_03	Temperature—Updated
Beaver Creek—source to Idaho Creek	ID17040214SK021_02	Temperature—Updated *E. coli*
Beaver Creek—source to Idaho Creek	ID17040214SK021_03	Temperature—Updated
Pleasant Valley Creek—source to mouth	ID17040214SK023_02	*E. coli* Temperature
Huntley Canyon Creek—source to mouth	ID17040214SK024_02	Temperature—Updated

Table 28. Summary of assessment outcomes for Category 5 AUs evaluated.

AU NAME	AU ID	CAUSE	TMDL	Recommended Changes to Next IR	Justification
Ching Creek - source to mouth	ID17040214SK006_03	ESCHERICHIA COLI (E. COLI)	Yes	Delist from Category 5 for E. coli; include in Category 4a for E. coli.	Bacteria TMDL completed based on 30-day geometric mean concentrations.
Crooked/Crab Creek - source to mouth	ID17040214SK008_03	COMBINED BIOTA/HABITAT BIOASSESSMENTS	Yes	Include in Category 4a for temperature	Temperature criteria exceeded. TMDL developed based on PNV Methodology.
Warm Creek - Cottonwood Cr. to mouth and East Camas Creek	ID17040214SK009_02	COMBINED BIOTA/HABITAT BIOASSESSMENTS	Yes	Include in Category 4a for temperature	Temperature criteria exceeded. TMDL developed based on PNV methodology.
East Camas Creek	ID17040214SK010_03	ESCHERICHIA COLI (E. COLI)	Yes	Include in Category 4a for E. Coli	Bacteria TMDL completed based on 30-day geometric mean concentrations.
West Camas Creek - source to Targhee National Forest Boundary	ID17040214SK013_03	ESCHERICHIA COLI (E. COLI)	Yes	Delist from Category 5 for E. coli; include in Category 4a for *E. coli.*	Bacteria TMDL completed based on 30-day geometric mean concentrations.
Rattlesnake Creek - source to mouth	ID17040214SK016_02	COMBINED BIOTA/HABITAT BIOASSESSMENTS	Yes	Delist from Category 5 for combined biota/habitat bioassessments. Include in Category 4a for temperature.	Temperature criteria exceeded. TMDL developed based on PNV methodology. BURP data and SEI survey indicate sediment is not an impairment cause.
Threemile Creek - source to mouth	ID17040214SK017_03	FECAL COLIFORM	Yes	Delist from Category 5 for fecal coliform, included in Category 4a for E. coli	Bacteria TMDL *completed* based on 30-day geometric mean concentrations.
Beaver Creek - Miners Creek to Rattlesnake Creek	ID17040214SK018_02	COMBINED BIOTA/HABITAT BIOASSESSMENTS	Yes	Delist from Category 5 for combined biota/habitat bioassessments, move to category 4a for sedimentation/siltation	BURP metrics showed low FSBI score, high % fines, and low substrate size diversity indicating sediment is likely causing impairment. SEI survey showed bank stability below natural conditions. Sediment TMDL completed based on SEI survey.
Beaver Creek - Miners Creek to Rattlesnake Creek	ID17040214SK018_04	ESCHERICHIA COLI (E. COLI)	Yes	Delist from Category 5 for E. coli; include in Category 4a for E. coli.	Bacteria TMDL completed based on 30-day geometric mean concentrations.
Miner's Creek - source to mouth	ID17040214SK019_03	COMBINED BIOTA/HABITAT BIOASSESSMENTS	No	No	Not included in this project.

AU NAME	AU ID	CAUSE	TMDL	Recommended Changes to Next IR	Justification
Beaver Creek - source to Idaho Creek	ID17040214SK021_02	ESCHERICHIA COLI (E. COLI)	Yes	Delist from Category 5 for *E. coli*; include in Category 4a *for E.* coli.	Bacteria TMDL completed based on 30-day geometric mean concentrations.
Pleasant Valley Creek - source to mouth	ID17040214SK023_02	COMBINED BIOTA/HABITAT BIOASSESSMENTS	Yes	Delist from Category 5 for combined biota/habitat bioassessments, move to Category 4a for temperature.	Temperature criteria exceeded. TMDL developed based on PNV methodology.
		ESCHERICHIA COLI (E. COLI)	Yes	Delist from Category 5 for E. coli; include in Category 4a for E. coli	Bacteria TMDL completed based on 30-day geometric mean concentrations

Table 29. Summary of assessment outcomes for Category 4a AUs evaluated.

AU Name	AU ID	Impairment	Five Year Review	New TMDL	Recommended Changes to Next IR	Justification
Camas Creek - Spring Creek to Beaver Creek	ID17040214SK002_05	Sedimentation/ Siltation	Yes	No	Keep in Category 4a for sedimentation/siltation.	Access to AU was not available. No data is available to recommend delisting.
Camas Creek - Spring Creek to Beaver Creek	ID17040214SK002_05	Temperature	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
East Camas Creek	ID17040214SK010_02	Temperature	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
East Camas Creek	ID17040214SK010_03	Temperature	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
East Camas Creek - source to Larkspur Creek	ID17040214SK011_02	Temperature	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade

AU Name	AU ID	Impairment	Five Year Review	New TMDL	Recommended Changes to Next IR	Justification
East Camas Creek - source to Larkspur Creek	ID17040214SK011_03	Temperature	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
West Camas Creek	ID17040214SK012_03	Temperature	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
West Camas Creek -source to Targhee National Forest Boundary	ID17040214SK013_02	Temperature	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
West Camas Creek -source to Targhee National Forest Boundary	ID17040214SK013_03	Temperature	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
Beaver Creek - Dry Creek to canal (T09N, R36E)	ID17040214SK014_05	Temperature	No	No	Keep in Category 4a for temperature.	Not included in this project.
Threemile Creek - source to mouth	ID17040214SK017_02	Temperature	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
Threemile Creek - source to mouth	ID17040214SK017_03	Temperature	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
Beaver Creek - Miners Creek to Rattlesnake Creek	ID17040214SK018_02	Temperature	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade

AU Name	AU ID	Impairment	Five Year Review	New TMDL	Recommended Changes to Next IR	Justification
Beaver Creek - Miners Creek to Rattlesnake Creek	ID17040214SK018_04	Temperature	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
Beaver Creek - Idaho Creek to Miners Creek	ID17040214SK020_03	Temperature	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
Beaver Creek - source to Idaho Creek	ID17040214SK021_02	Temperature	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
Beaver Creek - source to Idaho Creek	ID17040214SK021_03	Temperature	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade
Huntley Canyon Creek - source to mouth	ID17040214SK024_02	Temperature	Yes	Yes	Keep in Category 4a for temperature.	Temperature TMDL completed based on updated PNV method. Excess solar load from lack of existing shade

This document was prepared with input from the public, as described in Appendix G. Following the public comment period, comments and DEQ responses will also be included in this appendix, and a distribution list will be included in Appendix H.

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GIS Coverages

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Glossary

§303(d)	Refers to section 303 subsection "d" of the Clean Water Act. Section 303(d) requires states to develop a list of water bodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to United States Environmental Protection Agency approval.
Assessment Unit (AU)	A group of similar streams that have similar land use practices, ownership, or land management. However, stream order is the main basis for determining AUs. All the waters of the state are defined using AUs, and because AUs are a subset of water body identification numbers, they tie directly to the water quality standards so that beneficial uses defined in the water quality standards are clearly tied to streams on the landscape
Beneficial Use	Any of the various uses of water that are recognized in water quality standards, including, but not limited to, aquatic life, recreation, water supply, wildlife habitat, and aesthetics.
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.
Exceedance	A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.
Fully Supporting	In compliance with water quality standards and within the range of biological reference conditions for all designated and existing beneficial uses as determined through the Water Body Assessment Guidance (DEQ 2016a).
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	The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Load is the product of flow (discharge) and concentration.
Load Capacity (LC)	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, a margin of safety, and natural background contributions, it becomes a total maximum daily load.
Margin of Safety (MOS)	An implicit or explicit portion of a water body's load capacity set aside to allow for uncertainly about the relationship between the pollutant loads and the quality of the receiving water body. The margin of safety 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 margin of safety is not allocated to any sources of pollution.
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 nonirrigated 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 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 (2016a).
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 plants.
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 that alter the functioning of natural processes and produce undesirable environmental and health effects. Pollution includes human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.
Potential Natural Vegetation (PNV)	A.U. Küchler (1964) defined potential natural vegetation as vegetation that would exist without human interference and if the resulting plant succession were projected to its climax condition while allowing for natural disturbance processes such as fire. Our use of the term reflects Küchler's definition in that riparian vegetation at PNV would produce a system potential level of shade on streams and includes recognition of some level of natural disturbance.
Stream Order	Hierarchical ordering of streams based on the degree of branching. A 1st-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.
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 basis. 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.
Wasteload Allocation (WLA)	The portion of receiving water's load 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 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, aquatic habitat, or industrial processes.
Water Quality Standards	State-adopted and United States 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.

Appendix A. Beneficial Uses

Idaho's "Water Quality Standards" (IDAPA 58.01.02) list beneficial uses and set water quality goals for waters of the state. IDAPA 58.01.02. 050.02 requires that surface waters of the state be protected for beneficial uses, wherever attainable. These beneficial uses are interpreted as existing uses, designated uses, and presumed uses.

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" (40 CFR 131.3). The existing instream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.051.01). Existing uses need to be protected, whether or not the level of water quality to fully support the uses currently exists. A practical application of this concept would be to apply the existing use of SS to a water that supported SS since November 28, 1975, but does not now due to other factors, such as blockage of migration, channelization, sedimentation, or excess heat.

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" (40 CFR 131.3). 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. Multiple uses often apply to the same water; in this case, water quality must be sufficiently maintained to meet the most sensitive use (designated or existing). 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 or SS. Designated uses are described in Idaho's "Water Quality Standards" (IDAPA 58.01.02.100) and specifically listed by water body in sections 110–160.

Undesignated Surface Waters and Presumed Use Protection

In Idaho, due to a change in scale of cataloging waters in 2000, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations (IDAPA 58.01.02.110–160). The water quality standards have three sections that address nondesignated waters. Sections 101.02 and 101.03 specifically address nondesignated man-made waterways and private waters. Man-made waterways and private waters have no presumed use protections. Man-made waters are protected for the use for which they were constructed unless otherwise designated in the water quality standards. Private waters are not protected for any beneficial uses unless specifically designated in the water quality standards.

All other undesignated waters are addressed by section 101.01. Under this section, absent information on existing uses, DEQ presumes that most Idaho waters will support COLD and

either PCR or SCR recreation (IDAPA 58.01.02.101.01). To protect these so-called presumed uses, DEQ applies the numeric cold water and recreation criteria to undesignated waters. If in addition to presumed uses, an additional existing use (e.g., SS) exists, then the additional numeric criteria for SS would also apply (e.g., intergravel dissolved oxygen, temperature) because of the requirement to protect water quality for that existing use. However, if some other use that requires less stringent criteria for protection (such as seasonal COLD) is found to be an existing use, then a use designation (rulemaking) is needed before that use can be applied in lieu of cold water criteria (IDAPA 58.01.02.101.01).

Appendix B. State and Site-Specific Water Quality Standards and Criteria

Table B1. Selected numeric criteria supportive of designated beneficial uses in Idaho's water quality standards.

Parameter	Primary Contact Recreation	Secondary Contact Recreation	Cold Water Aquatic Life	Salmonid Spawning[a]
Water Quality Standards: IDAPA 58.01.02.250–251				
Bacteria				
• Geometric mean	<126 *E. coli*/100 mL[b]	<126 *E. coli*/100 mL	—	—
• Single sample	≤406 *E. coli*/100 mL	≤576 *E. coli*/100 mL	—	—
Temperature[c]	—	—	22 °C or less daily maximum; 19 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average

a During spawning and incubation periods for inhabiting species
b Escherichia coli per 100 milliliters
c Temperature exemption: Exceeding the temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the ninetieth percentile of the 7-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.

Water Quality Standards Applicable to Salmonid Spawning Temperature

Idaho's water quality standards for temperature are specific numeric values not to be exceeded during the SS and egg incubation period, which varies by species. For spring-spawning salmonids, the default spawning and incubation period recognized by the Idaho Department of Environmental Quality (DEQ) is generally March 15 to July 15 (DEQ 2016b). Fall spawning can occur as early as September 1 and continue with incubation into the following spring up to June 1. As per IDAPA 58.01.02.250.02.f.ii., the following water quality criteria need to be met during that time period:

- 13 °C as a daily maximum water temperature
- 9 °C as a daily average water temperature

For the purposes of a temperature TMDL, the highest recorded water temperature in a recorded data set (excluding any high water temperatures that may occur on days when air temperatures exceed the 90th percentile of the highest annual maximum weekly maximum air temperatures) is compared to the daily maximum criterion of 13 °C. The difference between the two water temperatures represents the temperature reduction necessary to achieve compliance with temperature standards.

Natural Background Provisions

For PNV temperature TMDLs, it is assumed that natural temperatures may exceed these criteria during certain time periods. If PNV targets are achieved yet stream temperatures are warmer

than these criteria, it is assumed that the stream's temperature is natural (provided there are no point sources or human-induced ground water sources of heat) and natural background provisions of Idaho's water quality standards apply:

> 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. (IDAPA 58.01.02.200.09)

Section 401 relates to point source wastewater treatment requirements. In this case, if temperature criteria for any aquatic life use are exceeded due to natural conditions, then a point source discharge cannot raise the water temperature by more than 0.3 °C (IDAPA 58.01.02.401.01.c).

Appendix C. Data Sources

Table C-1. Data sources for Beaver-Camas subbasin assessment.

Water Body/Area	Data Source	Type of Data	Collection Date
Beaver-Camas subbasin	DEQ Idaho Falls Regional Office	PNV analyses	March–November 2018
		Solar Pathfinder effective shade and stream width	July–August 2018
		Streambank erosion inventories	July–August 2018
		E. coli sampling	September–October 2018
		Temperature loggers	May–November 2018
Beaver-Camas subbasin	Bureau of Land Management—Upper Snake Field Office	Restoration projects	December 2018
Beaver-Camas subbasin	US Forest Service—Caribou Targhee National Forest	Restoration projects and fish data	December 2018
Beaver-Camas subbasin	IDFG—Upper Snake Regional Office	Restoration projects and fishery management information	November 2018
Camas Creek	NRCS	Restoration projects	March 2019
Beaver-Camas subbasin	IDWR website—GIS data	Points of diversion—water rights shapefiles	October 2019
Beaver-Camas subbasin	NRCS USDA–SNOTEL (National Water and Climate Center)	2018 snow depth	December 2019
Beaver and Camas Creeks	USGS website—Stream Gages	Streamflow (cfs)	December 2019
Dubois, Camas, Kilgore, and Spencer, Idaho	WRCC—Period of Monthly Climate Summary	Historical temperatures in the Beaver-Camas subbasin	November 2019

Beaver-Camas Subbasin E. coli Data

Table C-2. *E. coli* sample results Beaver-Camas Subbasin

Ching Creek[a] – source to mouth		**ID17040214SK006_03**
		Geometric Mean
		254.0
Crooked/Crab Creek – source to mouth		**ID17040214SK008_03**
Sample Date	**Result ($^{cfu}/_{100\ mL}$)**	**Geometric Mean**
9/12/2018	116.9	124.3
9/19/2018	156.5	
9/26/2018	98.5	
10/03/2018	143.9	
10/10/2018	114.5	
East Camas Creek		**ID17040214SK010_03**
Sample Date	**Result ($^{cfu}/_{100\ mL}$)**	**Geometric Mean**
8/27/2012	613.1	134.6
8/30/2012	166.4	
9/10/2012	122.3	
9/17/2012	90.9	
9/24/2012	38.9	
West Camas Creek – source to Targhee National Forest Boundary		**ID17040214SK013_03**
Sample Date	**Result ($^{cfu}/_{100\ mL}$)**	**Geometric Mean**
8/27/2012	1553.1	282.2
8/30/2012	290.9	
9/10/2012	118.7	
9/17/2012	260.3	
9/24/2012	128.1	
Threemile Creek – source to mouth		**ID17040214SK017_03**
Sample Date	**Result ($^{cfu}/_{100\ mL}$)**	**Geometric Mean**
9/12/2018	266.7	394.6
9/19/2018	435.2	
9/26/2018	410.6	
10/3/2018	435.2	
10/10/2018	461.1	
Beaver Creek – Miner's Creek to Rattlesnake Creek		**ID17040214SK018_04**
Sample Date	**Result ($^{cfu}/_{100\ mL}$)**	**Geometric Mean**
8/27/2012	1732.9	333.6
8/30/2012	1732.9	
9/10/2012	71.7	
9/17/2012	275.5	

9/24/2012	69.7	
Beaver Creek – source to Idaho Creek		**ID17040214SK021_02**
Sample Date	**Result ($^{cfu}/_{100\ mL}$)**	**Geometric Mean**
8/27/2012	770.1	433.3
8/30/2012	816.4	
9/10/2012	186.0	
9/17/2012	201.4	
9/24/2012	648.8	
Pleasant Valley Creek – source to mouth		**ID17040214SK023_02**
Sample Date	**Result ($^{cfu}/_{100\ mL}$)**	**Geometric Mean**
8/21/2013	1732.9	1169.8
8/26/2013	770.1	
9/3/2013	1986.3	
9/9/2013	1203.3	
9/16/2013	686.7	

Notes: a. Ching Creek was listed in Category 5 for *E. coli* the 2010 Integrated Report based on collected samples and geomean number; however individual sample dates and results are not available.

Beaver-Camas Subbasin Temperature Logger Data

Table C-3. Temperature logger locations.

Location	AU Number	Latitude	Longitude	Logger #
Camas Creek	ID17040214SK002_05	44.288809	-111.89356	10685687
Crooked/Crab Creek	ID17040214SK008_03	44.42315	-111.95194	10961482
Warm Creek	ID17040214SK009_02	44.38968	-111.89352	10685684
East Camas Creek	ID17040214SK010_03	44.447124	-111.90332	10546361
East Camas Creek	ID17040214SK011_02	44.50034	-111.94234	10685678
East Camas Creek	ID17040214SK011_03	44.49972	-111.94667	10685681
West Camas Creek	ID17040214SK012_03	44.389557	-111.90183	10685685
West Camas Creek	ID17040214SK013_03	44.471904	-112.02238	10546356
Rattlesnake Creek	ID17040214SK016_02	44.37234	-112.04781	10685686
Threemile Creek	ID17040214SK017_02	44.38597	-112.11132	10685688
Threemile Creek	ID17040214SK017_03	44.34993	-112.14348	10349114
Beaver Creek	ID17040214SK020_03	44.43547	-112.20413	10685679
Beaver Creek	ID17040214SK021_03	44.520112	-112.25163	10685680
Pleasant Valley Creek	ID17040214SK023_02	44.431960	-112.26882	10546357
Huntley Canyon Creek	ID17040214SK024_02	44.368349	-112.19881	10685683

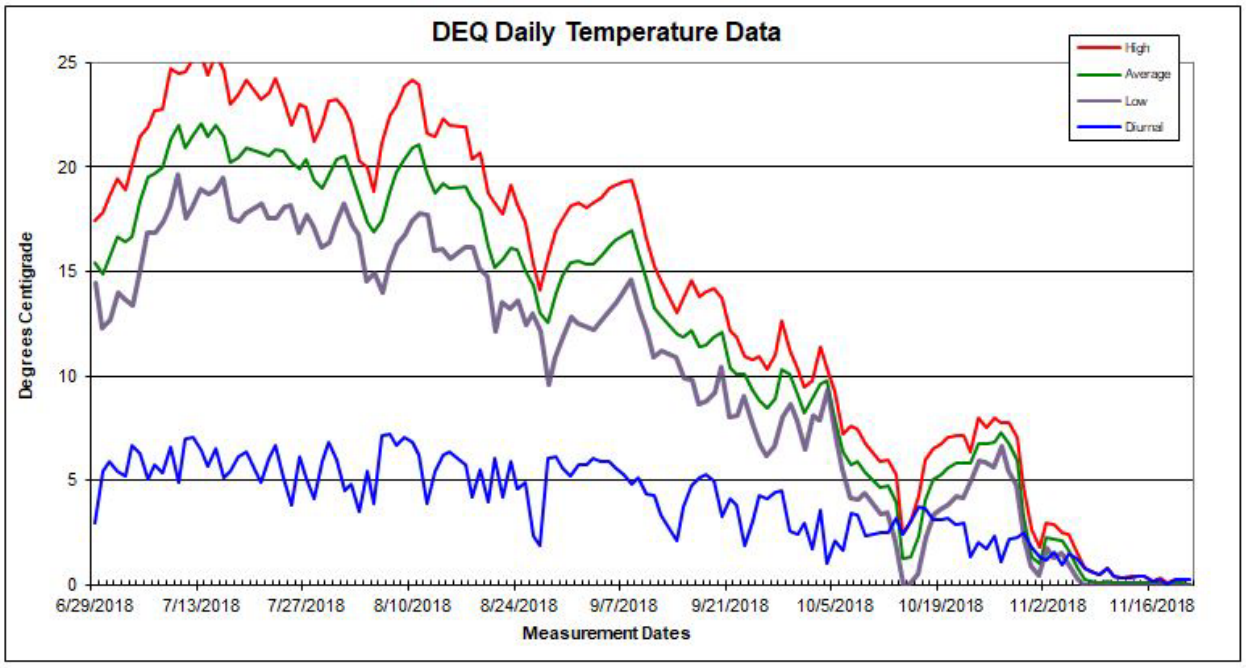


Figure C-1. Temperature data for Camas Creek ID17040214SK002_05.

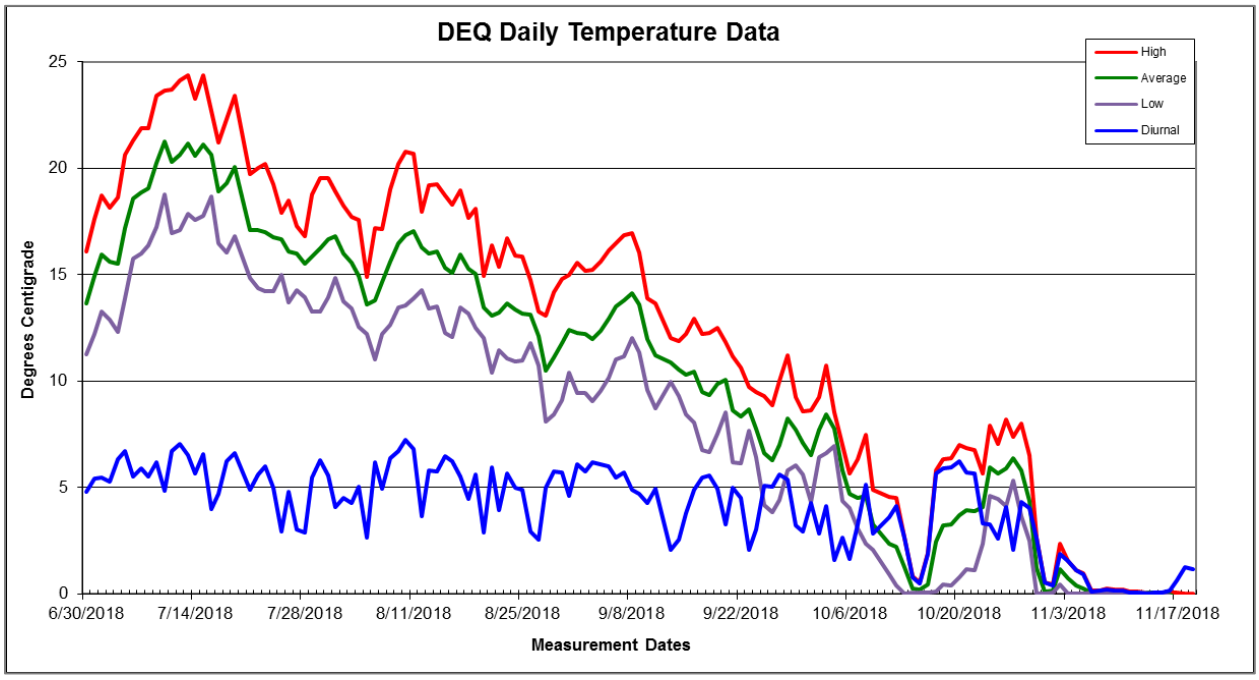


Figure C-2. Temperature data for Crooked/Crab Creek ID17040214SK008_03.

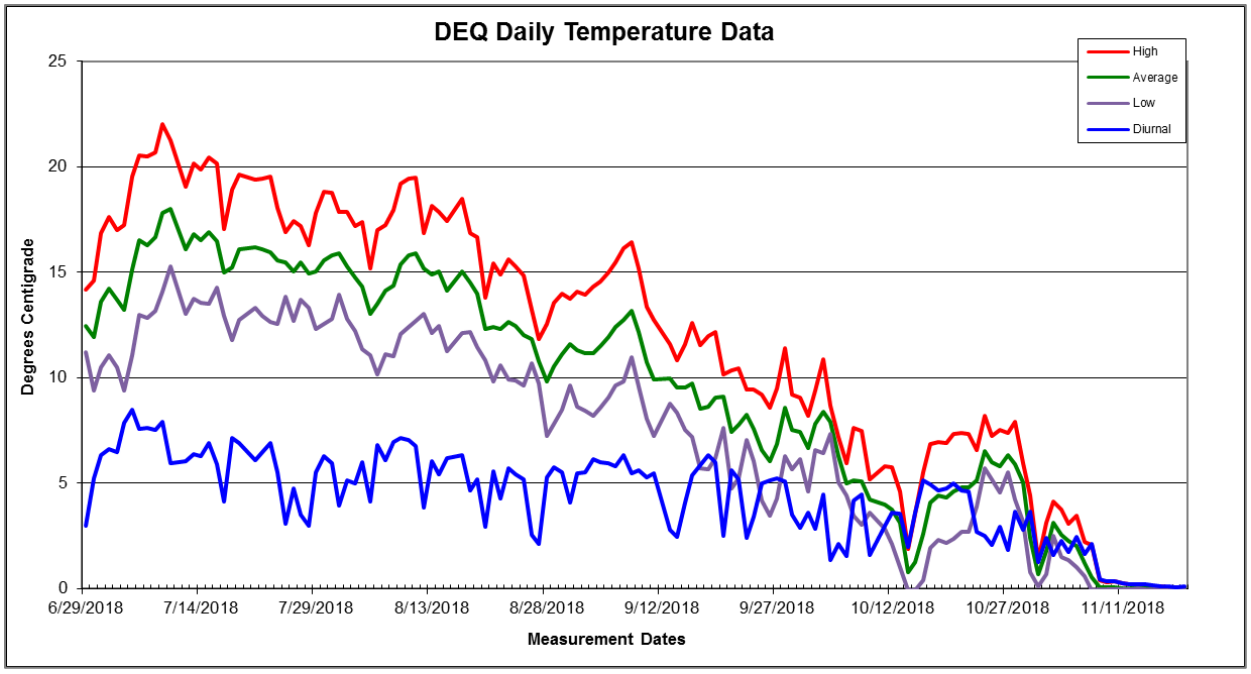


Figure C-3. Temperature data for Warm Creek ID17040214SK009_02.

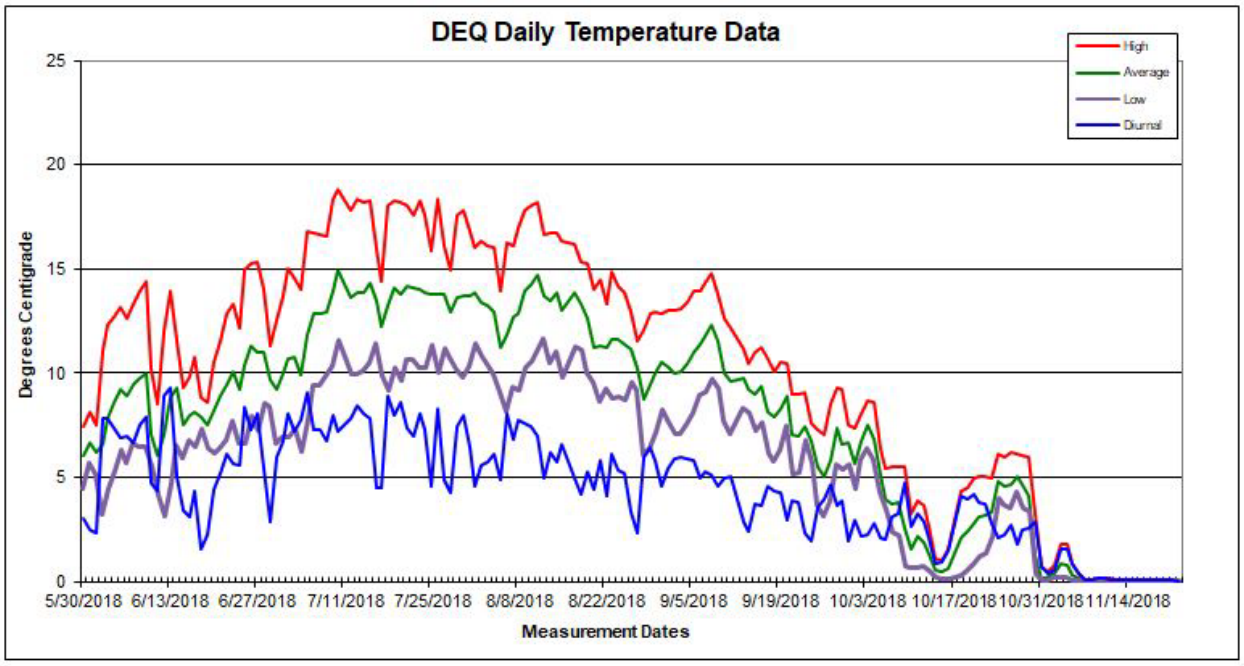


Figure C-4. Temperature data for East Camas Creek ID17040214SK010_03.

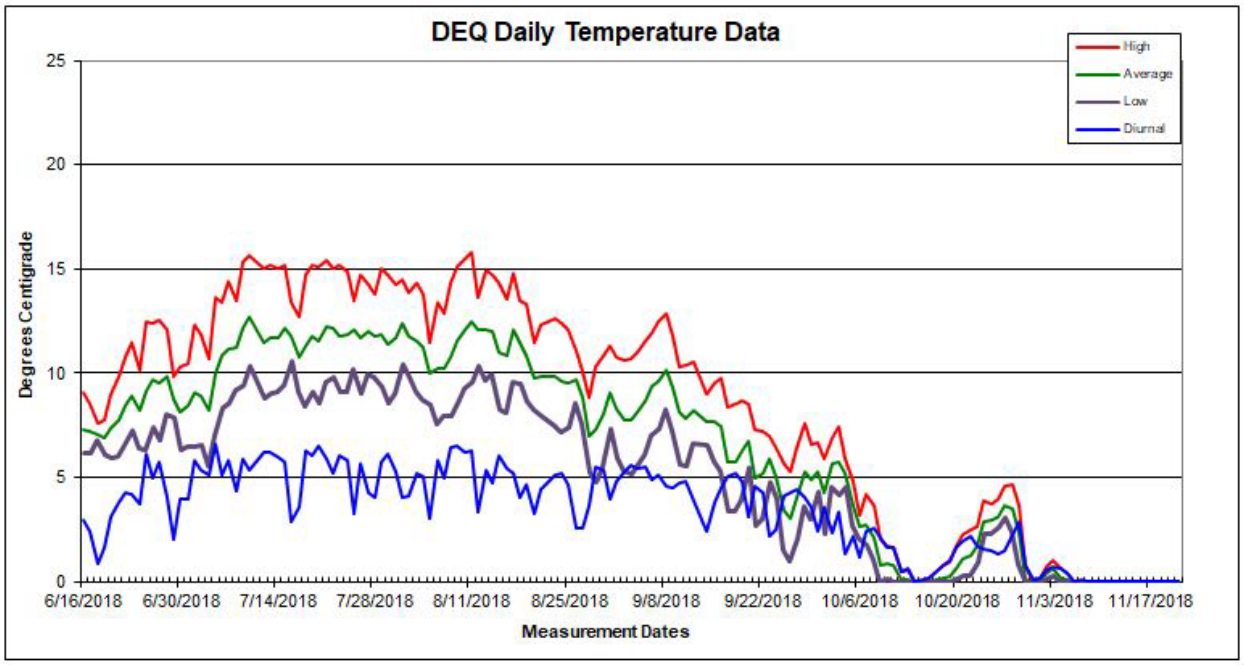


Figure C-5. Temperature data for East Camas Creek ID17040214SK011_02.

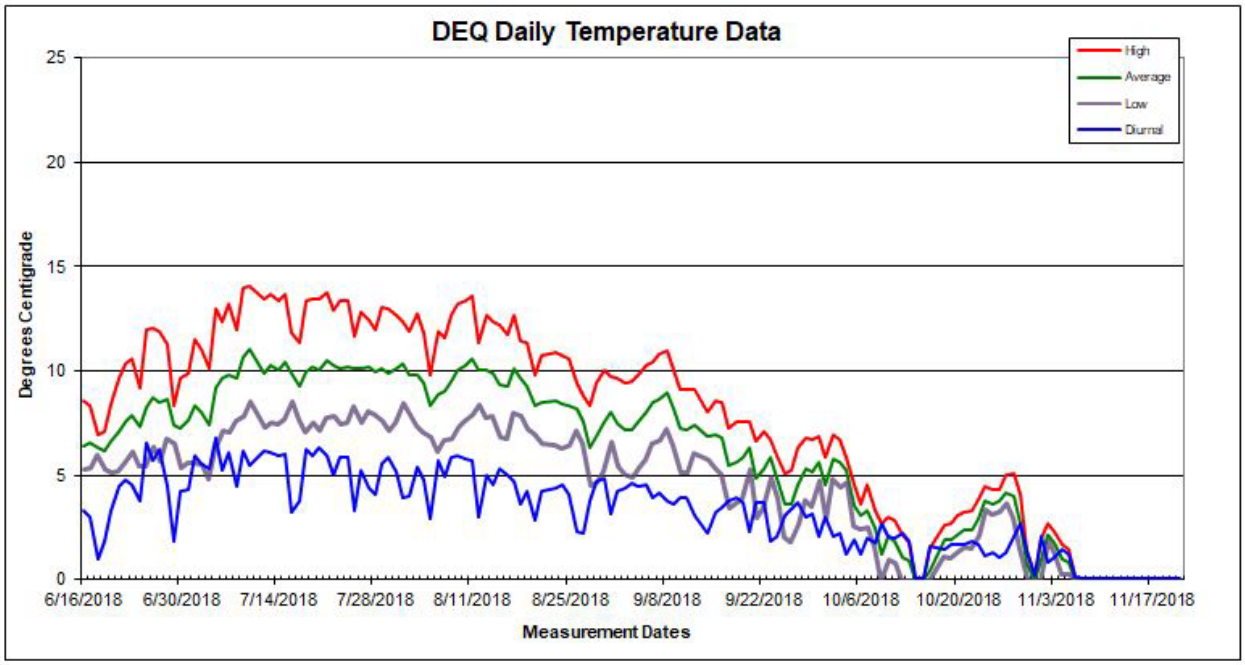


Figure C-6. Temperature data for East Camas Creek ID17040214SK011_03.

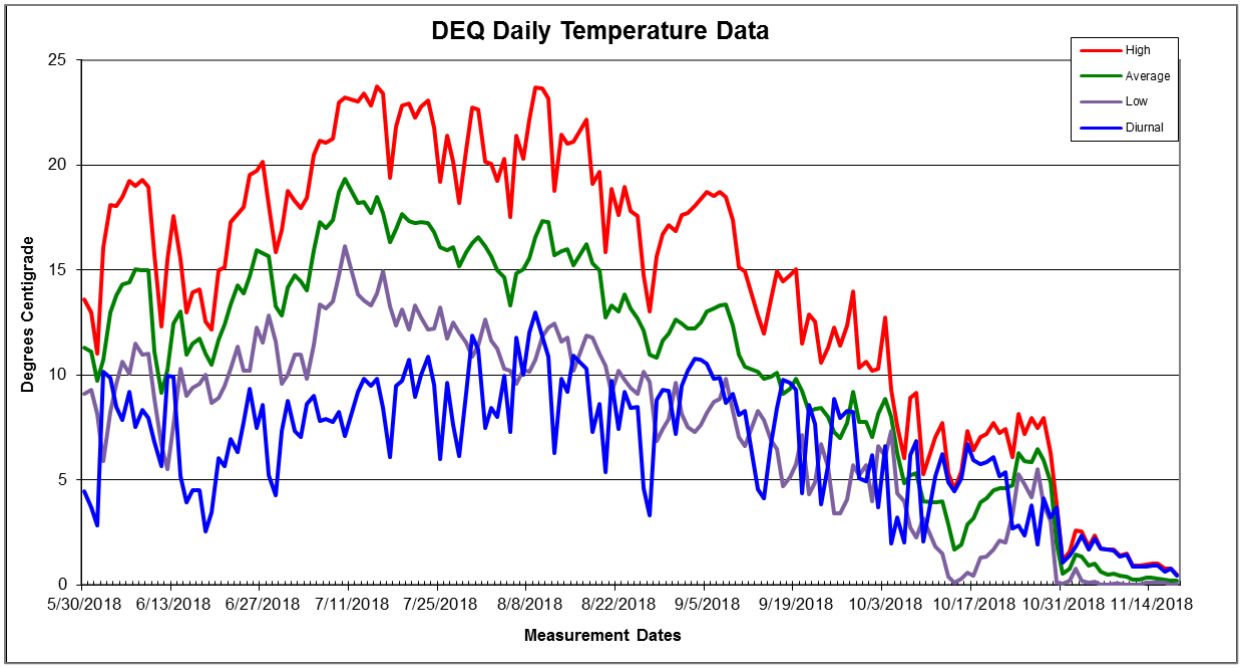


Figure C-7. Temperature data for West Camas Creek ID17040214SK012_03.

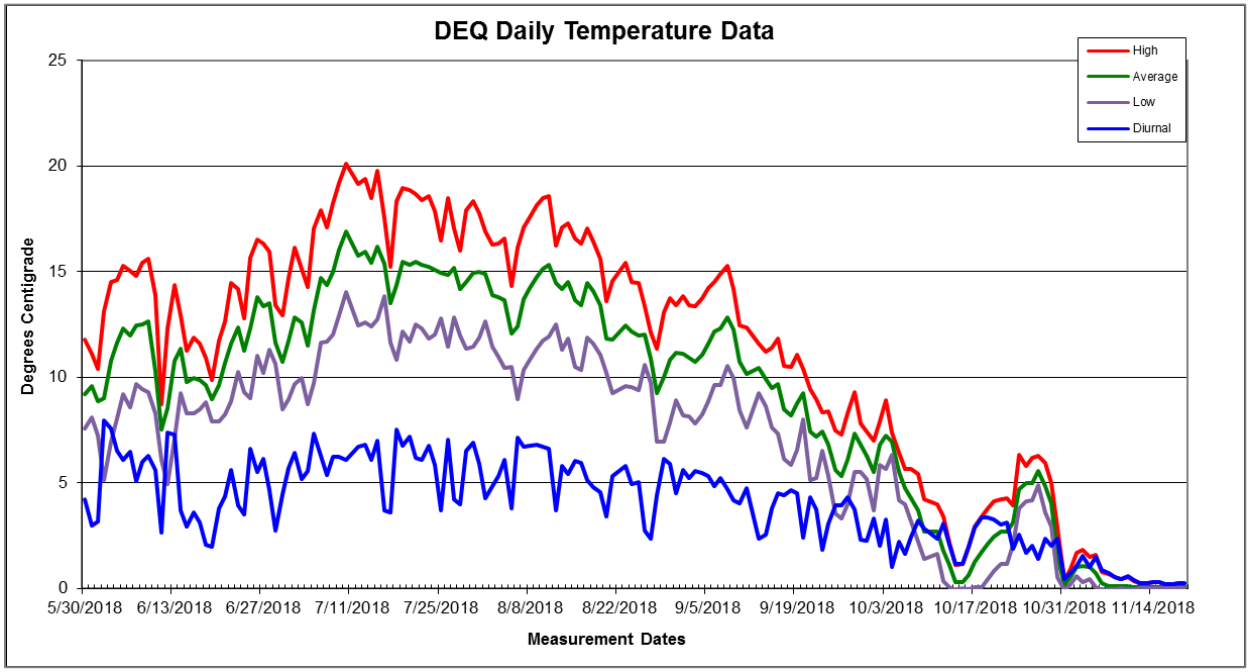


Figure C-8. Temperature data for West Camas Creek ID17040214SK013_03.

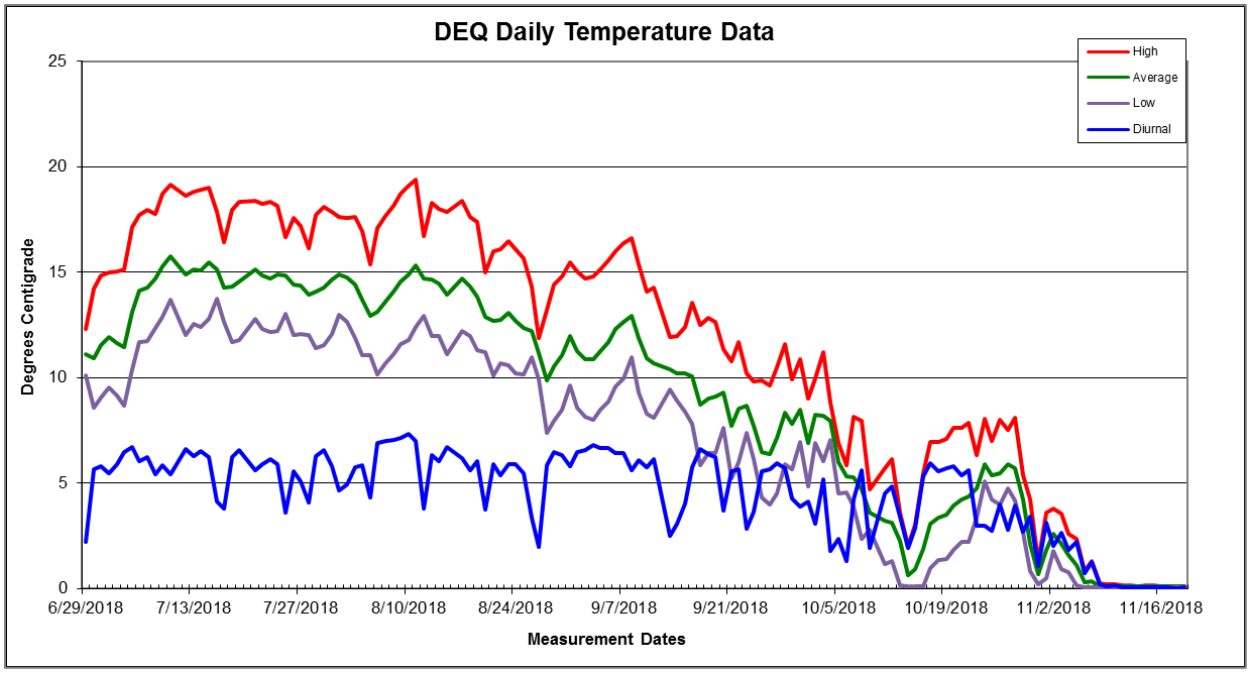


Figure C-9. Temperature data for Rattlesnake Creek ID17040214SK016_02.

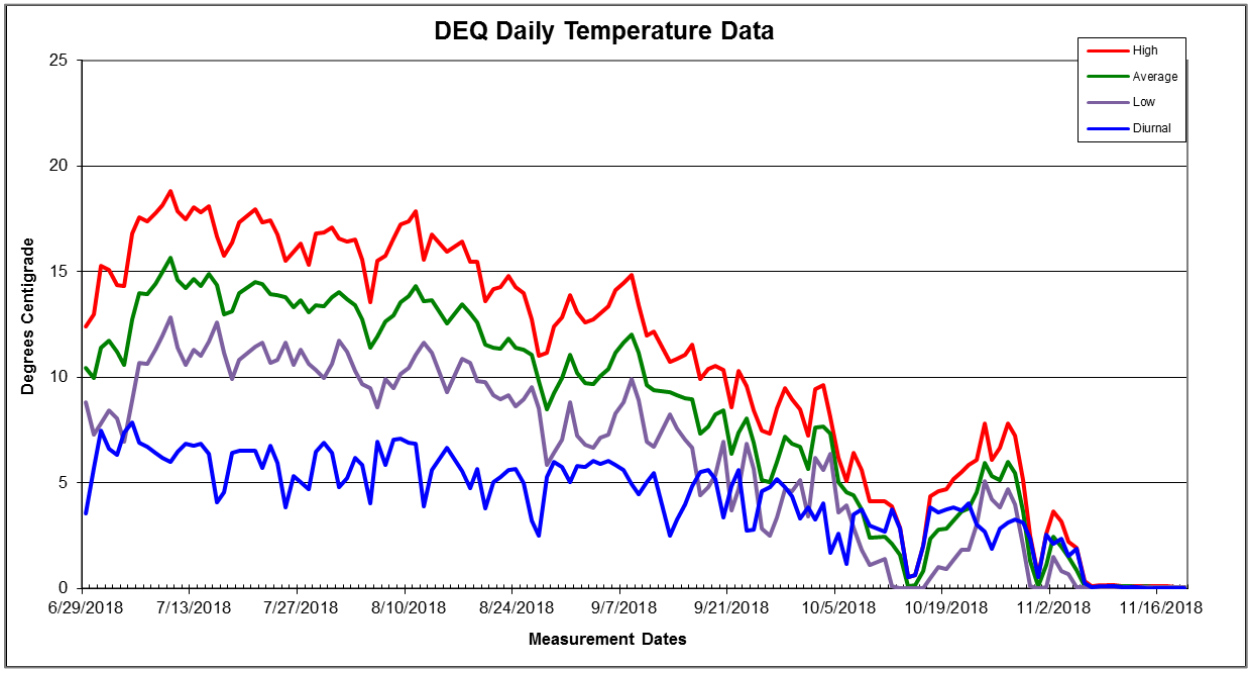


Figure C-10. Temperature data for Threemile Creek ID17040214SK017_02.

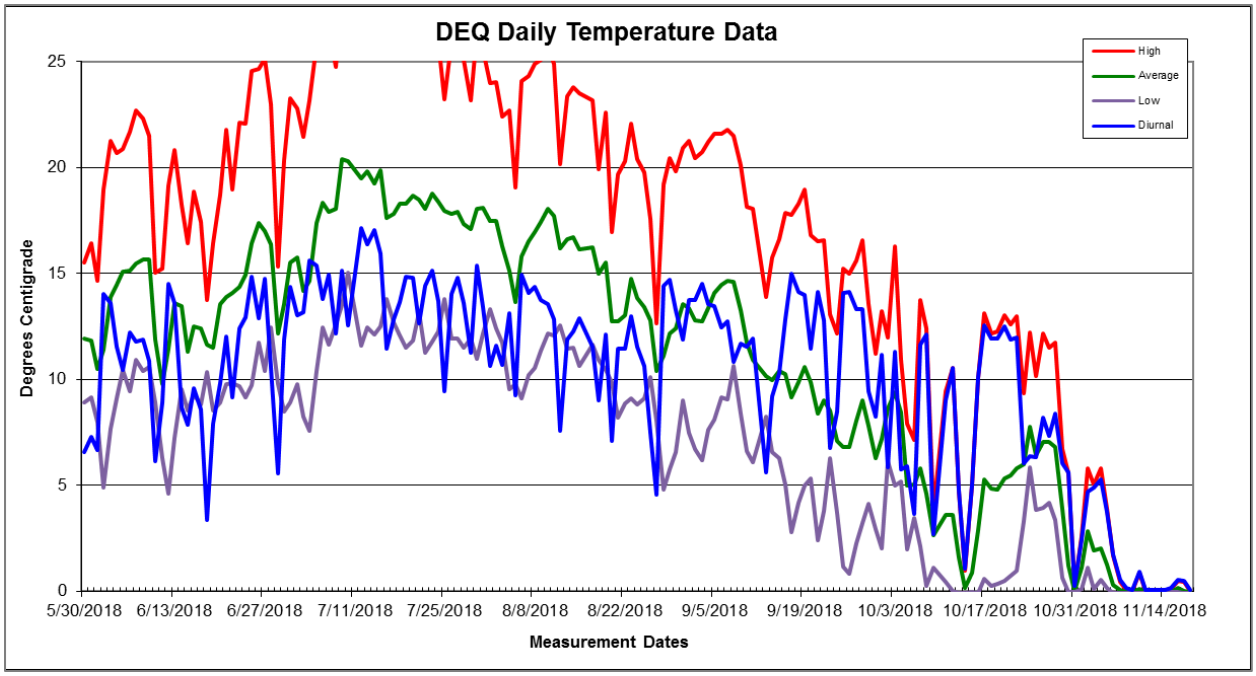


Figure C-11. Temperature data for Threemile Creek ID17040214SK017_03.

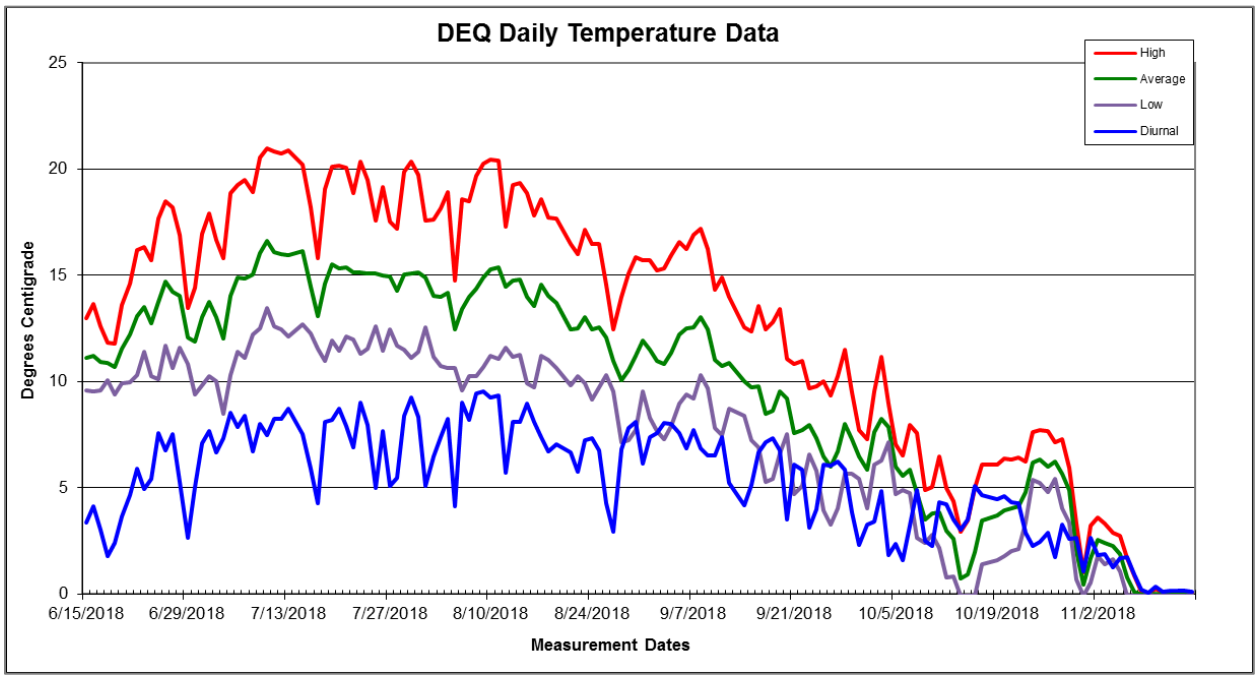


Figure C-12. Temperature data for Beaver Creek ID17040214SK020_03.

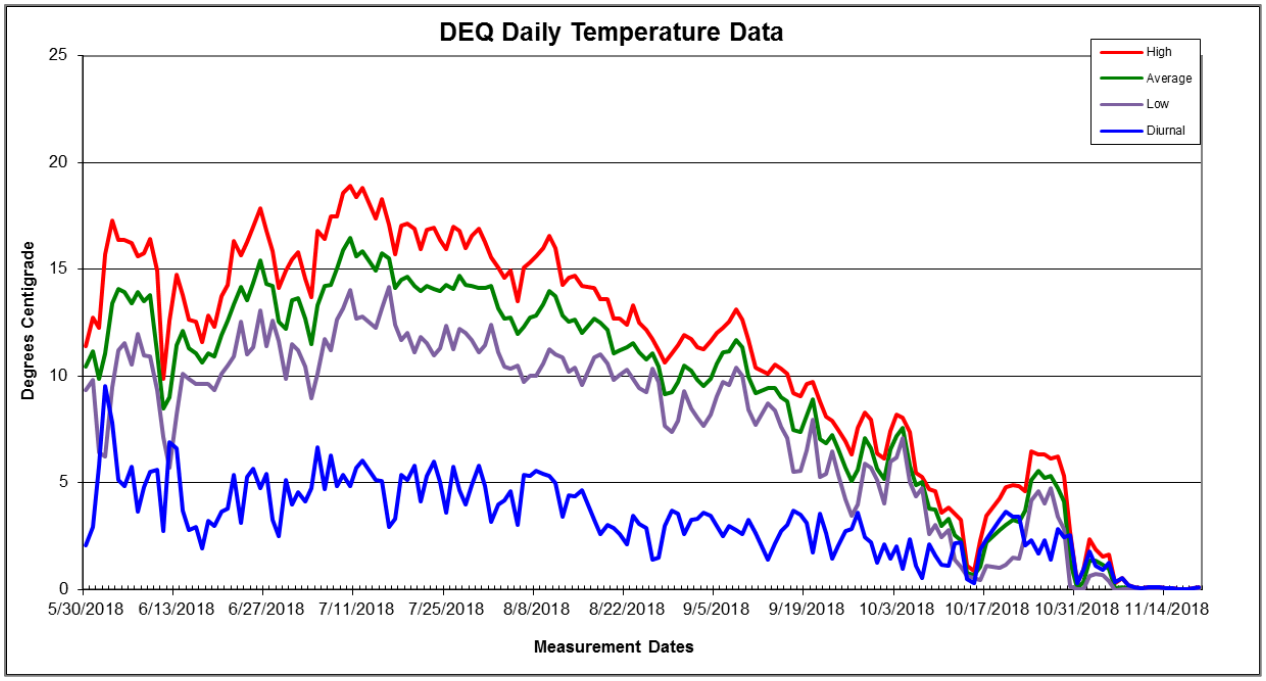


Figure C-13. Temperature data for Beaver Creek ID17040214SK021_03.

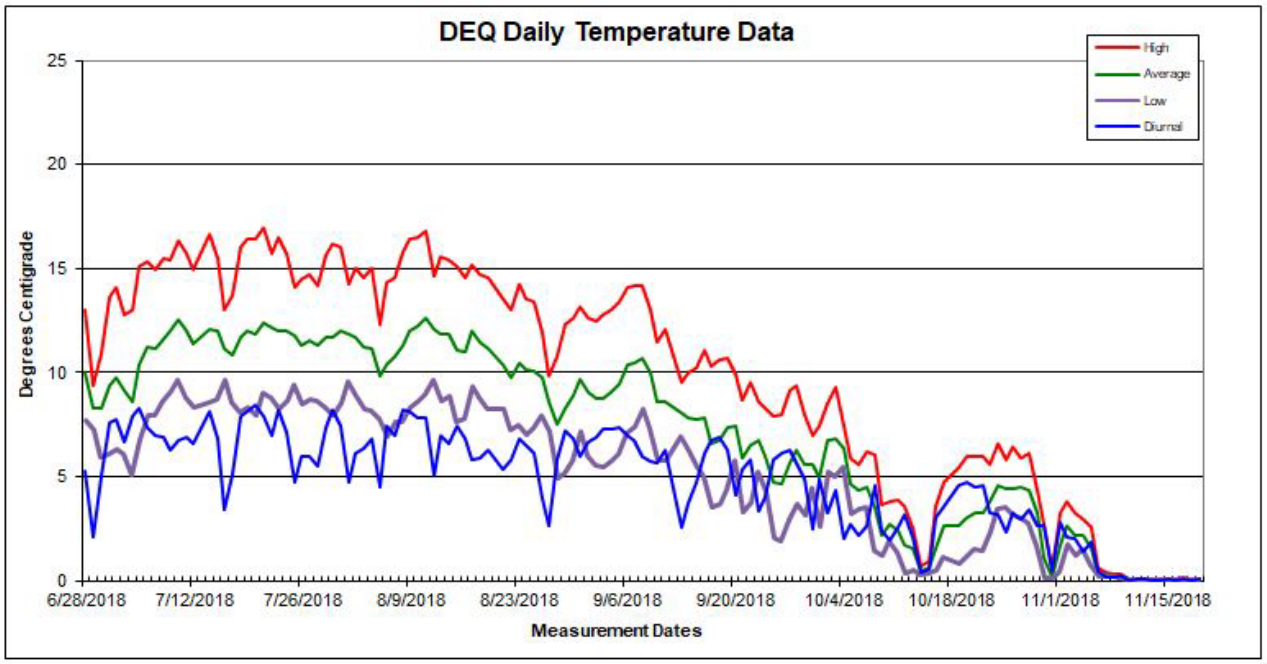


Figure C-14. Temperature data for Pleasant Valley Creek ID17040214SK023_02.

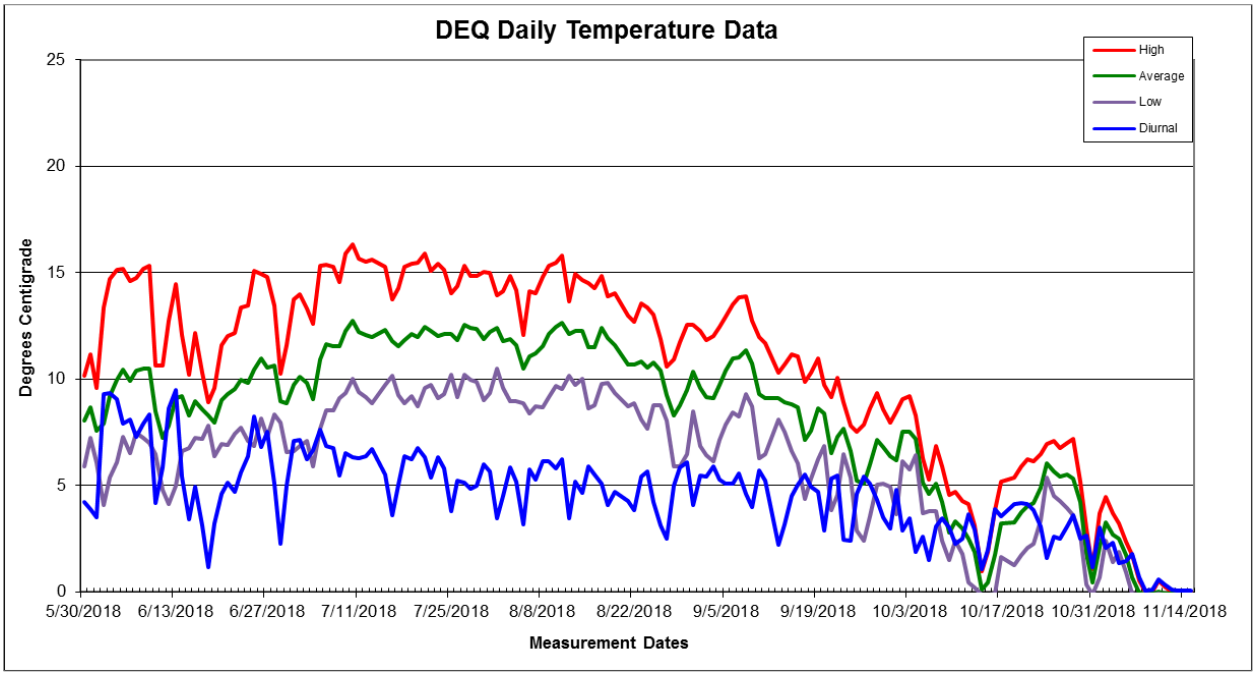


Figure C-15. Temperature data for Huntley Canyon Creek ID17040214SK024_02.

Table C-4. Bankfull width estimates from regional curves and BURP data for the Beaver-Camas subbasin.

Location	AU Number	Area (square miles)	Upper Snake Basin Bankfull Width Measurement (meters)	BURP Bankfull Width Measurement (meters)[a]	Year Measured
Camas Creek—beginning of AU	ID17040214SK002_05	221.4	17	—	—
East Camas Creek—end of AU	—	384.3	21	—	—
Crooked/Crab Creek	ID17040214SK008_03	4.3	3	2	1998
Crooked/Crab Creek Trib 02	—	0.4	1	—	—
Crooked/Crab Creek	—	18.2	6	—	—
Saw Creek	ID17040214SK009_02	6.7	4	2	2012
Warm Creek	—	17.3	5	—	—
Larkspur Creek	ID17040214SK010_02	1.8	2	—	—
East Camas Creek	ID17040214SK010_03	15.5	5	5	2001
East Camas Creek	ID17040214SK011_02	4.7	3	—	—
East Camas Creek Trib 01	—	1.4	2	—	—
East Camas Creek Trib 01a	—	0.5	1	—	—
Mule Meadows Creek	—	0.9	1	—	—
Spruce Creek	—	1.6	2	—	—
East Camas Creek	ID17040214SK011_03	10.3	4	—	—
West Camas Creek	ID17040214SK012_03	56.9	9	6	2005
West Camas Creek Trib 06	—	0.1	1	—	—
West Camas Creek Trib 06a	—	1.3	2	—	—
West Camas Creek Trib 06b	—	0.3	1	—	—
West Camas Creek Trib 07	—	1.7	2	—	—
West Camas Creek Trib 08	—	0.5	1	—	—
West Camas Creek Alex Draw Creek	ID17040214SK013_02	5.9	3	1	2002
Alex Draw Creek Trib 01	—	0.8	1	—	—
Alex Draw Creek Trib 02	—	2.6	2	—	—
Alex Draw Creek Trib 03	—	0.8	1	—	—
Allen Canyon Creek	—	2.7	2	—	—
Allen Canyon Creek Trib 01	—	0.6	1	—	—
Castle Creek	—	1.1	2	1	2001
Disaster Creek	—	1.3	2	1	2002
East Steel Creek	—	1.6	2		

Location	AU Number	Area (square miles)	Upper Snake Basin Bankfull Width Measurement (meters)	BURP Bankfull Width Measurement (meters)[a]	Year Measured
Jug Creek	—	0.9	2	3	1996
Pass Creek	—	1.1	2	1	1996
Pete Creek	—	7.6	4	2	2008
Pete Creek Trib 01	—	1.9	2	—	—
Pete Creek Trib 02	—	1.4	2	—	—
Steel Creek	—	3.4	3	1	2002
Stump Creek	—	1.8	2	1	2002
West Camas Creek	—	13.8	5	5	1996
West Camas Creek Trib 01	—	0.4	1	—	—
West Camas Creek Trib 02	—	0.8	1	—	—
West Camas Creek Trib 03	—	1.2	2	—	—
West Camas Creek Trib 04	—	0.2	1	—	—
West Camas Creek Trib 05	—	1.0	2	—	—
West Camas Creek Trib 05a	—	0.5	1	—	—
West Steel Creek	—	1.2	2	—	—
West Camas Creek	ID17040214SK013_03	42.4	8	6	2004
Rattlesnake Creek	ID17040214SK016_02				
Corral Creek	—	4.9	3	3	2008
Corral Creek Trib 01	—	1.5	2	—	—
Corral Creek Trib 02	—	2.5	2	—	—
Corral Creek Trib 02a	—	1.0	2	—	—
Corral Creek Trib 02b	—	1.2	2	—	—
Corral Creek Trib 02b1	—	0.5	1	—	—
Corral Creek Trib 02c	—	1.6	2	—	—
Rattlesnake Creek	ID17040214SK016_02				
Spring Creek	—	4.4	3	3	2008
Spring Creek Trib 01	—	1.5	2	—	—
Spring Creek Trib 02	—	0.6	1	—	—
East Fork Rattlesnake Creek	—	6	3	6	1998
East Fork Rattlesnake Creek Trib 02	—	0.8	1	—	—
Rattlesnake Creek Trib 01	—	0.9	2	—	—
Rattlesnake Creek Trib 02	—	3.6	3	—	—
West Fork Rattlesnake Creek	—	6.3	4	2	1998

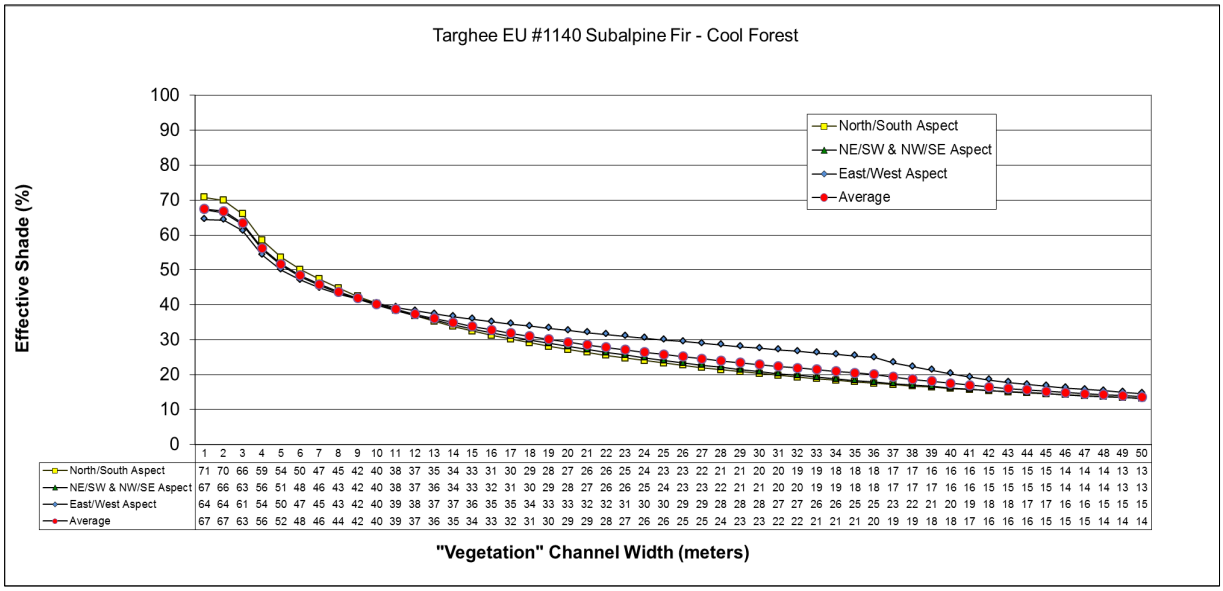
Location	AU Number	Area (square miles)	Upper Snake Basin Bankfull Width Measurement (meters)	BURP Bankfull Width Measurement (meters)[a]	Year Measured
West Fork Rattlesnake Creek Trib 01	—	1.6	2		
West Fork Rattlesnake Creek Trib 02	—	0.5	1	—	—
Threemile Creek	ID17040214SK017_02				
East Threemile Creek	—	4.2	3	3	1998
Middle Threemile Creek	—	4.5	3	2	1998
Middle Threemile Creek Trib 01	—	1.6	2	—	—
Threemile Creek	—	10.3	4	3	1998
Threemile Creek Trib 01	—	0.7	1	—	—
Threemile Creek Trib 02	—	0.2	1	—	—
West Threemile Creek	—	2.8	2	2	1998
Threemile Creek	ID17040214SK017_03	14.3	5	4	1998
Beaver Creek	ID17040214SK018_02	—	—	—	—
Beaver Creek Trib 08	—	1.4	2	—	—
Beaver Creek Trib 09	—	1.0	2	—	—
Beaver Creek Trib 10	—	2.8	2	—	—
Beaver Creek Trib 10a	—	1.6	2	—	—
Calf Creek	—	1.9	2	—	—
Calf Creek Trib 01	—	0.4	1	—	—
Clay Creek	—	1.2	2	—	—
Cobble Creek	—	0.5	1	—	—
Dairy Creek	—	9.9	4	3	1998
Dairy Creek Trib 01	—	0.5	1	—	—
Left Fork Creek	—	2.1	2	—	—
Picnic Hollow Creek	—	1.2	2	2	1996
Stoddard Creek	—	4.3	3	4	1996
Telephone Creek	—	1.2	2	2	2008
Thomas Draw Creek	—	1.2	2	—	—
Van Noy Canyon Creek	—	1.3	2	1	1998
Beaver Creek	ID17040214SK018_04	125.4	13	7	2012
Beaver Creek	ID17040214SK020_03	82.2	11	—	—
Beaver Creek	ID17040214SK021_02	4.6	3	—	—
Beaver Creek Trib 01	—	0.8	1	—	—
Beaver Creek Trib 02	—	3.2	3	—	—
Beaver Creek Trib 02a	—	1.0	2	—	—
Beaver Creek Trib 02b	—	0.7	1	—	—
Beaver Creek Trib 03	—	0.1	2	—	—
Beaver Creek Trib 04	—	1.1	2	—	—
Beaver Creek Trib 05	—	0.9	1	—	—

Location	AU Number	Area (square miles)	Upper Snake Basin Bankfull Width Measurement (meters)	BURP Bankfull Width Measurement (meters)[a]	Year Measured
Beaver Creek Trib 06	—	1.9	2	—	—
Berry Creek	—	2.8	2	1	1998
Chicken Creek	—	2.1	2	4	1998
East Modoc Creek	—	2.7	2	2	1998
Horse Creek	—	0.8	1	1	1998
Kettle Creek	—	1.2	2	—	—
Long Creek	—	7.7	4	2	1998
Long Creek Trib 01	—	3.9	3	—	—
Long Creek Trib 01a	—	1.1	2	—	—
Long Creek Trib 01b	—	0.7	1	—	—
Middle Modoc Creek	—	1.9	2	—	—
Modoc Creek	—	19.6	6	3	1998
Modoc Creek Trib 01	—	1.4	2	—	—
Modoc Creek Trib 02	—	0.6	1	—	—
Modoc Creek Trib 03	—	0.8	1	—	—
Robbins Creek	—	4.0	3	—	—
Tenpin Creek	—	1.1	2	—	—
West Modoc Creek	—	1.6	2	2	2012
Beaver Creek	ID17040214SK021_03	49.2	9	—	—
Pleasant Valley Creek	ID17040214SK023_02			—	—
Pleasant Valley Creek at Swampy Draw	—	3.5	3	4	—
Swampy Draw	—	1.5	2	—	—
White Pine Canyon	—	0.8	1	4	2002
Kite Canyon	—	1.9	2	1	2002
Brooks Canyon	—	0.9	1	1	2002
Pleasant Valley Creek at Road 323 Bridge	—	9.2	4	2	2002
Ramshorn Creek	—	2.4	2	—	—
Headquarters Creek	—	0.9	1	—	—
School Section Creek	—	1.7	2	1	2012
Pleasant Valley Creek at Beaver Creek	—	17.6	6	—	—
Huntley Canyon Creek	ID17040214SK024_02	4.1	3	2	2001
Huntley Canyon Creek Trib 01	—	0.4	1	—	—

a. The Upper Snake Basin bankfull width measurement (meters) was taken at the mouth of each stream; however, the BURP bankfull width measurement (meters) was taken where BURP data were collected, which is normally not at the mouth of the stream. BURP data must be collected in streams that are wadeable. This accounts for the differences between the numbers.

Shade Curves Used for Target Shade Analysis

Figure C-16. Subalpine Fir–Cool Forest vegetation type #1140.



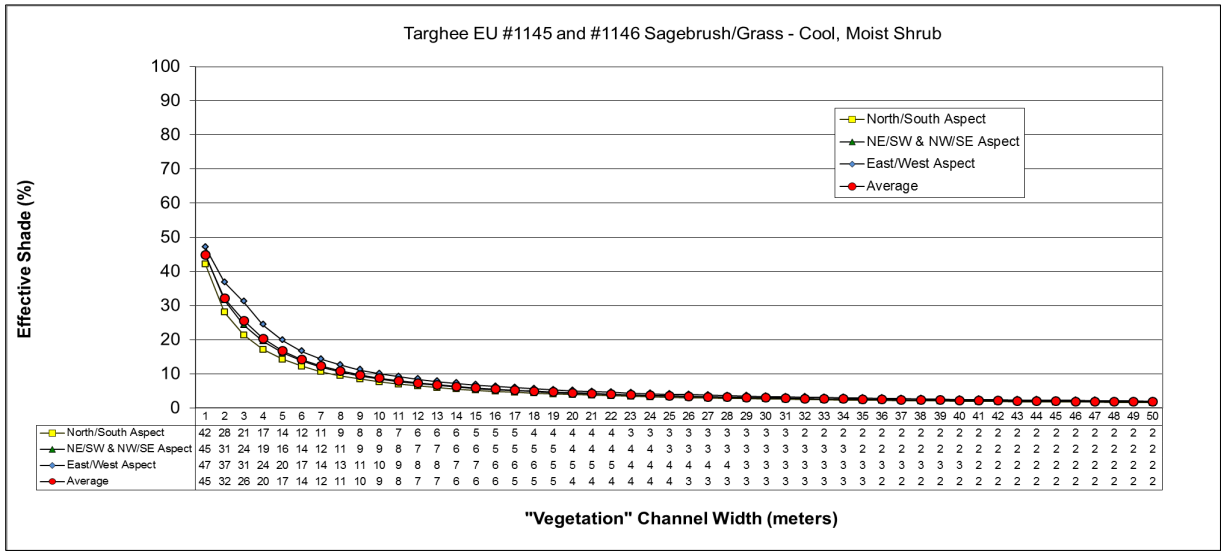


Figure C-17. Sagebrush/Grass–Cool, Moist Shrub vegetation types #1145 and #1146.

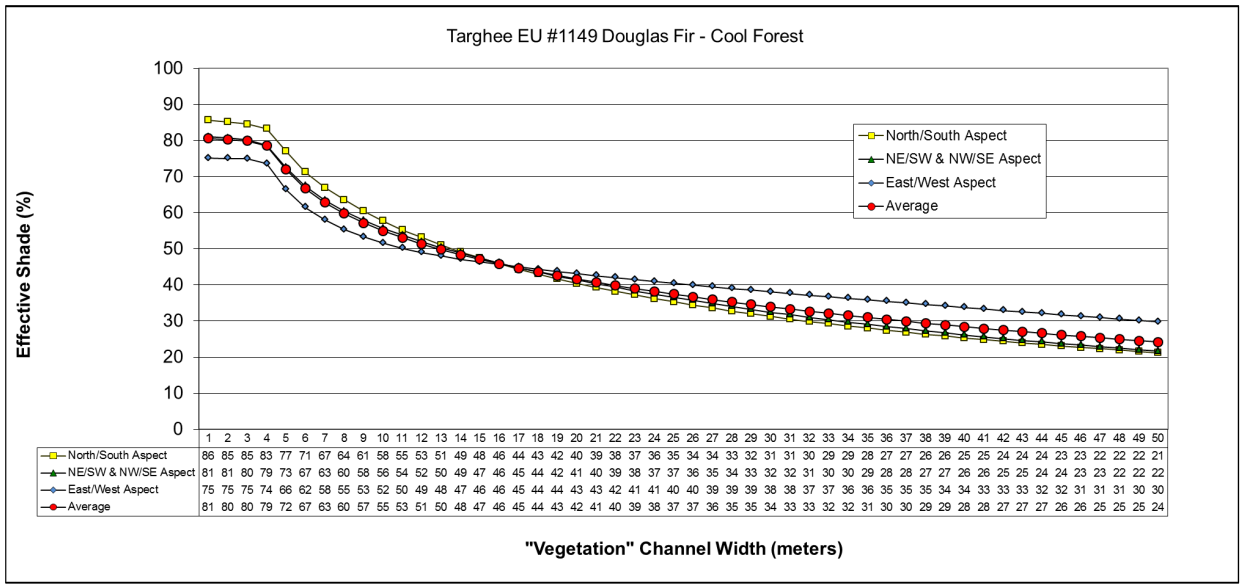


Figure C-18. Douglas Fir–Cool Forest vegetation type #1149.

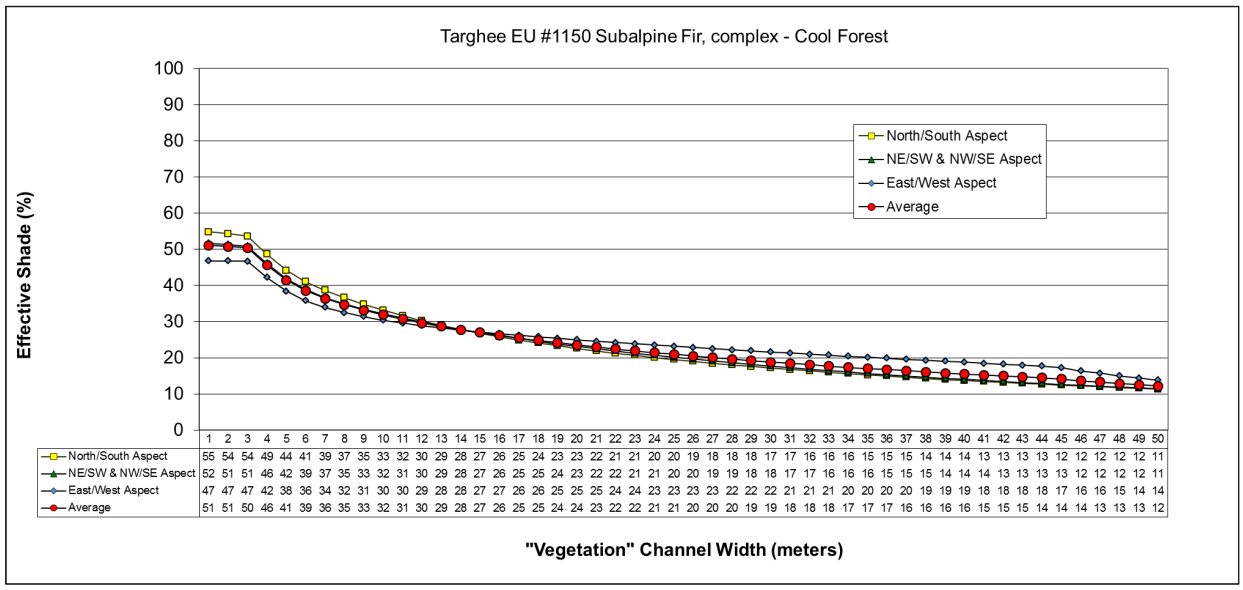


Figure C-19. Subalpine Fir, Complex–Cool Forest vegetation type #1150.

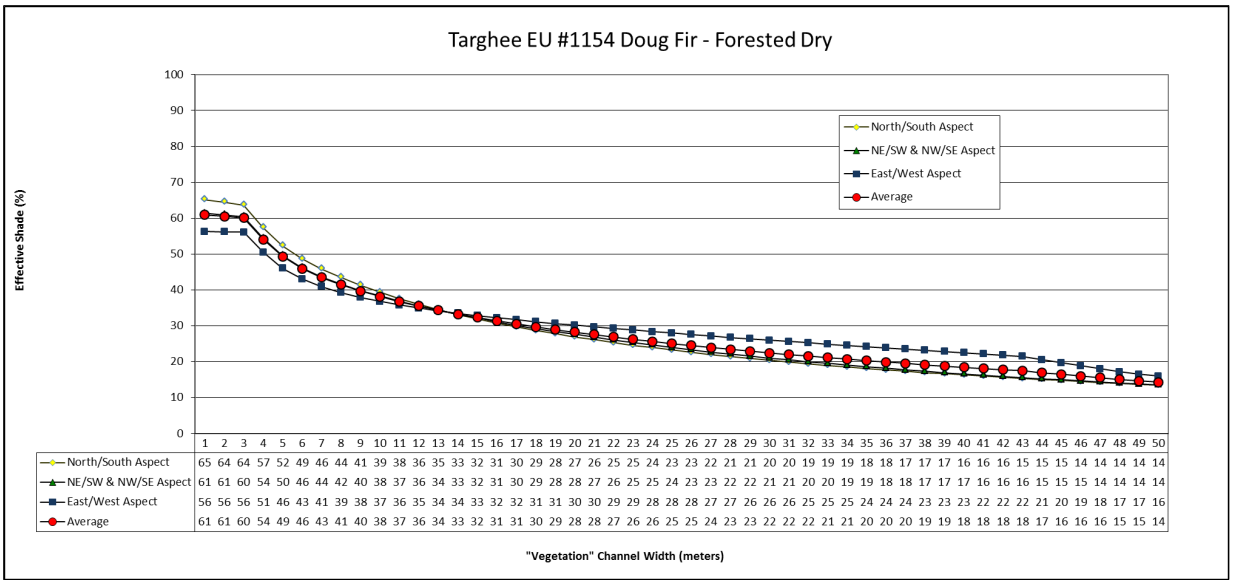


Figure C-20. Douglas Fir–Forested Dry vegetation type #1154.

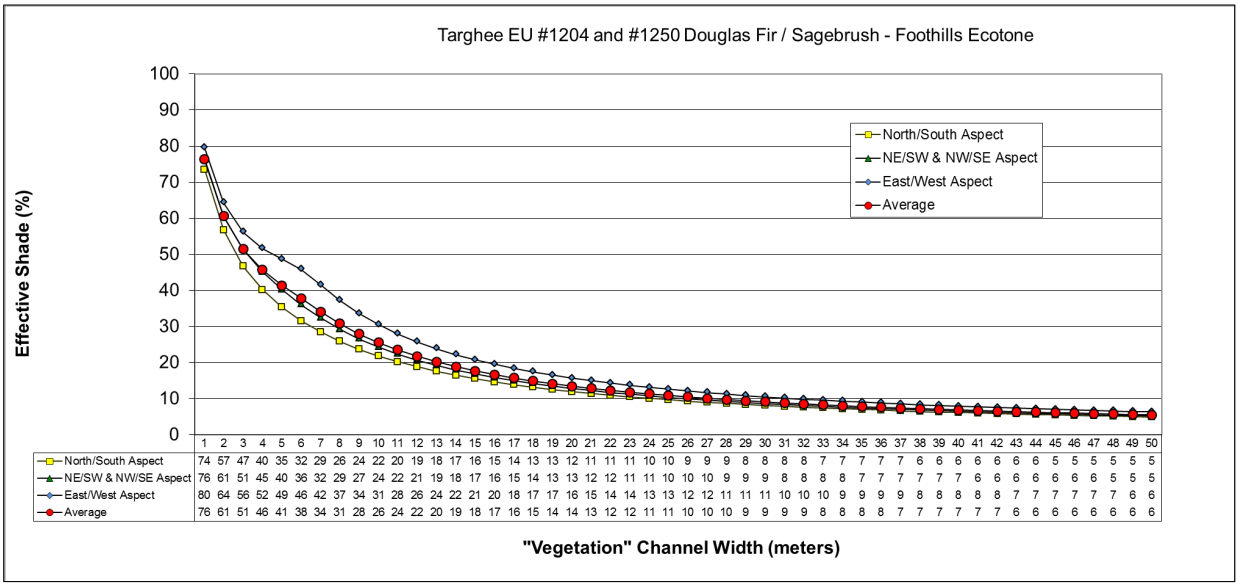


Figure C-21. Douglas Fir/Sagebrush–Foothills Ecotone vegetation type #1204 and #1250.

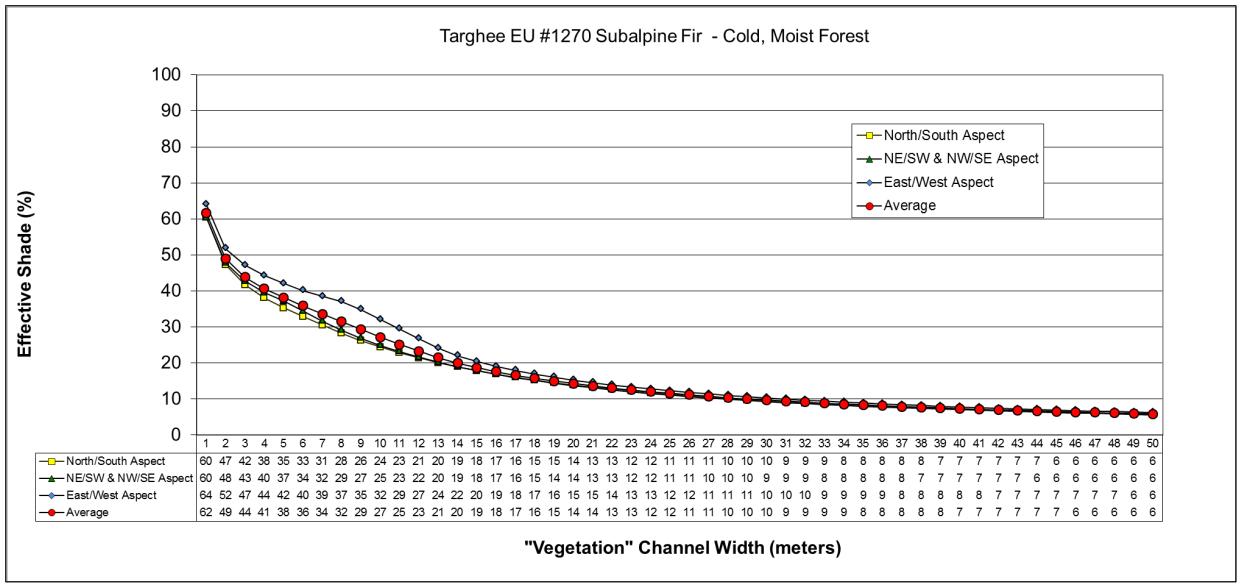


Figure C-22. Subalpine Fir–Cold, Moist Forest vegetation type #1270.

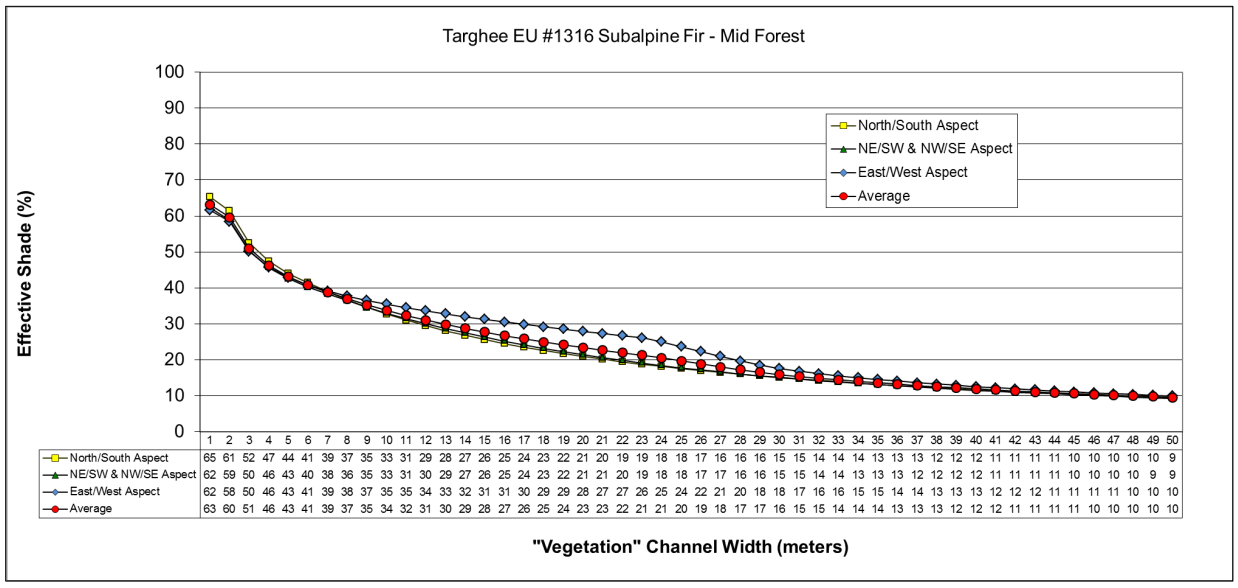


Figure C-23. Subalpine Fir–Mid-Forest vegetation type #1316.

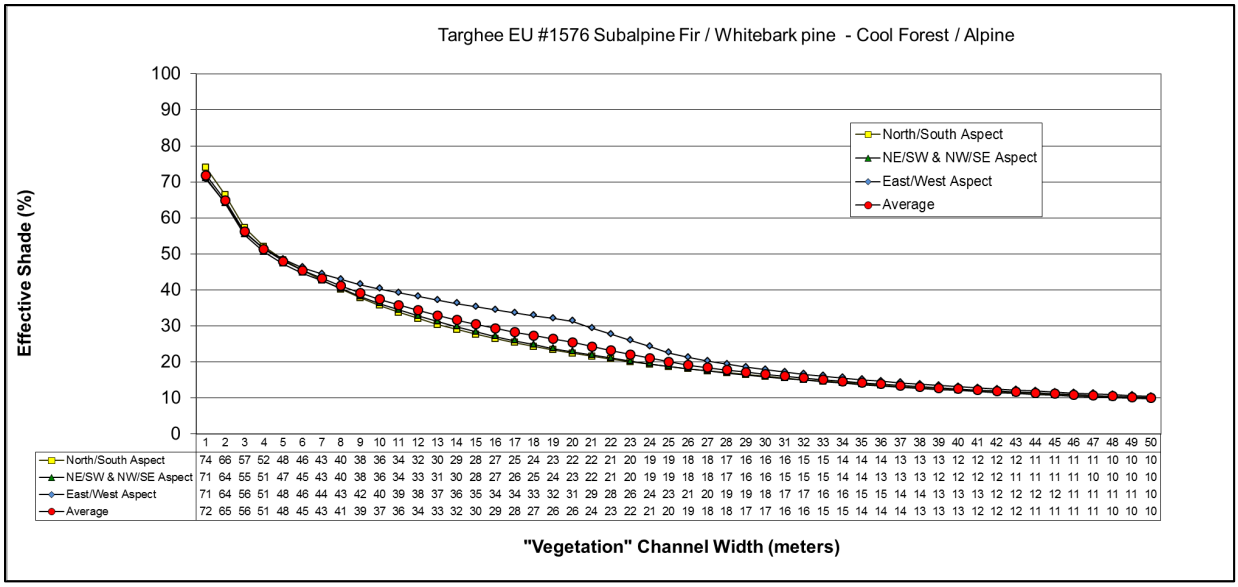


Figure C-24. Subalpine Fir–Whitebark Pine–Cool Forest/Alpine vegetation type #1576.

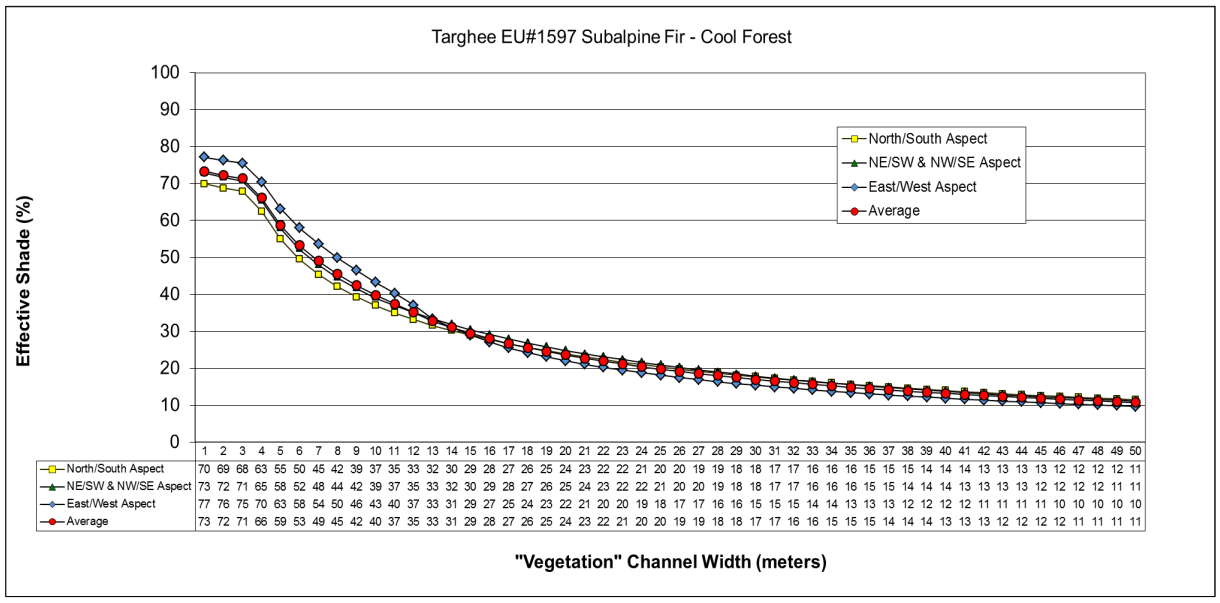


Figure C-25. Subalpine Fir–Cool Forest vegetation type #1597.

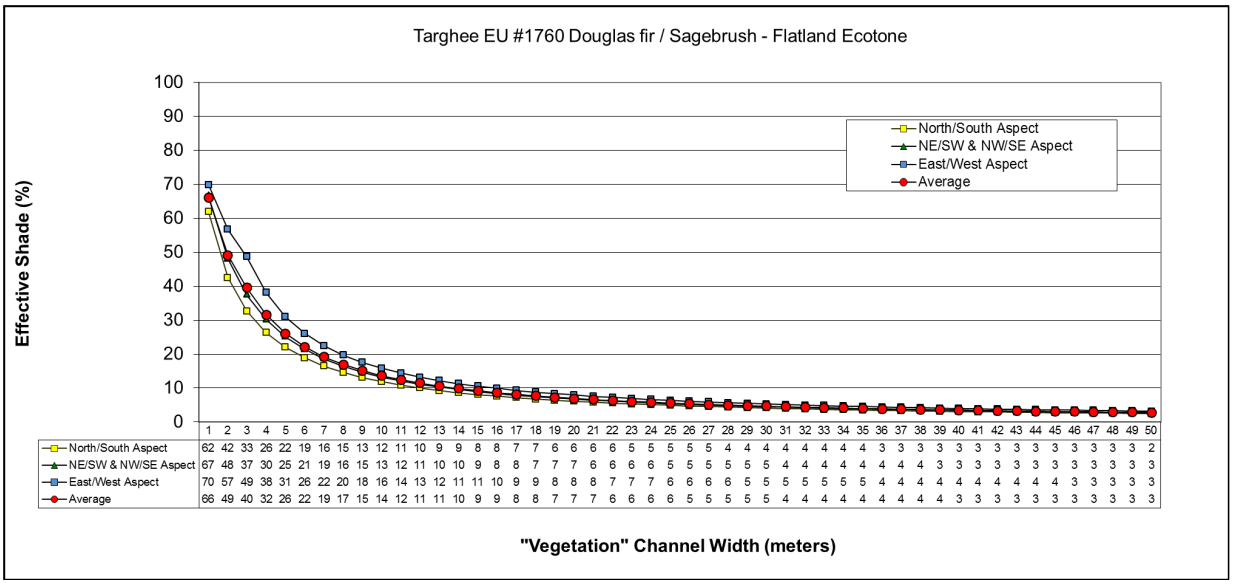


Figure C-26. Douglas fir/Sagebrush-Flatland Ecotone vegetation type #1760.

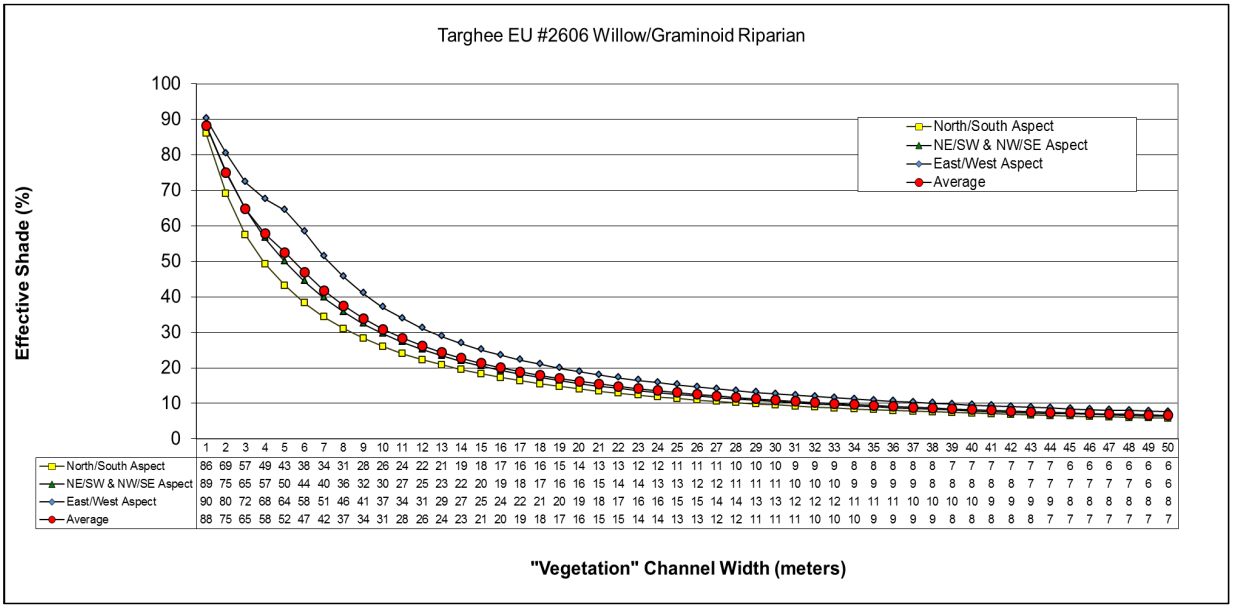


Figure C-27. Willow/Graminoid Riparian vegetation type #2606.

Existing and Target Solar Loads for the Beaver-Camas Subbasin

Table C-5. Existing and target solar loads for the 5th-order assessment unit of Camas Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
002_05	Camas Creek	1	657	1145/1146-Cool Moist Shrub	5%	5.63	17	11,000	62,000	10%	5.33	17	11,000	59,000	(3,000)	5%
002_05	Camas Creek	2	2216	1145/1146-Cool Moist Shrub	5%	5.63	17	38,000	210,000	0%	5.93	17	38,000	230,000	20,000	-5%
002_05	Camas Creek	3	326	1145/1146-Cool Moist Shrub	5%	5.63	17	5,500	31,000	10%	5.33	17	5,500	29,000	(2,000)	5%
002_05	Camas Creek	4	1356	1145/1146-Cool Moist Shrub	5%	5.63	17	23,000	130,000	0%	5.93	17	23,000	140,000	10,000	-5%
002_05	Camas Creek	5	824	1145/1146-Cool Moist Shrub	5%	5.63	17	14,000	79,000	10%	5.33	17	14,000	75,000	(4,000)	5%
002_05	Camas Creek	6	3112	1145/1146-Cool Moist Shrub	5%	5.63	17	53,000	300,000	0%	5.93	17	53,000	310,000	10,000	-5%
002_05	Camas Creek	7	255	1145/1146-Cool Moist Shrub	5%	5.63	17	4,300	24,000	10%	5.33	17	4,300	23,000	(1,000)	5%
002_05	Camas Creek	8	628	1145/1146-Cool Moist Shrub	5%	5.63	17	11,000	62,000	0%	5.93	17	11,000	65,000	3,000	-5%
002_05	Camas Creek	9	238	1145/1146-Cool Moist Shrub	5%	5.63	17	4,000	23,000	10%	5.33	17	4,000	21,000	(2,000)	5%
002_05	Camas Creek	10	995	1145/1146-Cool Moist Shrub	5%	5.63	17	17,000	96,000	0%	5.93	17	17,000	100,000	4,000	-5%
002_05	Camas Creek	11	800	1145/1146-Cool Moist Shrub	5%	5.63	17	14,000	79,000	10%	5.33	17	14,000	75,000	(4,000)	5%
002_05	Camas Creek	12	449	1145/1146-Cool Moist Shrub	5%	5.63	17	7,600	43,000	20%	4.74	17	7,600	36,000	(7,000)	15%
002_05	Camas Creek	13	901	1145/1146-Cool Moist Shrub	5%	5.63	17	15,000	84,000	10%	5.33	17	15,000	80,000	(4,000)	5%
002_05	Camas Creek	14	221	1145/1146-Cool Moist Shrub	5%	5.63	18	4,000	23,000	20%	4.74	18	4,000	19,000	(4,000)	15%
002_05	Camas Creek	15	534	1145/1146-Cool Moist Shrub	5%	5.63	18	9,600	54,000	10%	5.33	18	9,600	51,000	(3,000)	5%
002_05	Camas Creek	16	371	1145/1146-Cool Moist Shrub	5%	5.63	18	6,700	38,000	20%	4.74	18	6,700	32,000	(6,000)	15%
002_05	Camas Creek	17	536	1145/1146-Cool Moist Shrub	5%	5.63	18	9,600	54,000	10%	5.33	18	9,600	51,000	(3,000)	5%
002_05	Camas Creek	18	136	1145/1146-Cool Moist Shrub	5%	5.63	18	2,400	14,000	10%	5.33	18	2,400	13,000	(1,000)	5%
002_05	Camas Creek	19	1096	1145/1146-Cool Moist Shrub	5%	5.63	18	20,000	110,000	20%	4.74	18	20,000	95,000	(15,000)	15%
002_05	Camas Creek	20	499	1145/1146-Cool Moist Shrub	5%	5.63	18	9,000	51,000	0%	5.93	18	9,000	53,000	2,000	-5%
002_05	Camas Creek	21	1487	1145/1146-Cool Moist Shrub	5%	5.63	18	27,000	150,000	10%	5.33	18	27,000	140,000	(10,000)	5%
002_05	Camas Creek	22	3824	1145/1146-Cool Moist Shrub	5%	5.63	18	69,000	390,000	0%	5.93	18	69,000	410,000	20,000	-5%
002_05	Camas Creek	23	540	1145/1146-Cool Moist Shrub	5%	5.63	18	9,700	55,000	10%	5.33	18	9,700	52,000	(3,000)	5%
002_05	Camas Creek	24	9656	1145/1146-Cool Moist Shrub	5%	5.63	19	180,000	1,000,000	0%	5.93	19	180,000	1,100,000	100,000	-5%
002_05	Camas Creek	25	335	1145/1146-Cool Moist Shrub	5%	5.63	19	6,400	36,000	10%	5.33	19	6,400	34,000	(2,000)	5%
002_05	Camas Creek	26	2925	1145/1146-Cool Moist Shrub	5%	5.63	19	56,000	320,000	0%	5.93	19	56,000	330,000	10,000	-5%
002_05	Camas Creek	27	1379	1145/1146-Cool Moist Shrub	4%	5.69	20	28,000	160,000	10%	5.33	20	28,000	150,000	(10,000)	6%
002_05	Camas Creek	28	968	1145/1146-Cool Moist Shrub	4%	5.69	20	19,000	110,000	0%	5.93	20	19,000	110,000	0	-4%
002_05	Camas Creek	29	639	1145/1146-Cool Moist Shrub	4%	5.69	20	13,000	74,000	10%	5.33	20	13,000	69,000	(5,000)	6%
002_05	Camas Creek	30	4109	1145/1146-Cool Moist Shrub	4%	5.69	20	82,000	470,000	0%	5.93	20	82,000	490,000	20,000	-4%
002_05	Camas Creek	31	6458	1145/1146-Cool Moist Shrub	4%	5.69	20	130,000	740,000	0%	5.93	20	130,000	770,000	30,000	-4%
002_05	Camas Creek	32	9504	1145/1146-Cool Moist Shrub	4%	5.69	21	200,000	1,100,000	0%	5.93	21	200,000	1,200,000	100,000	-4%
002_05	Camas Creek	33	2419	1145/1146-Cool Moist Shrub	4%	5.69	21	51,000	290,000	0%	5.93	21	51,000	300,000	10,000	-4%
							Totals		6,500,000					6,700,000	250,000	

Notes: All AU numbers start with ID17040214SK_ in all load tables (Table C5–Table C24). Significant figures are determined by the lowest level in the calculation, typically that of the channel width. Some rounding errors may result.

Table C-6 Existing and target solar loads for the 3rd-order assessment unit of Crooked/Crab Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
008_03	Crab Creek	9	600	2606-Riparian	65%	2.07	3	2,000	4,000	70%	1.78	3	2,000	4,000	0	5%
008_03	Crab Creek	10	349	2606-Riparian	65%	2.07	3	1,000	2,000	60%	2.37	3	1,000	2,000	0	-5%
008_03	Crab Creek	11	174	1760-Forest/Shrub Steppe	40%	3.56	3	500	2,000	20%	4.74	3	500	2,000	0	-20%
008_03	Crab Creek	12	2264	1760-Forest/Shrub Steppe	40%	3.56	3	7,000	20,000	0%	5.93	3	7,000	40,000	20,000	-40%
008_03	Crab Creek	13	3964	1760-Forest/Shrub Steppe	40%	3.56	3	10,000	40,000	0%	5.93	3	10,000	60,000	20,000	-40%
008_03	Crab Creek	14	314	1760-Forest/Shrub Steppe	40%	3.56	3	900	3,000	40%	3.56	3	900	3,000	0	0%
008_03	Crab Creek	15	586	1760-Forest/Shrub Steppe	40%	3.56	3	2,000	7,000	20%	4.74	3	2,000	9,000	2,000	-20%
008_03	Crab Creek	16	482	1760-Forest/Shrub Steppe	40%	3.56	3	1,000	4,000	0%	5.93	3	1,000	6,000	2,000	-40%
008_03	Crab Creek	17	187	1760-Forest/Shrub Steppe	40%	3.56	3	600	2,000	50%	2.96	3	600	2,000	0	10%
008_03	Crab Creek	18	540	1760-Forest/Shrub Steppe	40%	3.56	3	2,000	7,000	0%	5.93	3	2,000	10,000	3,000	-40%
008_03	Crab Creek	19	567	1760-Forest/Shrub Steppe	40%	3.56	3	2,000	7,000	60%	2.37	3	2,000	5,000	(2,000)	20%
008_03	Crab Creek Trib 02	1	402	2606-Riparian	88%	0.71	1	400	300	50%	2.96	1	400	1,000	700	-38%
008_03	Crab Creek Trib 02	2	381	2606-Riparian	88%	0.71	1	400	300	60%	2.37	1	400	900	600	-28%
008_03	Crab Creek Trib 02	3	396	2606-Riparian	88%	0.71	1	400	300	50%	2.96	1	400	1,000	700	-38%
008_03	Crab Creek Trib 02	4	574	2606-Riparian	88%	0.71	1	600	400	70%	1.78	1	600	1,000	600	-18%
008_03	Crab Creek Trib 02	5	1490	1760-Forest/Shrub Steppe	66%	2.01	1	1,000	2,000	0%	5.93	1	1,000	6,000	4,000	-66%
008_03	Crab Creek Trib 02	6	247	2606-Riparian	88%	0.71	1	200	100	80%	1.19	1	200	200	100	-8%
008_03	Crooked Creek	1	3643	1760-Forest/Shrub Steppe	22%	4.62	6	20,000	90,000	0%	5.93	6	20,000	100,000	10,000	-22%
008_03	Crooked Creek	2	271	2606-Riparian	47%	3.14	6	2,000	6,000	20%	4.74	6	2,000	9,000	3,000	-27%
							Totals		200,000					260,000	65,000	

Table C-7. Existing and target solar loads for the 2nd-order assessment unit of Warm Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
009_02	Saw Creek	1	1869	1149-Cool Forest	81%	1.13	1	2,000	2,000	80%	1.19	1	2,000	2,000	0	-1%
009_02	Saw Creek	2	1350	2606-Riparian	88%	0.71	1	1,000	700	70%	1.78	1	1,000	2,000	1,000	-18%
009_02	Saw Creek	3	884	2606-Riparian	88%	0.71	1	900	600	10%	5.33	1	900	5,000	4,000	-78%
009_02	Saw Creek	4	1409	1760-Forest/Shrub Steppe	49%	3.02	2	3,000	9,000	70%	1.78	2	3,000	5,000	(4,000)	21%
009_02	Saw Creek	5	1282	1760-Forest/Shrub Steppe	49%	3.02	2	3,000	9,000	0%	5.93	2	3,000	20,000	10,000	-49%
009_02	Saw Creek	6	457	1760-Forest/Shrub Steppe	49%	3.02	2	900	3,000	70%	1.78	2	900	2,000	(1,000)	21%
009_02	Saw Creek	7	4614	1760-Forest/Shrub Steppe	40%	3.56	3	10,000	40,000	0%	5.93	3	10,000	60,000	20,000	-40%
009_02	Saw Creek	8	201	1760-Forest/Shrub Steppe	32%	4.03	4	800	3,000	60%	2.37	4	800	2,000	(1,000)	28%
009_02	Warm Creek	1	1800	2606-Riparian	88%	0.71	1	2,000	1,000	0%	5.93	1	2,000	10,000	9,000	-88%
009_02	Warm Creek	2	146	2606-Riparian	75%	1.48	2	300	400	20%	4.74	2	300	1,000	600	-55%
009_02	Warm Creek	3	681	2606-Riparian	75%	1.48	2	1,000	1,000	40%	3.56	2	1,000	4,000	3,000	-35%
009_02	Warm Creek	4	299	2606-Riparian	75%	1.48	2	600	900	30%	4.15	2	600	2,000	1,000	-45%
009_02	Warm Creek	5	186	2606-Riparian	75%	1.48	2	400	600	10%	5.33	2	400	2,000	1,000	-65%
009_02	Warm Creek	6	692	2606-Riparian	65%	2.07	3	2,000	4,000	0%	5.93	3	2,000	10,000	6,000	-65%
009_02	Warm Creek	7	888	2606-Riparian	65%	2.07	3	3,000	6,000	70%	1.78	3	3,000	5,000	(1,000)	5%
009_02	Warm Creek	8	635	2606-Riparian	58%	2.49	4	3,000	7,000	60%	2.37	4	3,000	7,000	0	2%
009_02	Warm Creek	9	244	2606-Riparian	58%	2.49	4	1,000	2,000	50%	2.96	4	1,000	3,000	1,000	-8%
009_02	Warm Creek	10	307	2606-Riparian	58%	2.49	4	1,000	2,000	0%	5.93	4	1,000	6,000	4,000	-58%
009_02	Warm Creek	11	236	2606-Riparian	58%	2.49	4	900	2,000	70%	1.78	4	900	2,000	0	12%
009_02	Warm Creek	12	201	2606-Riparian	52%	2.84	5	1,000	3,000	10%	5.33	5	1,000	5,000	2,000	-42%
009_02	Warm Creek	13	146	2606-Riparian	52%	2.84	5	700	2,000	70%	1.78	5	700	1,000	(1,000)	18%
009_02	Warm Creek	14	285	2606-Riparian	52%	2.84	5	1,000	3,000	10%	5.33	5	1,000	5,000	2,000	-42%
							Totals		100,000					160,000	57,000	

Table C-8. Existing and target solar loads for the 2nd-order assessment unit of East Camas Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
010_02	Larkspur Creek	1	287	1149-Cool Forest	81%	1.13	1	300	300	40%	3.56	1	300	1,000	700	-41%
010_02	Larkspur Creek	2	2072	1149-Cool Forest	81%	1.13	1	2,000	2,000	80%	1.19	1	2,000	2,000	0	-1%
010_02	Larkspur Creek	3	1552	1149-Cool Forest	80%	1.19	2	3,000	4,000	70%	1.78	2	3,000	5,000	1,000	-10%
							Totals		6,300					8,000	1,700	

Table C-9. Existing and target solar loads for the 3rd-order assessment unit of East Camas Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
010_03	East Camas Creek	9	125	2606-Riparian	58%	2.49	4	500	1,000	60%	2.37	4	500	1,000	0	2%
010_03	East Camas Creek	10	1223	2606-Riparian	58%	2.49	4	5,000	10,000	50%	2.96	4	5,000	10,000	0	-8%
010_03	East Camas Creek	11	1489	2606-Riparian	58%	2.49	4	6,000	10,000	40%	3.56	4	6,000	20,000	10,000	-18%
010_03	East Camas Creek	12	1117	2606-Riparian	58%	2.49	4	4,000	10,000	60%	2.37	4	4,000	9,000	(1,000)	2%
010_03	East Camas Creek	13	565	2606-Riparian	52%	2.84	5	3,000	9,000	20%	4.74	5	3,000	10,000	1,000	-32%
010_03	East Camas Creek	14	300	2606-Riparian	52%	2.84	5	2,000	6,000	0%	5.93	5	2,000	10,000	4,000	-52%
010_03	East Camas Creek	15	1039	2606-Riparian	52%	2.84	5	5,000	10,000	60%	2.37	5	5,000	10,000	0	8%
010_03	East Camas Creek	16	339	2606-Riparian	52%	2.84	5	2,000	6,000	70%	1.78	5	2,000	4,000	(2,000)	18%
010_03	East Camas Creek	17	192	2606-Riparian	52%	2.84	5	1,000	3,000	0%	5.93	5	1,000	6,000	3,000	-52%
010_03	East Camas Creek	18	455	2606-Riparian	52%	2.84	5	2,000	6,000	30%	4.15	5	2,000	8,000	2,000	-22%
							Totals		71,000					88,000	17,000	

Table C-10. Existing and target solar loads for the 2nd-order assessment unit of East Camas Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
011_02	East Camas Creek	1	380	1576-Cool Forest/Alpine	72%	1.66	1	400	700	0%	5.93	1	400	2,000	1,000	-72%
011_02	East Camas Creek	2	561	1149-Cool Forest	81%	1.13	1	600	700	40%	3.56	1	600	2,000	1,000	-41%
011_02	East Camas Creek	3	910	1149-Cool Forest	81%	1.13	1	900	1,000	40%	3.56	1	900	3,000	2,000	-41%
011_02	East Camas Creek	4	1260	1149-Cool Forest	80%	1.19	2	3,000	4,000	50%	2.96	2	3,000	9,000	5,000	-30%
011_02	East Camas Creek	5	1695	1149-Cool Forest	80%	1.19	3	5,000	6,000	30%	4.15	3	5,000	20,000	10,000	-50%
011_02	East Camas Creek Trib 01	1	1577	1270-Cold Moist Forest	62%	2.25	1	1,600	3,600	0%	5.93	1	1,600	9,500	5,900	-62%
011_02	East Camas Creek Trib 01	2	714	1149-Cool Forest	80%	1.19	2	1,430	1,690	40%	3.56	2	1,430	5,080	3,390	-40%
011_02	East Camas Creek Trib 01	3	634	1149-Cool Forest	80%	1.19	2	1,268	1,503	10%	5.33	2	1,268	6,762	5,259	-70%
011_02	East Camas Creek Trib 01a	1	1301	1270-Cold Moist Forest	62%	2.25	1	1,301	2,929	0%	5.93	1	1,301	7,708	4,779	-62%
011_02	East Camas Creek Trib 01a	2	495	1149-Cool Forest	81%	1.13	1	495	557	60%	2.37	1	495	1,173	616	-21%
011_02	Mule Meadows Creek	1	200	1576-Cool Forest/Alpine	72%	1.66	1	200	332	0%	5.93	1	200	1,185	853	-72%
011_02	Mule Meadows Creek	2	1469	1597-Cool Forest	73%	1.60	1	1,000	2,000	70%	1.78	1	1,000	2,000	0	-3%
011_02	Spruce Creek	1	546	1316-Mid Forest	63%	2.19	1	500	1,000	10%	5.33	1	500	3,000	2,000	-53%
011_02	Spruce Creek	2	1148	1140-Cool Forest	67%	1.96	1	1,000	2,000	20%	4.74	1	1,000	5,000	3,000	-47%
011_02	Spruce Creek	3	713	1140-Cool Forest	67%	1.96	1	700	1,000	60%	2.37	1	700	2,000	1,000	-7%
011_02	Spruce Creek	4	1934	1150-Cool Forest	51%	2.90	2	4,000	10,000	80%	1.19	2	4,000	5,000	(5,000)	29%
							Totals		39,000					84,000	41,000	

Table C-11. Existing and target solar loads for the 3rd-order assessment unit of East Camas Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
011_03	East Camas Creek	6	3307	1149-Cool Forest	79%	1.24	4	10,000	10,000	80%	1.19	4	10,000	10,000	0	1%
011_03	East Camas Creek	7	1164	1149-Cool Forest	79%	1.24	4	5,000	6,000	60%	2.37	4	5,000	10,000	4,000	-19%
011_03	East Camas Creek	8	986	2606-Riparian	58%	2.49	4	4,000	10,000	50%	2.96	4	4,000	10,000	0	-8%
							Totals		26,000					30,000	4,000	

Table C-12. Existing and target solar loads for the 3rd-order assessment unit of West Camas Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
012_03	West Camas Creek	1	296	2606-Riparian	34%	3.91	9	3,000	10,000	60%	2.37	9	3,000	7,000	(3,000)	26%
012_03	West Camas Creek	2	1283	2606-Riparian	34%	3.91	9	10,000	40,000	0%	5.93	9	10,000	60,000	20,000	-34%
012_03	West Camas Creek	3	241	2606-Riparian	34%	3.91	9	2,000	8,000	60%	2.37	9	2,000	5,000	(3,000)	26%
012_03	West Camas Creek	4	509	2606-Riparian	34%	3.91	9	5,000	20,000	0%	5.93	9	5,000	30,000	10,000	-34%
012_03	West Camas Creek	5	338	2606-Riparian	34%	3.91	9	3,000	10,000	30%	4.15	9	3,000	10,000	0	-4%
012_03	West Camas Creek	6	458	2606-Riparian	34%	3.91	9	4,000	20,000	60%	2.37	9	4,000	9,000	(10,000)	26%
012_03	West Camas Creek	7	218	2606-Riparian	34%	3.91	9	2,000	8,000	10%	5.33	9	2,000	10,000	2,000	-24%
012_03	West Camas Creek	8	94	2606-Riparian	34%	3.91	9	800	3,000	0%	5.93	9	800	5,000	2,000	-34%
012_03	West Camas Creek	9	152	2606-Riparian	34%	3.91	9	1,000	4,000	50%	2.96	9	1,000	3,000	(1,000)	16%
012_03	West Camas Creek	10	137	2606-Riparian	34%	3.91	9	1,000	4,000	0%	5.93	9	1,000	6,000	2,000	-34%
012_03	West Camas Creek	11	364	2606-Riparian	34%	3.91	9	3,000	10,000	60%	2.37	9	3,000	7,000	(3,000)	26%
012_03	West Camas Creek	12	744	2606-Riparian	34%	3.91	9	7,000	30,000	10%	5.33	9	7,000	40,000	10,000	-24%
012_03	West Camas Creek	13	590	2606-Riparian	34%	3.91	9	5,000	20,000	0%	5.93	9	5,000	30,000	10,000	-34%
012_03	West Camas Creek	14	217	2606-Riparian	34%	3.91	9	2,000	8,000	50%	2.96	9	2,000	6,000	(2,000)	16%
012_03	West Camas Creek	15	391	2606-Riparian	34%	3.91	9	4,000	20,000	0%	5.93	9	4,000	20,000	0	-34%
012_03	West Camas Creek	16	218	2606-Riparian	34%	3.91	9	2,000	8,000	60%	2.37	9	2,000	5,000	(3,000)	26%
012_03	West Camas Creek	17	136	2606-Riparian	34%	3.91	9	1,000	4,000	0%	5.93	9	1,000	6,000	2,000	-34%
012_03	West Camas Creek	18	356	2606-Riparian	34%	3.91	9	3,000	10,000	70%	1.78	9	3,000	5,000	(5,000)	36%
012_03	West Camas Creek	19	284	2606-Riparian	34%	3.91	9	3,000	10,000	60%	2.37	9	3,000	7,000	(3,000)	26%
012_03	West Camas Creek	20	313	2606-Riparian	34%	3.91	9	3,000	10,000	50%	2.96	9	3,000	9,000	(1,000)	16%
012_03	West Camas Creek	21	269	2606-Riparian	34%	3.91	9	2,000	8,000	70%	1.78	9	2,000	4,000	(4,000)	36%
012_03	West Camas Creek	22	426	2606-Riparian	34%	3.91	9	4,000	20,000	0%	5.93	9	4,000	20,000	0	-34%
012_03	West Camas Creek	23	552	2606-Riparian	34%	3.91	9	5,000	20,000	60%	2.37	9	5,000	10,000	(10,000)	26%
012_03	West Camas Creek	24	260	2606-Riparian	34%	3.91	9	2,000	8,000	50%	2.96	9	2,000	6,000	(2,000)	16%
012_03	West Camas Creek	25	291	2606-Riparian	34%	3.91	9	3,000	10,000	60%	2.37	9	3,000	7,000	(3,000)	26%
012_03	West Camas Creek	26	1022	2606-Riparian	34%	3.91	9	9,000	40,000	50%	2.96	9	9,000	30,000	(10,000)	16%
012_03	West Camas Creek	27	303	2606-Riparian	34%	3.91	9	3,000	10,000	60%	2.37	9	3,000	7,000	(3,000)	26%
012_03	West Camas Creek	28	455	2606-Riparian	34%	3.91	9	4,000	20,000	50%	2.96	9	4,000	10,000	(10,000)	16%
012_03	West Camas Creek	29	634	2606-Riparian	34%	3.91	9	6,000	20,000	40%	3.56	9	6,000	20,000	0	6%
012_03	West Camas Creek	30	222	2606-Riparian	34%	3.91	9	2,000	8,000	50%	2.96	9	2,000	6,000	(2,000)	16%
012_03	West Camas Creek	31	150	2606-Riparian	34%	3.91	9	1,000	4,000	10%	5.33	9	1,000	5,000	1,000	-24%
012_03	West Camas Creek	32	1060	2606-Riparian	34%	3.91	9	10,000	40,000	30%	4.15	9	10,000	40,000	0	-4%
012_03	West Camas Creek	33	503	2606-Riparian	34%	3.91	9	5,000	20,000	0%	5.93	9	5,000	30,000	10,000	-34%
012_03	West Camas Creek	34	514	2606-Riparian	34%	3.91	9	5,000	20,000	30%	4.15	9	5,000	20,000	0	-4%
012_03	West Camas Creek Trib 06	1	269	2606-Riparian	88%	0.71	1	300	200	50%	2.96	1	300	900	700	-38%
012_03	West Camas Creek Trib 06	2	527	2606-Riparian	88%	0.71	1	500	400	30%	4.15	1	500	2,000	2,000	-58%
012_03	West Camas Creek Trib 06	3	271	2606-Riparian	88%	0.71	1	300	200	10%	5.33	1	300	2,000	2,000	-78%
012_03	West Camas Creek Trib 06	4	773	1760-Forest/Shrub Steppe	66%	2.01	1	800	2,000	60%	2.37	1	800	2,000	0	-6%
012_03	West Camas Creek Trib 06	5	433	1760-Forest/Shrub Steppe	49%	3.02	2	900	3,000	50%	2.96	2	900	3,000	0	1%
012_03	West Camas Creek Trib 06	6	240	1760-Forest/Shrub Steppe	49%	3.02	2	480	1,500	0%	5.93	2	480	2,800	1,300	-49%
012_03	West Camas Creek Trib 06a	1	9756	1760-Forest/Shrub Steppe	49%	3.02	2	14,600	44,100	0%	5.93	2	14,600	86,500	42,400	-49%
012_03	West Camas Creek Trib 06b	1	2720	1760-Forest/Shrub Steppe	66%	2.01	1	2,720	5,479	0%	5.93	1	2,720	16,120	10,640	-66%
012_03	West Camas Creek Trib 07	1	491	1760-Forest/Shrub Steppe	49%	3.02	2	982	2,967	0%	5.93	2	982	5,818	2,851	-49%
012_03	West Camas Creek Trib 07	2	242	1760-Forest/Shrub Steppe	49%	3.02	2	484	1,463	70%	1.78	2	484	860	(602)	21%
012_03	West Camas Creek Trib 07	3	90	1760-Forest/Shrub Steppe	49%	3.02	2	180	544	0%	5.93	2	180	1,067	523	-49%
012_03	West Camas Creek Trib 07	4	454	1760-Forest/Shrub Steppe	49%	3.02	2	900	3,000	70%	1.78	2	900	2,000	(1,000)	21%
012_03	West Camas Creek Trib 07	5	192	1760-Forest/Shrub Steppe	49%	3.02	2	400	1,000	0%	5.93	2	400	2,000	1,000	-49%
012_03	West Camas Creek Trib 07	6	249	1760-Forest/Shrub Steppe	49%	3.02	2	500	2,000	10%	5.33	2	500	3,000	1,000	-39%
012_03	West Camas Creek Trib 07	7	668	1760-Forest/Shrub Steppe	49%	3.02	2	1,000	3,000	0%	5.93	2	1,000	6,000	3,000	-49%
012_03	West Camas Creek Trib 07	8	192	1760-Forest/Shrub Steppe	49%	3.02	2	400	1,000	10%	5.33	2	400	2,000	1,000	-39%
012_03	West Camas Creek Trib 07	9	356	1760-Forest/Shrub Steppe	49%	3.02	2	700	2,000	0%	5.93	2	700	4,000	2,000	-49%
012_03	West Camas Creek Trib 07	10	235	1760-Forest/Shrub Steppe	49%	3.02	2	500	2,000	60%	2.37	2	500	1,000	(1,000)	11%
012_03	West Camas Creek Trib 08	1	2067	1760-Forest/Shrub Steppe	66%	2.01	1	2,000	4,000	0%	5.93	1	2,000	10,000	6,000	-66%
							Totals		580,000					650,000	65,000	

Table C-13. Existing and target solar loads for the 2nd-order assessment unit of West Camas Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
013_02	Alex Draw	1	134	1149-Cool Forest	81%	1.13	1	100	100	0%	5.93	1	100	600	500	-81%
013_02	Alex Draw	2	175	1149-Cool Forest	81%	1.13	1	200	200	60%	2.37	1	200	500	300	-21%
013_02	Alex Draw	3	517	1145/1146-Cool Moist Shrub	45%	3.26	1	500	2,000	0%	5.93	1	500	3,000	1,000	-45%
013_02	Alex Draw	4	203	1145/1146-Cool Moist Shrub	45%	3.26	1	200	700	60%	2.37	1	200	500	(200)	15%
013_02	Alex Draw	5	278	1145/1146-Cool Moist Shrub	45%	3.26	1	300	1,000	10%	5.33	1	300	2,000	1,000	-35%
013_02	Alex Draw	6	466	1145/1146-Cool Moist Shrub	45%	3.26	1	500	2,000	60%	2.37	1	500	1,000	(1,000)	15%
013_02	Alex Draw	7	132	1145/1146-Cool Moist Shrub	32%	4.03	2	300	1,000	0%	5.93	2	300	2,000	1,000	-32%
013_02	Alex Draw	8	131	1145/1146-Cool Moist Shrub	32%	4.03	2	300	1,000	30%	4.15	2	300	1,000	0	-2%
013_02	Alex Draw	9	80	1145/1146-Cool Moist Shrub	32%	4.03	2	200	800	0%	5.93	2	200	1,000	200	-32%
013_02	Alex Draw	10	119	1145/1146-Cool Moist Shrub	32%	4.03	2	200	800	20%	4.74	2	200	900	100	-12%
013_02	Alex Draw	11	299	1145/1146-Cool Moist Shrub	32%	4.03	2	600	2,000	0%	5.93	2	600	4,000	2,000	-32%
013_02	Alex Draw	12	847	1145/1146-Cool Moist Shrub	32%	4.03	2	2,000	8,000	20%	4.74	2	2,000	9,000	1,000	-12%
013_02	Alex Draw	13	286	1145/1146-Cool Moist Shrub	26%	4.38	3	900	4,000	50%	2.96	3	900	3,000	(1,000)	24%
013_02	Alex Draw	14	593	1145/1146-Cool Moist Shrub	26%	4.38	3	2,000	9,000	40%	3.56	3	2,000	7,000	(2,000)	14%
013_02	Alex Draw	15	248	1145/1146-Cool Moist Shrub	26%	4.38	3	700	3,000	60%	2.37	3	700	2,000	(1,000)	34%
013_02	Alex Draw	16	273	2606-Riparian	65%	2.07	3	800	2,000	50%	2.96	3	800	2,000	0	-15%
013_02	Alex Draw Trib 01	1	191	1597-Cool Forest	73%	1.60	1	200	300	20%	4.74	1	200	900	600	-53%
013_02	Alex Draw Trib 01	2	592	1597-Cool Forest	73%	1.60	1	600	1,000	70%	1.78	1	600	1,000	0	-3%
013_02	Alex Draw Trib 01	3	321	1597-Cool Forest	73%	1.60	1	300	500	80%	1.19	1	300	400	(100)	7%
013_02	Alex Draw Trib 01	4	179	1597-Cool Forest	73%	1.60	1	200	300	40%	3.56	1	200	700	400	-33%
013_02	Alex Draw Trib 01	5	416	1149-Cool Forest	81%	1.13	1	400	500	80%	1.19	1	400	500	0	-1%
013_02	Alex Draw Trib 01	6	536	1149-Cool Forest	81%	1.13	1	500	600	70%	1.78	1	500	900	300	-11%
013_02	Alex Draw Trib 01	7	636	1145/1146-Cool Moist Shrub	45%	3.26	1	600	2,000	60%	2.37	1	600	1,000	(1,000)	15%
013_02	Alex Draw Trib 01	8	306	1145/1146-Cool Moist Shrub	45%	3.26	1	300	1,000	40%	3.56	1	300	1,000	0	-5%
013_02	Alex Draw Trib 02	1	1475	1597-Cool Forest	73%	1.60	1	1,000	2,000	90%	0.59	1	1,000	600	(1,000)	17%
013_02	Alex Draw Trib 02	2	176	1149-Cool Forest	81%	1.13	1	200	200	20%	4.74	1	200	900	700	-61%
013_02	Alex Draw Trib 02	3	722	1149-Cool Forest	80%	1.19	2	1,000	1,000	80%	1.19	2	1,000	1,000	0	0%
013_02	Alex Draw Trib 02	4	189	1145/1146-Cool Moist Shrub	32%	4.03	2	400	2,000	0%	5.93	2	400	2,000	0	-32%
013_02	Alex Draw Trib 02	5	280	1145/1146-Cool Moist Shrub	32%	4.03	2	600	2,000	60%	2.37	2	600	1,000	(1,000)	28%
013_02	Alex Draw Trib 02	6	263	1145/1146-Cool Moist Shrub	32%	4.03	2	500	2,000	50%	2.96	2	500	1,000	(1,000)	18%
013_02	Alex Draw Trib 02	7	345	1145/1146-Cool Moist Shrub	32%	4.03	2	700	3,000	20%	4.74	2	700	3,000	0	-12%
013_02	Alex Draw Trib 03	1	425	1597-Cool Forest	73%	1.60	1	400	600	70%	1.78	1	400	700	100	-3%
013_02	Alex Draw Trib 03	2	384	1149-Cool Forest	81%	1.13	1	400	500	0%	5.93	1	400	2,000	2,000	-81%
013_02	Alex Draw Trib 03	3	260	1149-Cool Forest	81%	1.13	1	300	300	50%	2.96	1	300	900	600	-31%
013_02	Alex Draw Trib 03	4	1128	1149-Cool Forest	81%	1.13	1	1,000	1,000	70%	1.78	1	1,000	2,000	1,000	-11%
013_02	Alex Draw Trib 03	5	310	1149-Cool Forest	81%	1.13	1	300	300	60%	2.37	1	300	700	400	-21%
013_02	Alex Draw Trib 03	6	135	1149-Cool Forest	81%	1.13	1	100	100	40%	3.56	1	100	400	300	-41%
013_02	Alex Draw Trib 03	7	181	1149-Cool Forest	81%	1.13	1	200	200	70%	1.78	1	200	400	200	-11%
013_02	Alex Draw Trib 03	8	370	1145/1146-Cool Moist Shrub	45%	3.26	1	400	1,000	60%	2.37	1	400	900	(100)	15%
013_02	Allan Canyon Creek	1	1800	1597-Cool Forest	73%	1.60	1	2,000	3,000	50%	2.96	1	2,000	6,000	3,000	-23%
013_02	Allan Canyon Creek	2	1630	1149-Cool Forest	81%	1.13	1	2,000	2,000	50%	2.96	1	2,000	6,000	4,000	-31%
013_02	Allan Canyon Creek	3	555	1149-Cool Forest	80%	1.19	2	1,000	1,000	60%	2.37	2	1,000	2,000	1,000	-20%
013_02	Allan Canyon Creek	4	394	1149-Cool Forest	80%	1.19	2	800	900	40%	3.56	2	800	3,000	2,000	-40%
013_02	Allan Canyon Creek	5	1053	1760-Forest/Shrub Steppe	49%	3.02	2	2,000	6,000	0%	5.93	2	2,000	10,000	4,000	-49%
013_02	Allan Canyon Creek	6	125	2606-Riparian	75%	1.48	2	300	400	60%	2.37	2	300	700	300	-15%

Table C-13 (con't.). Existing and target solar loads for the 2nd-order assessment unit of West Camas Creek.

013_02	Allan Canyon Creek Trib 01	1	1244	1149-Cool Forest	81%	1.13	1	1,000	1,000	40%	3.56	1	1,000	4,000	3,000	-41%
013_02	Allan Canyon Creek Trib 01	2	644	1760-Forest/Shrub Steppe	66%	2.01	1	600	1,000	0%	5.93	1	600	4,000	3,000	-66%
013_02	Allan Canyon Creek Trib 01	3	237	1760-Forest/Shrub Steppe	66%	2.01	1	200	400	60%	2.37	1	200	500	100	-6%
013_02	Castle Creek	1	283	1149-Cool Forest	81%	1.13	1	300	300	60%	2.37	1	300	700	400	-21%
013_02	Castle Creek	2	548	1149-Cool Forest	81%	1.13	1	500	600	50%	2.96	1	500	1,000	400	-31%
013_02	Castle Creek	3	257	1149-Cool Forest	81%	1.13	1	300	300	40%	3.56	1	300	1,000	700	-41%
013_02	Castle Creek	4	268	1149-Cool Forest	81%	1.13	1	300	300	30%	4.15	1	300	1,000	700	-51%
013_02	Castle Creek	5	672	1149-Cool Forest	81%	1.13	1	700	800	50%	2.96	1	700	2,000	1,000	-31%
013_02	Castle Creek	6	466	1149-Cool Forest	80%	1.19	2	900	1,000	60%	2.37	2	900	2,000	1,000	-20%
013_02	Castle Creek	7	146	1145/1146-Cool Most Shrub	32%	4.03	2	300	1,000	30%	4.15	2	300	1,000	0	-2%
013_02	Castle Creek	8	149	1145/1146-Cool Most Shrub	32%	4.03	2	300	1,000	20%	4.74	2	300	1,000	0	-12%
013_02	Castle Creek	9	117	1145/1146-Cool Most Shrub	32%	4.03	2	200	800	0%	5.93	2	200	1,000	200	-32%
013_02	Castle Creek	10	101	1145/1146-Cool Most Shrub	32%	4.03	2	200	800	50%	2.96	2	200	600	(200)	18%
013_02	Disaster Creek	1	203	1149-Cool Forest	81%	1.13	1	200	200	50%	2.96	1	200	600	400	-31%
013_02	Disaster Creek	2	90	1149-Cool Forest	81%	1.13	1	90	100	40%	3.56	1	90	300	200	-41%
013_02	Disaster Creek	3	91	1149-Cool Forest	81%	1.13	1	90	100	30%	4.15	1	90	400	300	-51%
013_02	Disaster Creek	4	314	1149-Cool Forest	81%	1.13	1	300	300	50%	2.96	1	300	900	600	-31%
013_02	Disaster Creek	5	83	1149-Cool Forest	81%	1.13	1	80	90	0%	5.93	1	80	500	400	-81%
013_02	Disaster Creek	6	124	1149-Cool Forest	81%	1.13	1	100	100	30%	4.15	1	100	400	300	-51%
013_02	Disaster Creek	7	115	1149-Cool Forest	81%	1.13	1	100	100	20%	4.74	1	100	500	400	-61%
013_02	Disaster Creek	8	151	1149-Cool Forest	81%	1.13	1	200	200	30%	4.15	1	200	800	600	-51%
013_02	Disaster Creek	9	109	1149-Cool Forest	81%	1.13	1	100	100	60%	2.37	1	100	200	100	-21%
013_02	Disaster Creek	10	201	1149-Cool Forest	80%	1.19	2	400	500	20%	4.74	2	400	2,000	2,000	-60%
013_02	Disaster Creek	11	345	1149-Cool Forest	80%	1.19	2	700	800	30%	4.15	2	700	3,000	2,000	-50%
013_02	Disaster Creek	12	207	1149-Cool Forest	80%	1.19	2	400	500	40%	3.56	2	400	1,000	500	-40%
013_02	Disaster Creek	13	503	1145/1146-Cool Moist Shrub	32%	4.03	2	1,000	4,000	50%	2.96	2	1,000	3,000	(1,000)	18%
013_02	East Steel Creek	1	1230	1597-Cool Forest	73%	1.60	1	1,000	2,000	70%	1.78	1	1,000	2,000	0	-3%
013_02	East Steel Creek	2	302	1597-Cool Forest	73%	1.60	1	300	500	30%	4.15	1	300	1,000	500	-43%
013_02	East Steel Creek	3	314	1597-Cool Forest	73%	1.60	1	300	500	70%	1.78	1	300	500	0	-3%
013_02	East Steel Creek	4	1053	1149-Cool Forest	81%	1.13	1	1,000	1,000	60%	2.37	1	1,000	2,000	1,000	-21%
013_02	East Steel Creek	5	551	1149-Cool Forest	80%	1.19	2	1,000	1,000	50%	2.96	2	1,000	3,000	2,000	-30%
013_02	East Steel Creek	6	199	1149-Cool Forest	80%	1.19	2	400	500	60%	2.37	2	400	900	400	-20%
013_02	East Steel Creek	7	650	1149-Cool Forest	80%	1.19	2	1,000	1,000	50%	2.96	2	1,000	3,000	2,000	-30%
013_02	Jug Creek	1	499	1149-Cool Forest	81%	1.13	1	500	600	40%	3.56	1	500	2,000	1,000	-41%
013_02	Jug Creek	2	534	1145/1146-Cool Moist Shrub	45%	3.26	1	500	2,000	0%	5.93	1	500	3,000	1,000	-45%
013_02	Jug Creek	3	905	1145/1146-Cool Moist Shrub	32%	4.03	2	2,000	8,000	10%	5.33	2	2,000	10,000	2,000	-22%
013_02	Pass Creek	1	1216	1149-Cool Forest	81%	1.13	1	1,000	1,000	30%	4.15	1	1,000	4,000	3,000	-51%
013_02	Pass Creek	2	357	1145/1146-Cool Moist Shrub	45%	3.26	1	400	1,000	0%	5.93	1	400	2,000	1,000	-45%
013_02	Pass Creek	3	555	1145/1146-Cool Moist Shrub	45%	3.26	1	600	2,000	10%	5.33	1	600	3,000	1,000	-35%
013_02	Pass Creek	4	922	1145/1146-Cool Moist Shrub	32%	4.03	2	2,000	8,000	0%	5.93	2	2,000	10,000	2,000	-32%
013_02	Pass Creek	5	152	1145/1146-Cool Moist Shrub	32%	4.03	2	300	1,000	10%	5.33	2	300	2,000	1,000	-22%
013_02	Pass Creek	6	185	1145/1146-Cool Moist Shrub	32%	4.03	2	400	2,000	30%	4.15	2	400	2,000	0	-2%
013_02	Pete Creek	1	152	1149-Cool Forest	81%	1.13	1	200	200	50%	2.96	1	200	600	400	-31%
013_02	Pete Creek	2	190	1149-Cool Forest	81%	1.13	1	200	200	40%	3.56	1	200	700	500	-41%
013_02	Pete Creek	3	98	1149-Cool Forest	81%	1.13	1	100	100	10%	5.33	1	100	500	400	-71%
013_02	Pete Creek	4	1201	1149-Cool Forest	81%	1.13	1	1,000	1,000	60%	2.37	1	1,000	2,000	1,000	-21%
013_02	Pete Creek	5	573	1145/1146-Cool Moist Shrub	45%	3.26	1	600	2,000	50%	2.96	1	600	2,000	0	5%
013_02	Pete Creek	6	90	1145/1146-Cool Moist Shrub	32%	4.03	2	200	800	40%	3.56	2	200	700	(100)	8%
013_02	Pete Creek	7	157	1145/1146-Cool Moist Shrub	32%	4.03	2	300	1,000	30%	4.15	2	300	1,000	0	-2%
013_02	Pete Creek	8	192	1145/1146-Cool Moist Shrub	32%	4.03	2	400	2,000	0%	5.93	2	400	2,000	0	-32%
013_02	Pete Creek	9	784	1145/1146-Cool Moist Shrub	32%	4.03	2	2,000	8,000	50%	2.96	2	2,000	6,000	(2,000)	18%
013_02	Pete Creek	10	413	1145/1146-Cool Moist Shrub	32%	4.03	2	800	3,000	50%	2.96	2	800	2,000	(1,000)	18%

Table C-13 (con't.). Existing and target solar loads for the 2nd-order assessment unit of West Camas Creek.

013_02	Pete Creek	11	1250	1145/1146-Cool Moist Shrub	26%	4.38	3	4,000	20,000	40%	3.56	3	4,000	10,000	(10,000)	14%
013_02	Pete Creek	12	444	1145/1146-Cool Moist Shrub	26%	4.38	3	1,000	4,000	30%	4.15	3	1,000	4,000	0	4%
013_02	Pete Creek	13	616	1145/1146-Cool Moist Shrub	20%	4.74	4	2,000	9,000	50%	2.96	4	2,000	6,000	(3,000)	30%
013_02	Pete Creek	14	144	1145/1146-Cool Moist Shrub	20%	4.74	4	600	3,000	60%	2.37	4	600	1,000	(2,000)	40%
013_02	Pete Creek	15	651	1145/1146-Cool Moist Shrub	20%	4.74	4	3,000	10,000	40%	3.56	4	3,000	10,000	0	20%
013_02	Pete Creek	16	379	1145/1146-Cool Moist Shrub	20%	4.74	4	2,000	9,000	60%	2.37	4	2,000	5,000	(4,000)	40%
013_02	Pete Creek Trib 01	1	164	1149-Cool Forest	81%	1.13	1	200	200	40%	3.56	1	200	700	500	-41%
013_02	Pete Creek Trib 01	2	187	1149-Cool Forest	81%	1.13	1	200	200	60%	2.37	1	200	500	300	-21%
013_02	Pete Creek Trib 01	3	49	1149-Cool Forest	81%	1.13	1	50	60	0%	5.93	1	50	300	200	-81%
013_02	Pete Creek Trib 01	4	333	1149-Cool Forest	81%	1.13	1	300	300	40%	3.56	1	300	1,000	700	-41%
013_02	Pete Creek Trib 01	5	292	1149-Cool Forest	81%	1.13	1	300	300	70%	1.78	1	300	500	200	-11%
013_02	Pete Creek Trib 01	6	166	1149-Cool Forest	81%	1.13	1	200	200	60%	2.37	1	200	500	300	-21%
013_02	Pete Creek Trib 01	7	281	1149-Cool Forest	81%	1.13	1	300	300	70%	1.78	1	300	500	200	-11%
013_02	Pete Creek Trib 01	8	139	1149-Cool Forest	80%	1.19	2	300	400	60%	2.37	2	300	700	300	-20%
013_02	Pete Creek Trib 01	9	363	1149-Cool Forest	80%	1.19	2	700	800	70%	1.78	2	700	1,000	200	-10%
013_02	Pete Creek Trib 01	10	194	1145/1146-Cool Moist Shrub	32%	4.03	2	400	2,000	60%	2.37	2	400	900	(1,000)	28%
013_02	Pete Creek Trib 01	11	258	1145/1146-Cool Moist Shrub	32%	4.03	2	500	2,000	50%	2.96	2	500	1,000	(1,000)	18%
013_02	Pete Creek Trib 01	12	403	1145/1146-Cool Moist Shrub	32%	4.03	2	800	3,000	60%	2.37	2	800	2,000	(1,000)	28%
013_02	Pete Creek Trib 02	1	313	1149-Cool Forest	81%	1.13	1	300	300	40%	3.56	1	300	1,000	700	-41%
013_02	Pete Creek Trib 02	2	589	1149-Cool Forest	81%	1.13	1	600	700	50%	2.96	1	600	2,000	1,000	-31%
013_02	Pete Creek Trib 02	3	765	1149-Cool Forest	81%	1.13	1	800	900	60%	2.37	1	800	2,000	1,000	-21%
013_02	Pete Creek Trib 02	4	667	1149-Cool Forest	80%	1.19	2	1,000	1,000	50%	2.96	2	1,000	3,000	2,000	-30%
013_02	Pete Creek Trib 02	5	785	1145/1146-Cool Moist Shrub	32%	4.03	2	2,000	8,000	40%	3.56	2	2,000	7,000	(1,000)	8%
013_02	Steel Creek	1	235	2606-Riparian	88%	0.71	1	200	100	50%	2.96	1	200	600	500	-38%
013_02	Steel Creek	2	718	2606-Riparian	88%	0.71	1	700	500	60%	2.37	1	700	2,000	2,000	-28%
013_02	Steel Creek	3	104	2606-Riparian	75%	1.48	2	200	300	0%	5.93	2	200	1,000	700	-75%
013_02	Steel Creek	4	130	2606-Riparian	75%	1.48	2	300	400	60%	2.37	2	300	700	300	-15%
013_02	Steel Creek	5	226	2606-Riparian	65%	2.07	3	700	1,000	20%	4.74	3	700	3,000	2,000	-45%
013_02	Stump Creek	1	1044	1149-Cool Forest	81%	1.13	1	1,000	1,000	60%	2.37	1	1,000	2,000	1,000	-21%
013_02	Stump Creek	2	178	1149-Cool Forest	81%	1.13	1	200	200	40%	3.56	1	200	700	500	-41%
013_02	Stump Creek	3	1210	1145/1146-Cool Moist Shrub	45%	3.26	1	1,000	3,000	60%	2.37	1	1,000	2,000	(1,000)	15%
013_02	Stump Creek	4	1282	1145/1146-Cool Moist Shrub	32%	4.03	2	3,000	10,000	0%	5.93	2	3,000	20,000	10,000	-32%
013_02	West Camas Creek	1	2603	1576-Cool Forest/Alpine	72%	1.66	1	3,000	5,000	0%	5.93	1	3,000	20,000	20,000	-72%
013_02	West Camas Creek	2	581	1149-Cool Forest	80%	1.19	2	1,000	1,000	50%	2.96	2	1,000	3,000	2,000	-30%
013_02	West Camas Creek	3	1062	1149-Cool Forest	80%	1.19	2	2,000	2,000	70%	1.78	2	2,000	4,000	2,000	-10%
013_02	West Camas Creek	4	179	1149-Cool Forest	80%	1.19	2	400	500	20%	4.74	2	400	2,000	2,000	-60%
013_02	West Camas Creek	5	336	1149-Cool Forest	80%	1.19	2	700	800	50%	2.96	2	700	2,000	1,000	-30%
013_02	West Camas Creek	6	1534	1149-Cool Forest	80%	1.19	3	5,000	6,000	70%	1.78	3	5,000	9,000	3,000	-10%
013_02	West Camas Creek	7	319	1145/1146-Cool Moist Shrub	26%	4.38	3	1,000	4,000	60%	2.37	3	1,000	2,000	(2,000)	34%
013_02	West Camas Creek	8	534	1145/1146-Cool Moist Shrub	26%	4.38	3	2,000	9,000	70%	1.78	3	2,000	4,000	(5,000)	44%
013_02	West Camas Creek	9	576	1145/1146-Cool Moist Shrub	26%	4.38	3	2,000	9,000	60%	2.37	3	2,000	5,000	(4,000)	34%
013_02	West Camas Creek	10	237	1145/1146-Cool Moist Shrub	26%	4.38	3	700	3,000	70%	1.78	3	700	1,000	(2,000)	44%
013_02	West Camas Creek	11	477	1145/1146-Cool Moist Shrub	26%	4.38	3	1,000	4,000	50%	2.96	3	1,000	3,000	(1,000)	24%
013_02	West Camas Creek	12	461	1145/1146-Cool Moist Shrub	26%	4.38	3	1,000	4,000	40%	3.56	3	1,000	4,000	0	14%
013_02	West Camas Creek	13	204	1145/1146-Cool Moist Shrub	26%	4.38	3	600	3,000	30%	4.15	3	600	2,000	(1,000)	4%
013_02	West Camas Creek	14	172	1145/1146-Cool Moist Shrub	20%	4.74	4	700	3,000	20%	4.74	4	700	3,000	0	0%
013_02	West Camas Creek	15	1213	1145/1146-Cool Moist Shrub	20%	4.74	4	5,000	20,000	40%	3.56	4	5,000	20,000	0	20%
013_02	West Camas Creek	16	628	1145/1146-Cool Moist Shrub	17%	4.92	5	3,000	10,000	30%	4.15	5	3,000	10,000	0	13%
013_02	West Camas Creek	17	363	1145/1146-Cool Moist Shrub	17%	4.92	5	2,000	10,000	40%	3.56	5	2,000	7,000	(3,000)	23%
013_02	West Camas Creek	18	284	1145/1146-Cool Moist Shrub	17%	4.92	5	1,000	5,000	50%	2.96	5	1,000	3,000	(2,000)	33%
013_02	West Camas Creek	19	363	2606-Riparian	52%	2.84	5	2,000	6,000	30%	4.15	5	2,000	8,000	2,000	-22%

Table C-13 (con't.). Existing and target solar loads for the 2nd-order assessment unit of West Camas Creek.

013_02	West Camas Creek Trib 01	1	1971	1576-Cool Forest/Alpine	72%	1.66	1	2,000	3,000	0%	5.93	1	2,000	10,000	7,000	-72%
013_02	West Camas Creek Trib 02	1	1437	1576-Cool Forest/Alpine	72%	1.66	1	1,000	2,000	0%	5.93	1	1,000	6,000	4,000	-72%
013_02	West Camas Creek Trib 02	2	523	1149-Cool Forest	81%	1.13	1	500	600	60%	2.37	1	500	1,000	400	-21%
013_02	West Camas Creek Trib 02	3	168	1149-Cool Forest	81%	1.13	1	200	200	40%	3.56	1	200	700	500	-41%
013_02	West Camas Creek Trib 02	4	266	1149-Cool Forest	81%	1.13	1	300	300	0%	5.93	1	300	2,000	2,000	-81%
013_02	West Camas Creek Trib 03	1	303	1576-Cool Forest/Alpine	72%	1.66	1	300	500	0%	5.93	1	300	2,000	2,000	-72%
013_02	West Camas Creek Trib 03	2	344	1149-Cool Forest	81%	1.13	1	300	300	40%	3.56	1	300	1,000	700	-41%
013_02	West Camas Creek Trib 03	3	425	1149-Cool Forest	81%	1.13	1	400	500	30%	4.15	1	400	2,000	2,000	-51%
013_02	West Camas Creek Trib 03	4	238	1149-Cool Forest	81%	1.13	1	200	200	0%	5.93	1	200	1,000	800	-81%
013_02	West Camas Creek Trib 03	5	755	1149-Cool Forest	80%	1.19	2	2,000	2,000	50%	2.96	2	2,000	6,000	4,000	-30%
013_02	West Camas Creek Trib 03	6	195	1149-Cool Forest	80%	1.19	2	400	500	70%	1.78	2	400	700	200	-10%
013_02	West Camas Creek Trib 04	1	602	1760-Forest/Shrub Steppe	66%	2.01	1	600	1,000	0%	5.93	1	600	4,000	3,000	-66%
013_02	West Camas Creek Trib 04	2	139	2606-Riparian	88%	0.71	1	100	70	60%	2.37	1	100	200	100	-28%
013_02	West Camas Creek Trib 04	3	577	2606-Riparian	88%	0.71	1	600	400	50%	2.96	1	600	2,000	2,000	-38%
013_02	West Camas Creek Trib 05	1	590	1597-Cool Forest	73%	1.60	1	600	1,000	60%	2.37	1	600	1,000	0	-13%
013_02	West Camas Creek Trib 05	2	522	1149-Cool Forest	81%	1.13	1	500	600	50%	2.96	1	500	1,000	400	-31%
013_02	West Camas Creek Trib 05	3	1369	1149-Cool Forest	81%	1.13	1	1,000	1,000	40%	3.56	1	1,000	4,000	3,000	-41%
013_02	West Camas Creek Trib 05	4	102	1760-Forest/Shrub Steppe	49%	3.02	2	200	600	0%	5.93	2	200	1,000	400	-49%
013_02	West Camas Creek Trib 05	5	192	1760-Forest/Shrub Steppe	49%	3.02	2	400	1,000	30%	4.15	2	400	2,000	1,000	-19%
013_02	West Camas Creek Trib 05a	1	207	1597-Cool Forest	73%	1.60	1	200	300	60%	2.37	1	200	500	200	-13%
013_02	West Camas Creek Trib 05a	2	405	1597-Cool Forest	73%	1.60	1	400	600	50%	2.96	1	400	1,000	400	-23%
013_02	West Camas Creek Trib 05a	3	2027	1149-Cool Forest	81%	1.13	1	2,000	2,000	50%	2.96	1	2,000	6,000	4,000	-31%
013_02	West Camas Creek Trib 05a	4	208	1760-Forest/Shrub Steppe	66%	2.01	1	200	400	0%	5.93	1	200	1,000	600	-66%
013_02	West Steel Creek	1	468	1597-Cool Forest	73%	1.60	1	500	800	70%	1.78	1	500	900	100	-3%
013_02	West Steel Creek	2	211	1149-Cool Forest	81%	1.13	1	200	200	60%	2.37	1	200	500	300	-21%
013_02	West Steel Creek	3	219	1149-Cool Forest	81%	1.13	1	200	200	50%	2.96	1	200	600	400	-31%
013_02	West Steel Creek	4	1290	1149-Cool Forest	81%	1.13	1	1,300	1,500	50%	2.96	1	1,300	3,900	2,400	-31%
013_02	West Steel Creek	5	864	1149-Cool Forest	80%	1.19	2	1,730	2,050	50%	2.96	2	1,730	5,130	3,080	-30%
							Totals		360,000					460,000	110,000	

Table C-14. Existing and target solar loads for the 3rd-order assessment unit of West Camas Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
013_03	West Camas Creek	1	1073	2606-Riparian	47%	3.14	6	6,438	20,220	50%	2.96	6	6,438	19,070	(1,150)	3%
013_03	West Camas Creek	2	1027	2606-Riparian	47%	3.14	6	6,162	19,350	30%	4.15	6	6,162	25,557	6,207	-17%
013_03	West Camas Creek	3	1289	2606-Riparian	47%	3.14	6	7,734	24,287	60%	2.37	6	7,734	18,330	(5,957)	13%
013_03	West Camas Creek	4	1649	2606-Riparian	42%	3.44	7	11,543	39,668	50%	2.96	7	11,543	34,196	(5,471)	8%
013_03	West Camas Creek	5	496	2606-Riparian	42%	3.44	7	3,000	10,000	60%	2.37	7	3,000	7,000	(3,000)	18%
013_03	West Camas Creek	6	596	2606-Riparian	42%	3.44	7	4,000	10,000	40%	3.56	7	4,000	10,000	0	-2%
013_03	West Camas Creek	7	806	2606-Riparian	42%	3.44	7	6,000	20,000	20%	4.74	7	6,000	30,000	10,000	-22%
013_03	West Camas Creek	8	1227	2606-Riparian	37%	3.73	8	10,000	40,000	40%	3.56	8	10,000	40,000	0	3%
013_03	West Camas Creek	9	384	2606-Riparian	37%	3.73	8	3,000	10,000	30%	4.15	8	3,000	10,000	0	-7%
013_03	West Camas Creek	10	990	2606-Riparian	37%	3.73	8	8,000	30,000	40%	3.56	8	8,000	30,000	0	3%
013_03	West Camas Creek	11	507	2606-Riparian	37%	3.73	8	4,000	10,000	50%	2.96	8	4,000	10,000	0	13%
013_03	West Camas Creek	12	478	2606-Riparian	37%	3.73	8	4,000	10,000	30%	4.15	8	4,000	20,000	10,000	-7%
							Totals		240,000					250,000	11,000	

Table C-15. Existing and target solar loads for the 2nd-order assessment unit of Rattlesnake Creek.

AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
016_02	Corral Creek	1	992	1150-Cool Forest	51%	2.90	1	1,000	3,000	70%	1.78	1	1,000	2,000	(1,000)	19%
016_02	Corral Creek	2	547	1150-Cool Forest	51%	2.90	1	500	1,000	60%	2.37	1	500	1,000	0	9%
016_02	Corral Creek	3	2099	1149-Cool Forest	81%	1.13	1	2,000	2,000	70%	1.78	1	2,000	4,000	2,000	-11%
016_02	Corral Creek	4	251	1149-Cool Forest	80%	1.19	2	500	600	40%	3.56	2	500	2,000	1,000	-40%
016_02	Corral Creek	5	684	1149-Cool Forest	80%	1.19	2	1,000	1,000	60%	2.37	2	1,000	2,000	1,000	-20%
016_02	Corral Creek	6	446	1149-Cool Forest	80%	1.19	2	900	1,000	20%	4.74	2	900	4,000	3,000	-60%
016_02	Corral Creek	7	663	1149-Cool Forest	80%	1.19	2	1,000	1,000	60%	2.37	2	1,000	2,000	1,000	-20%
016_02	Corral Creek	8	1383	1145/1146-Cool Moist Shrub	32%	4.03	2	3,000	10,000	50%	2.96	2	3,000	9,000	(1,000)	18%
016_02	Corral Creek	9	1867	1145/1146-Cool Moist Shrub	26%	4.38	3	6,000	30,000	0%	5.93	3	6,000	40,000	10,000	-26%
016_02	Corral Creek Trib 01	1	3495	1250-Forest/Shrub Steppe	76%	1.42	1	3,000	4,000	0%	5.93	1	3,000	20,000	20,000	-76%
016_02	Corral Creek Trib 01	2	873	1149-Cool Forest	80%	1.19	2	2,000	2,000	70%	1.78	2	2,000	4,000	2,000	-10%
016_02	Corral Creek Trib 02	1	3553	1250-Forest/Shrub Steppe	76%	1.42	1	4,000	6,000	0%	5.93	1	4,000	20,000	10,000	-76%
016_02	Corral Creek Trib 02	2	1127	1250-Forest/Shrub Steppe	61%	2.31	2	2,000	5,000	0%	5.93	2	2,000	10,000	5,000	-61%
016_02	Corral Creek Trib 02a	1	2686	1250-Forest/Shrub Steppe	61%	2.31	2	5,000	10,000	0%	5.93	2	5,000	30,000	20,000	-61%
016_02	Corral Creek Trib 02b	1	2595	1250-Forest/Shrub Steppe	76%	1.42	1	3,000	4,000	0%	5.93	1	3,000	20,000	20,000	-76%
016_02	Corral Creek Trib 02b	2	857	1250-Forest/Shrub Steppe	61%	2.31	2	2,000	5,000	0%	5.93	2	2,000	10,000	5,000	-61%
016_02	Corral Creek Trib 02b1	1	2035	1250-Forest/Shrub Steppe	76%	1.42	1	2,000	3,000	0%	5.93	1	2,000	10,000	7,000	-76%
016_02	Corral Creek Trib 02c	1	2108	1250-Forest/Shrub Steppe	76%	1.42	1	2,000	3,000	0%	5.93	1	2,000	10,000	7,000	-76%
016_02	Corral Creek Trib 02c	2	1652	1145/1146-Cool Moist Shrub	32%	4.03	2	3,000	10,000	0%	5.93	2	3,000	20,000	10,000	-32%
016_02	East Fork Rattlesnake Creek	1	1867	1150-Cool Forest	51%	2.90	1	2,000	6,000	20%	4.74	1	2,000	9,000	3,000	-31%
016_02	East Fork Rattlesnake Creek	2	856	1150-Cool Forest	51%	2.90	1	900	3,000	50%	2.96	1	900	3,000	0	-1%
016_02	East Fork Rattlesnake Creek	3	1580	1149-Cool Forest	81%	1.13	1	2,000	2,000	50%	2.96	1	2,000	6,000	4,000	-31%
016_02	East Fork Rattlesnake Creek	4	2415	1149-Cool Forest	80%	1.19	2	5,000	6,000	20%	4.74	2	5,000	20,000	10,000	-60%
016_02	East Fork Rattlesnake Creek	5	738	1149-Cool Forest	80%	1.19	2	1,000	1,000	40%	3.56	2	1,000	4,000	3,000	-40%
016_02	East Fork Rattlesnake Creek	6	565	1145/1146-Cool Moist Shrub	26%	4.38	3	2,000	9,000	50%	2.96	3	2,000	6,000	(3,000)	24%
016_02	East Fork Rattlesnake Creek	7	959	1145/1146-Cool Moist Shrub	26%	4.38	3	3,000	10,000	30%	4.15	3	3,000	10,000	0	4%
016_02	East Fork Rattlesnake Creek	8	1537	1145/1146-Cool Moist Shrub	26%	4.38	3	5,000	20,000	0%	5.93	3	5,000	30,000	10,000	-26%
016_02	East Fork Rattlesnake Creek Trib 02	1	1160	1150-Cool Forest	51%	2.90	1	1,000	3,000	60%	2.37	1	1,000	2,000	(1,000)	9%
016_02	East Fork Rattlesnake Creek Trib 02	2	982	1150-Cool Forest	51%	2.90	1	1,000	3,000	50%	2.96	1	1,000	3,000	0	-1%
016_02	East Fork Rattlesnake Creek Trib 02	3	1443	1150-Cool Forest	51%	2.90	1	1,000	3,000	60%	2.37	1	1,000	2,000	(1,000)	9%
016_02	East Fork Rattlesnake Creek Trib 02	4	654	1150-Cool Forest	51%	2.90	1	700	2,000	50%	2.96	1	700	2,000	0	-1%
016_02	East Fork Rattlesnake Creek Trib 02	5	890	1149-Cool Forest	81%	1.13	1	900	1,000	40%	3.56	1	900	3,000	2,000	-41%

Table C-15 (con't.). Existing and target solar loads for the 2nd-order assessment unit of Rattlesnake Creek.

016_02	Rattlesnake Creek_Trib 01	1	547	1145/1146-Cool Moist Shrub	45%	3.26	1	500	2,000	60%	2.37	1	500	1,000	(1,000)	15%
016_02	Rattlesnake Creek_Trib 01	2	696	1145/1146-Cool Moist Shrub	45%	3.26	1	700	2,000	0%	5.93	1	700	4,000	2,000	-45%
016_02	Rattlesnake Creek_Trib 01	3	538	1145/1146-Cool Moist Shrub	45%	3.26	1	500	2,000	60%	2.37	1	500	1,000	(1,000)	15%
016_02	Rattlesnake Creek_Trib 01	4	1224	1145/1146-Cool Moist Shrub	32%	4.03	2	2,000	8,000	0%	5.93	2	2,000	10,000	2,000	-32%
016_02	Rattlesnake Creek_Trib 02	1	3608	1145/1146-Cool Moist Shrub	45%	3.26	1	4,000	10,000	0%	5.93	1	4,000	20,000	10,000	-45%
016_02	Spring Creek	1	1016	1250-Forest/Shrub Steppe	76%	1.42	1	1,000	1,000	0%	5.93	1	1,000	6,000	5,000	-76%
016_02	Spring Creek	2	1317	1250-Forest/Shrub Steppe	76%	1.42	1	1,000	1,000	50%	2.96	1	1,000	3,000	2,000	-26%
016_02	Spring Creek	3	2042	1250-Forest/Shrub Steppe	61%	2.31	2	4,000	9,000	0%	5.93	2	4,000	20,000	10,000	-61%
016_02	Spring Creek	4	901	1250-Forest/Shrub Steppe	51%	2.90	3	3,000	9,000	40%	3.56	3	3,000	10,000	1,000	-11%
016_02	Spring Creek	5	1701	1145/1146-Cool Moist Shrub	23%	4.56	3	5,000	20,000	0%	5.93	3	5,000	30,000	10,000	-23%
016_02	Spring Creek_Trib 01	1	2137	1250-Forest/Shrub Steppe	76%	1.42	1	2,000	3,000	0%	5.93	1	2,000	10,000	7,000	-76%
016_02	Spring Creek_Trib 01	2	374	1250-Forest/Shrub Steppe	76%	1.42	1	400	600	10%	5.33	1	400	2,000	1,000	-66%
016_02	Spring Creek_Trib 01	3	278	1250-Forest/Shrub Steppe	76%	1.42	1	300	400	0%	5.93	1	300	2,000	2,000	-76%
016_02	Spring Creek_Trib 01	4	1240	1250-Forest/Shrub Steppe	76%	1.42	1	1,000	1,000	60%	2.37	1	1,000	2,000	1,000	-16%
016_02	Spring Creek_Trib 01	5	1044	1250-Forest/Shrub Steppe	61%	2.31	2	2,000	5,000	0%	5.93	2	2,000	10,000	5,000	-61%
016_02	Spring Creek_Trib 01	6	960	1250-Forest/Shrub Steppe	61%	2.31	2	2,000	5,000	60%	2.37	2	2,000	5,000	0	-1%
016_02	Spring Creek_Trib 02	1	4126	1250-Forest/Shrub Steppe	51%	2.90	1	4,000	10,000	0%	5.93	1	4,000	20,000	10,000	-51%
016_02	West Fork Rattlesnake Creek	1	1320	1576-Cool Forest/Alpine	72%	1.66	1	1,000	2,000	70%	1.78	1	1,000	2,000	0	-2%
016_02	West Fork Rattlesnake Creek	2	3088	1150-Cool Forest	51%	2.90	1	3,000	9,000	60%	2.37	1	3,000	7,000	(2,000)	9%
016_02	West Fork Rattlesnake Creek	3	1541	1149-Cool Forest	80%	1.19	2	3,000	4,000	60%	2.37	2	3,000	7,000	3,000	-20%
016_02	West Fork Rattlesnake Creek	4	1870	2606-Riparian	75%	1.48	2	4,000	6,000	50%	2.96	2	4,000	10,000	4,000	-25%
016_02	West Fork Rattlesnake Creek	5	1242	2606-Riparian	65%	2.07	3	4,000	8,000	60%	2.37	3	4,000	9,000	1,000	-5%
016_02	West Fork Rattlesnake Creek	6	583	1145/1146-Cool Moist Shrub	26%	4.38	3	2,000	9,000	0%	5.93	3	2,000	10,000	1,000	-26%
016_02	West Fork Rattlesnake Creek	7	285	1145/1146-Cool Moist Shrub	26%	4.38	3	900	4,000	20%	4.74	3	900	4,000	0	-6%
016_02	West Fork Rattlesnake Creek	8	1047	1145/1146-Cool Moist Shrub	20%	4.74	4	4,000	20,000	0%	5.93	4	4,000	20,000	0	-20%
016_02	West Fork Rattlesnake Creek_Trib 01	1	568	1270-Cold Moist Forest	62%	2.25	1	600	1,000	40%	3.56	1	600	2,000	1,000	-22%
016_02	West Fork Rattlesnake Creek_Trib 01	2	409	1150-Cool Forest	51%	2.90	1	400	1,000	0%	5.93	1	400	2,000	1,000	-51%
016_02	West Fork Rattlesnake Creek_Trib 01	3	1290	1150-Cool Forest	51%	2.90	1	1,000	3,000	30%	4.15	1	1,000	4,000	1,000	-21%
016_02	West Fork Rattlesnake Creek_Trib 01	4	612	1150-Cool Forest	51%	2.90	2	1,000	3,000	60%	2.37	2	1,000	2,000	(1,000)	9%
016_02	West Fork Rattlesnake Creek_Trib 01	5	940	1150-Cool Forest	51%	2.90	2	2,000	6,000	30%	4.15	2	2,000	8,000	2,000	-21%
016_02	West Fork Rattlesnake Creek_Trib 02	1	515	1150-Cool Forest	51%	2.90	1	500	1,000	50%	2.96	1	500	1,000	0	-1%
016_02	West Fork Rattlesnake Creek_Trib 02	2	1170	1250-Forest/Shrub Steppe	76%	1.42	1	1,000	1,000	0%	5.93	1	1,000	6,000	5,000	-76%
016_02	West Fork Rattlesnake Creek_Trib 02	3	701	1149-Cool Forest	81%	1.13	1	700	800	60%	2.37	1	700	2,000	1,000	-21%
							Totals		340,000					570,000	230,000	

Table C-16. Existing and target solar loads for the 2nd-order assessment unit of Threemile Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
017_02	East Threemile Creek	1	207	1270-Cold Moist Forest	62%	2.25	1	200	500	30%	4.15	1	200	800	300	-32%
017_02	East Threemile Creek	2	413	1270-Cold Moist Forest	62%	2.25	1	400	900	50%	2.96	1	400	1,000	100	-12%
017_02	East Threemile Creek	3	272	1270-Cold Moist Forest	62%	2.25	1	300	700	30%	4.15	1	300	1,000	300	-32%
017_02	East Threemile Creek	4	926	1150-Cool Forest	51%	2.90	1	900	3,000	40%	3.56	1	900	3,000	0	-11%
017_02	East Threemile Creek	5	967	1150-Cool Forest	51%	2.90	1	1,000	3,000	50%	2.96	1	1,000	3,000	0	-1%
017_02	East Threemile Creek	6	1270	1150-Cool Forest	51%	2.90	2	3,000	9,000	40%	3.56	2	3,000	10,000	1,000	-11%
017_02	East Threemile Creek	7	2270	2606-Riparian	65%	2.07	3	7,000	10,000	50%	2.96	3	7,000	20,000	10,000	-15%
017_02	East Threemile Creek	8	553	2606-Riparian	58%	2.49	4	2,000	5,000	60%	2.37	4	2,000	5,000	0	2%
017_02	East Threemile Creek	9	960	2606-Riparian	58%	2.49	4	4,000	10,000	40%	3.56	4	4,000	10,000	0	-18%
017_02	East Threemile Creek	10	1150	2606-Riparian	58%	2.49	4	5,000	10,000	50%	2.96	4	5,000	10,000	0	-8%
017_02	Middle Threemile Creek	1	623	1149-Cool Forest	81%	1.13	1	600	700	40%	3.56	1	600	2,000	1,000	-41%
017_02	Middle Threemile Creek	2	799	1149-Cool Forest	81%	1.13	1	800	900	70%	1.78	1	800	1,000	100	-11%
017_02	Middle Threemile Creek	3	271	1149-Cool Forest	81%	1.13	1	300	300	50%	2.96	1	300	900	600	-31%
017_02	Middle Threemile Creek	4	1009	1149-Cool Forest	81%	1.13	1	1,000	1,000	60%	2.37	1	1,000	2,000	1,000	-21%
017_02	Middle Threemile Creek	5	369	1149-Cool Forest	80%	1.19	2	700	800	50%	2.96	2	700	2,000	1,000	-30%
017_02	Middle Threemile Creek	6	203	1149-Cool Forest	80%	1.19	2	400	500	70%	1.78	2	400	700	200	-10%
017_02	Middle Threemile Creek	7	584	1149-Cool Forest	80%	1.19	2	1,000	1,000	40%	3.56	2	1,000	4,000	3,000	-40%
017_02	Middle Threemile Creek	8	264	1145/1146-Cool Moist Shrub	32%	4.03	2	500	2,000	20%	4.74	2	500	2,000	0	-12%
017_02	Middle Threemile Creek	9	229	1145/1146-Cool Moist Shrub	32%	4.03	2	500	2,000	60%	2.37	2	500	1,000	(1,000)	28%
017_02	Middle Threemile Creek	10	712	1145/1146-Cool Moist Shrub	26%	4.38	3	2,000	9,000	50%	2.96	3	2,000	6,000	(3,000)	24%
017_02	Middle Threemile Creek	11	249	1145/1146-Cool Moist Shrub	26%	4.38	3	700	3,000	60%	2.37	3	700	2,000	(1,000)	34%
017_02	Middle Threemile Creek	12	138	1145/1146-Cool Moist Shrub	26%	4.38	3	400	2,000	0%	5.93	3	400	2,000	0	-26%
017_02	Middle Threemile Creek	13	208	1145/1146-Cool Moist Shrub	26%	4.38	3	600	3,000	70%	1.78	3	600	1,000	(2,000)	44%
017_02	Middle Threemile Creek	14	170	1145/1146-Cool Moist Shrub	26%	4.38	3	500	2,000	40%	3.56	3	500	2,000	0	14%
017_02	Middle Threemile Creek	15	100	1145/1146-Cool Moist Shrub	26%	4.38	3	300	1,000	40%	3.56	3	300	1,000	0	14%
017_02	Middle Threemile Creek	16	515	1145/1146-Cool Moist Shrub	26%	4.38	3	2,000	9,000	40%	3.56	3	2,000	7,000	(2,000)	14%
017_02	Middle Threemile Creek_Trib 01	2	1079	1149-Cool Forest	81%	1.13	1	1,000	1,000	0%	5.93	1	1,000	6,000	5,000	-81%
017_02	Middle Threemile Creek_Trib 01	3	164	1149-Cool Forest	81%	1.13	1	200	200	0%	5.93	1	200	1,000	800	-81%
017_02	Middle Threemile Creek_Trib 01	4	274	1149-Cool Forest	81%	1.13	1	300	300	20%	4.74	1	300	1,000	700	-61%
017_02	Middle Threemile Creek_Trib 01	5	582	1149-Cool Forest	81%	1.13	1	600	700	60%	2.37	1	600	1,000	300	-21%
017_02	Middle Threemile Creek_Trib 01	6	1150	1149-Cool Forest	80%	1.19	2	2,000	2,000	40%	3.56	2	2,000	7,000	5,000	-40%
017_02	Middle Threemile Creek_Trib 01	7	1125	1145/1146-Cool Moist Shrub	32%	4.03	2	2,000	8,000	50%	2.96	2	2,000	6,000	(2,000)	18%

Table C-16 (con't.). Existing and target solar loads for the 2nd-order assessment unit of Threemile Creek.

017_02	Threemile Creek	1	450	2606-Riparian	65%	2.07	3	1,000	2,000	40%	3.56	3	1,000	4,000	2,000	-25%
017_02	Threemile Creek	3	390	2606-Riparian	65%	2.07	3	1,000	2,000	50%	2.96	3	1,000	3,000	1,000	-15%
017_02	Threemile Creek	4	259	2606-Riparian	65%	2.07	3	800	2,000	0%	5.93	3	800	5,000	3,000	-65%
017_02	Threemile Creek	5	286	2606-Riparian	65%	2.07	3	900	2,000	60%	2.37	3	900	2,000	0	-5%
017_02	Threemile Creek	6	341	2606-Riparian	65%	2.07	3	1,000	2,000	60%	2.37	3	1,000	2,000	0	-5%
017_02	Threemile Creek	7	474	1145/1146-Cool Moist Shrub	20%	4.74	4	2,000	9,000	40%	3.56	4	2,000	7,000	(2,000)	20%
017_02	Threemile Creek	8	623	1145/1146-Cool Moist Shrub	20%	4.74	4	2,000	9,000	20%	4.74	4	2,000	9,000	0	0%
017_02	Threemile Creek	9	251	1145/1146-Cool Moist Shrub	20%	4.74	4	1,000	5,000	0%	5.93	4	1,000	6,000	1,000	-20%
017_02	Threemile Creek	10	359	1145/1146-Cool Moist Shrub	20%	4.74	4	1,000	5,000	60%	2.37	4	1,000	2,000	(3,000)	40%
017_02	Threemile Creek_Trib 01	1	164	1145/1146-Cool Moist Shrub	45%	3.26	1	200	700	30%	4.15	1	200	800	100	-15%
017_02	Threemile Creek_Trib 01	2	354	1145/1146-Cool Moist Shrub	45%	3.26	1	400	1,000	0%	5.93	1	400	2,000	1,000	-45%
017_02	Threemile Creek_Trib 01	3	305	1145/1146-Cool Moist Shrub	45%	3.26	1	300	1,000	40%	3.56	1	300	1,000	0	-5%
017_02	Threemile Creek_Trib 01	4	229	1145/1146-Cool Moist Shrub	45%	3.26	1	200	700	30%	4.15	1	200	800	100	-15%
017_02	Threemile Creek_Trib 01	5	381	1145/1146-Cool Moist Shrub	45%	3.26	1	400	1,000	0%	5.93	1	400	2,000	1,000	-45%
017_02	Threemile Creek_Trib 01	6	463	2606-Riparian	88%	0.71	1	500	400	60%	2.37	1	500	1,000	600	-28%
017_02	Threemile Creek_Trib 01	7	201	2606-Riparian	88%	0.71	1	200	100	10%	5.33	1	200	1,000	900	-78%
017_02	Threemile Creek_Trib 01	8	183	2606-Riparian	88%	0.71	1	200	100	20%	4.74	1	200	900	800	-68%
017_02	West Threemile Creek	1	296	1149-Cool Forest	81%	1.13	1	300	300	50%	2.96	1	300	900	600	-31%
017_02	West Threemile Creek	2	835	1149-Cool Forest	81%	1.13	1	800	900	10%	5.33	1	800	4,000	3,000	-71%
017_02	West Threemile Creek	3	436	1145/1146-Cool Moist Shrub	45%	3.26	1	400	1,000	0%	5.93	1	400	2,000	1,000	-45%
017_02	West Threemile Creek	4	1681	1145/1146-Cool Moist Shrub	45%	3.26	1	2,000	7,000	0%	5.93	1	2,000	10,000	3,000	-45%
017_02	West Threemile Creek	5	270	1145/1146-Cool Moist Shrub	32%	4.03	2	500	2,000	20%	4.74	2	500	2,000	0	-12%
017_02	West Threemile Creek	6	175	1145/1146-Cool Moist Shrub	32%	4.03	2	400	2,000	60%	2.37	2	400	900	(1,000)	28%
017_02	West Threemile Creek	7	534	1145/1146-Cool Moist Shrub	32%	4.03	2	1,000	4,000	50%	2.96	2	1,000	3,000	(1,000)	18%
017_02	West Threemile Creek	8	446	1145/1146-Cool Moist Shrub	32%	4.03	2	900	4,000	0%	5.93	2	900	5,000	1,000	-32%
017_02	West Threemile Creek	9	251	1145/1146-Cool Moist Shrub	32%	4.03	2	500	2,000	20%	4.74	2	500	2,000	0	-12%
017_02	West Threemile Creek	10	639	1145/1146-Cool Moist Shrub	32%	4.03	2	1,000	4,000	0%	5.93	2	1,000	6,000	2,000	-32%
017_02	West Threemile Creek	11	587	1145/1146-Cool Moist Shrub	32%	4.03	2	1,000	4,000	40%	3.56	2	1,000	4,000	0	8%
017_02	West Threemile Creek	12	167	1145/1146-Cool Moist Shrub	32%	4.03	2	300	1,000	10%	5.33	2	300	2,000	1,000	-22%
							Totals		180,000					210,000	36,000	

Table C-17. Existing and target solar loads for the 3rd-order assessment unit of Threemile Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
017_03	Threemile Creek	11	2713	1145/1146-Cool Moist Shrub	17%	4.92	5	10,000	50,000	0%	5.93	5	10,000	60,000	10,000	-17%
017_03	Threemile Creek	12	214	1145/1146-Cool Moist Shrub	17%	4.92	5	1,000	5,000	10%	5.33	5	1,000	5,000	0	-7%
							Totals		55,000					65,000	10,000	

Table C-18. Existing and target solar loads for the 2nd-order assessment unit of Beaver Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
018_02	Beaver Creek_Trib 08	1	2722	1145/1146-Cool Moist Shrub	45%	3.26	1	3,000	10,000	0%	5.93	1	3,000	20,000	10,000	-45%
018_02	Beaver Creek_Trib 08	2	2722	2606-Riparian	88%	0.71	1	3,000	2,000	0%	5.93	1	3,000	20,000	20,000	-88%
018_02	Beaver Creek_Trib 08	3	1779	2606-Riparian	75%	1.48	2	4,000	6,000	50%	2.96	2	4,000	10,000	4,000	-25%
018_02	Beaver Creek_Trib 09	1	2628	1145/1146-Cool Moist Shrub	32%	4.03	2	4,000	20,000	0%	5.93	2	4,000	20,000	0	-32%
018_02	Beaver Creek_Trib 10	1	4415	1145/1146-Cool Moist Shrub	45%	3.26	1	4,000	10,000	0%	5.93	1	4,000	20,000	10,000	-45%
018_02	Beaver Creek_Trib 10	2	1660	1145/1146-Cool Moist Shrub	32%	4.03	2	3,000	10,000	0%	5.93	2	3,000	20,000	10,000	-32%
018_02	Beaver Creek_Trib 10a	1	4174	1145/1146-Cool Moist Shrub	32%	4.03	2	6,000	20,000	0%	5.93	2	6,000	40,000	20,000	-32%
018_02	Calf Creek	1	434	1149-Cool Forest	81%	1.13	1	400	500	70%	1.78	1	400	700	200	-11%
018_02	Calf Creek	2	286	1145/1146-Cool Moist Shrub	45%	3.26	1	300	1,000	0%	5.93	1	300	2,000	1,000	-45%
018_02	Calf Creek	3	1407	1145/1146-Cool Moist Shrub	45%	3.26	1	1,000	3,000	50%	2.96	1	1,000	3,000	0	5%
018_02	Calf Creek	4	1128	1145/1146-Cool Moist Shrub	32%	4.03	2	2,000	8,000	40%	3.56	2	2,000	7,000	(1,000)	8%
018_02	Calf Creek Trib 01	1	1181	1149-Cool Forest	81%	1.13	1	1,000	1,000	70%	1.78	1	1,000	2,000	1,000	-11%
018_02	Calf Creek Trib 01	2	306	1149-Cool Forest	81%	1.13	1	300	300	50%	2.96	1	300	900	600	-31%
018_02	Calf Creek Trib 01	3	293	1145/1146-Cool Moist Shrub	45%	3.26	1	300	1,000	50%	2.96	1	300	900	(100)	5%
018_02	Calf Creek Trib 01	4	214	1145/1146-Cool Moist Shrub	45%	3.26	1	200	700	0%	5.93	1	200	1,000	300	-45%
018_02	Clay Creek	1	1074	1145/1146-Cool Moist Shrub	45%	3.26	1	1,000	3,000	20%	4.74	1	1,000	5,000	2,000	-25%
018_02	Clay Creek	2	867	1145/1146-Cool Moist Shrub	45%	3.26	1	900	3,000	10%	5.33	1	900	5,000	2,000	-35%
018_02	Clay Creek	3	2039	1145/1146-Cool Moist Shrub	32%	4.03	2	4,000	20,000	0%	5.93	2	4,000	20,000	0	-32%

Table C-18 (con't.). Existing and target solar loads for the 2nd-order assessment unit of Beaver Creek.

018_02	Cobble Creek	1	1674	1145/1146-Cool Moist Shrub	45%	3.26	1	2,000	7,000	0%	5.93	1	2,000	10,000	3,000	-45%
018_02	Cobble Creek	2	258	1154-Dry Forest	61%	2.31	1	300	700	0%	5.93	1	300	2,000	1,000	-61%
018_02	Dairy Creek	1	554	1149-Cool Forest	81%	1.13	1	600	700	70%	1.78	1	600	1,000	300	-11%
018_02	Dairy Creek	2	1229	1149-Cool Forest	81%	1.13	1	1,000	1,000	50%	2.96	1	1,000	3,000	2,000	-31%
018_02	Dairy Creek	3	398	1145/1146-Cool Moist Shrub	32%	4.03	2	800	3,000	0%	5.93	2	800	5,000	2,000	-32%
018_02	Dairy Creek	4	1254	1145/1146-Cool Moist Shrub	32%	4.03	2	3,000	10,000	50%	2.96	2	3,000	9,000	(1,000)	18%
018_02	Dairy Creek	5	1912	1145/1146-Cool Moist Shrub	26%	4.38	3	6,000	30,000	60%	2.37	3	6,000	10,000	(20,000)	34%
018_02	Dairy Creek	6	1316	2606-Riparian	65%	2.07	3	4,000	8,000	40%	3.56	3	4,000	10,000	2,000	-25%
018_02	Dairy Creek	7	297	2606-Riparian	58%	2.49	4	1,000	2,000	30%	4.15	4	1,000	4,000	2,000	-28%
018_02	Dairy Creek Trib 01	1	332	1149-Cool Forest	81%	1.13	1	300	300	70%	1.78	1	300	500	200	-11%
018_02	Dairy Creek Trib 01	2	594	1149-Cool Forest	81%	1.13	1	600	700	60%	2.37	1	600	1,000	300	-21%
018_02	Dairy Creek Trib 01	3	468	1149-Cool Forest	81%	1.13	1	500	600	0%	5.93	1	500	3,000	2,000	-81%
018_02	Dairy Creek Trib 01	4	438	1145/1146-Cool Moist Shrub	45%	3.26	1	400	1,000	0%	5.93	1	400	2,000	1,000	-45%
018_02	Left Fork Creek	1	813	1149-Cool Forest	81%	1.13	1	800	900	60%	2.37	1	800	2,000	1,000	-21%
018_02	Left Fork Creek	2	874	1149-Cool Forest	81%	1.13	1	900	1,000	10%	5.33	1	900	5,000	4,000	-71%
018_02	Left Fork Creek	3	582	1149-Cool Forest	81%	1.13	1	600	700	40%	3.56	1	600	2,000	1,000	-41%
018_02	Left Fork Creek	4	544	1145/1146-Cool Moist Shrub	45%	3.26	1	500	2,000	40%	3.56	1	500	2,000	0	-5%
018_02	Left Fork Creek	5	484	1145/1146-Cool Moist Shrub	32%	4.03	2	1,000	4,000	0%	5.93	2	1,000	6,000	2,000	-32%
018_02	Left Fork Creek	6	371	1145/1146-Cool Moist Shrub	32%	4.03	2	700	3,000	50%	2.96	2	700	2,000	(1,000)	18%
018_02	Left Fork Creek	7	1209	1145/1146-Cool Moist Shrub	32%	4.03	2	2,000	8,000	0%	5.93	2	2,000	10,000	2,000	-32%
018_02	Left Fork Creek	8	624	1145/1146-Cool Moist Shrub	32%	4.03	2	1,000	4,000	40%	3.56	2	1,000	4,000	0	8%
018_02	Left Fork Creek	9	202	1145/1146-Cool Moist Shrub	32%	4.03	2	400	2,000	0%	5.93	2	400	2,000	0	-32%
018_02	Picnic Hollow	1	1196	1149-Cool Forest	81%	1.13	1	1,000	1,000	70%	1.78	1	1,000	2,000	1,000	-11%
018_02	Picnic Hollow	2	1483	1149-Cool Forest	81%	1.13	1	1,000	1,000	20%	4.74	1	1,000	5,000	4,000	-61%
018_02	Picnic Hollow	3	488	1149-Cool Forest	80%	1.19	2	1,000	1,000	40%	3.56	2	1,000	4,000	3,000	-40%
018_02	Picnic Hollow	4	516	1145/1146-Cool Moist Shrub	32%	4.03	2	1,000	4,000	40%	3.56	2	1,000	4,000	0	8%
018_02	Picnic Hollow	5	252	1154-Dry Forest	61%	2.31	2	500	1,000	40%	3.56	2	500	2,000	1,000	-21%
018_02	Stoddard Creek	1	3384	1149-Cool Forest	81%	1.13	1	3,000	3,000	70%	1.78	1	3,000	5,000	2,000	-11%
018_02	Stoddard Creek	2	990	1149-Cool Forest	80%	1.19	2	2,000	2,000	60%	2.37	2	2,000	5,000	3,000	-20%
018_02	Stoddard Creek	3	468	1145/1146-Cool Moist Shrub	32%	4.03	2	900	4,000	20%	4.74	2	900	4,000	0	-12%
018_02	Stoddard Creek	4	796	1145/1146-Cool Moist Shrub	26%	4.38	3	2,000	9,000	60%	2.37	3	2,000	5,000	(4,000)	34%
018_02	Stoddard Creek	5	280	1145/1146-Cool Moist Shrub	26%	4.38	3	800	4,000	10%	5.33	3	800	4,000	0	-16%
018_02	Stoddard Creek	6	429	1145/1146-Cool Moist Shrub	26%	4.38	3	1,000	4,000	0%	5.93	3	1,000	6,000	2,000	-26%
018_02	Telephone Creek	1	482	1149-Cool Forest	81%	1.13	1	500	600	20%	4.74	1	500	2,000	1,000	-61%
018_02	Telephone Creek	2	2901	1145/1146-Cool Moist Shrub	45%	3.26	1	3,000	10,000	0%	5.93	1	3,000	20,000	10,000	-45%
018_02	Telephone Creek	3	1252	1145/1146-Cool Moist Shrub	32%	4.03	2	3,000	10,000	50%	2.96	2	3,000	9,000	(1,000)	18%
018_02	Thomas Draw	1	485	1149-Cool Forest	81%	1.13	1	500	600	70%	1.78	1	500	900	300	-11%
018_02	Thomas Draw	2	1154	1149-Cool Forest	81%	1.13	1	1,000	1,000	60%	2.37	1	1,000	2,000	1,000	-21%
018_02	Thomas Draw	3	1170	1145/1146-Cool Moist Shrub	32%	4.03	2	2,000	8,000	0%	5.93	2	2,000	10,000	2,000	-32%
018_02	Thomas Draw	4	559	2606-Riparian	75%	1.48	2	1,000	1,000	60%	2.37	2	1,000	2,000	1,000	-15%
018_02	Van Noy Canyon	1	1640	1149-Cool Forest	81%	1.13	1	2,000	2,000	80%	1.19	1	2,000	2,000	0	-1%
018_02	Van Noy Canyon	2	433	1149-Cool Forest	80%	1.19	2	900	1,000	20%	4.74	2	900	4,000	3,000	-60%
018_02	Van Noy Canyon	3	539	1145/1146-Cool Moist Shrub	32%	4.03	2	1,000	4,000	30%	4.15	2	1,000	4,000	0	-2%
018_02	Van Noy Canyon	4	183	1145/1146-Cool Moist Shrub	32%	4.03	2	400	2,000	40%	3.56	2	400	1,000	(1,000)	8%
018_02	Van Noy Canyon	5	189	1145/1146-Cool Moist Shrub	32%	4.03	2	400	2,000	70%	1.78	2	400	700	(1,000)	38%
018_02	Van Noy Canyon	6	276	1145/1146-Cool Moist Shrub	32%	4.03	2	600	2,000	0%	5.93	2	600	4,000	2,000	-32%
							Totals		290,000					400,000	110,000	

Table C-19. Existing and target solar loads for the 4th-order assessment unit of Beaver Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
018_04	Beaver Creek	18	1884	1154-Dry Forest	36%	3.79	12	20,000	80,000	50%	2.96	12	20,000	60,000	(20,000)	14%
018_04	Beaver Creek	19	2728	2606-Riparian	26%	4.38	12	30,000	100,000	40%	3.56	12	30,000	100,000	0	14%
018_04	Beaver Creek	20	686	2606-Riparian	26%	4.38	12	8,000	40,000	40%	3.56	12	8,000	30,000	(10,000)	14%
018_04	Beaver Creek	21	1383	2606-Riparian	26%	4.38	12	20,000	90,000	50%	2.96	12	20,000	60,000	(30,000)	24%
018_04	Beaver Creek	22	1139	2606-Riparian	26%	4.38	12	10,000	40,000	20%	4.74	12	10,000	50,000	10,000	-6%
018_04	Beaver Creek	23	437	2606-Riparian	24%	4.50	13	6,000	30,000	0%	5.93	13	6,000	40,000	10,000	-24%
018_04	Beaver Creek	24	1505	2606-Riparian	24%	4.50	13	20,000	90,000	50%	2.96	13	20,000	60,000	(30,000)	26%
018_04	Beaver Creek	25	1088	1445/1146-Cool Moist Shrub	7%	5.51	13	10,000	60,000	30%	4.15	13	10,000	40,000	(20,000)	23%
018_04	Beaver Creek	26	3527	1154-Dry Forest	34%	3.91	13	50,000	200,000	60%	2.37	13	50,000	100,000	(100,000)	26%
							Totals		730,000					540,000	0	

Table C-20. Existing and target solar loads for the 3rd-order assessment unit of Beaver Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
020_03	Beaver Creek	14	2085	2606-Riparian	31%	4.09	10	20,000	80,000	50%	2.96	10	20,000	60,000	(20,000)	19%
020_03	Beaver Creek	15	870	1154-Dry Forest	38%	3.67	10	9,000	30,000	70%	1.78	10	9,000	20,000	(10,000)	32%
020_03	Beaver Creek	16	1953	1154-Dry Forest	37%	3.73	11	20,000	70,000	60%	2.37	11	20,000	50,000	(20,000)	23%
020_03	Beaver Creek	17	933	1154-Dry Forest	37%	3.73	11	10,000	40,000	30%	4.15	11	10,000	40,000	0	-7%
							Totals		220,000					170,000	0	

Table C-21. Existing and target solar loads for the 2nd-order assessment unit of Beaver Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
021_02	Beaver Creek	1	3486	1145/1146-Cool Moist Shrub	45%	3.26	1	3,000	10,000	0%	5.93	1	3,000	20,000	10,000	-45%
021_02	Beaver Creek	2	364	1145/1146-Cool Moist Shrub	32%	4.03	2	700	3,000	10%	5.33	2	700	4,000	1,000	-22%
021_02	Beaver Creek	3	680	2606-Riparian	75%	1.48	2	1,000	1,000	70%	1.78	2	1,000	2,000	1,000	-5%
021_02	Beaver Creek	4	1957	2606-Riparian	75%	1.48	3	6,000	9,000	0%	5.93	3	6,000	40,000	30,000	-75%
021_02	Beaver Creek_Trib 01	2	2005	1145/1146-Cool Moist Shrub	45%	3.26	1	2,000	7,000	0%	5.93	1	2,000	10,000	3,000	-45%
021_02	Beaver Creek_Trib 01	3	251	1145/1146-Cool Moist Shrub	45%	3.26	1	300	1,000	0%	5.93	1	300	2,000	1,000	-45%
021_02	Beaver Creek_Trib 01	4	350	1145/1146-Cool Moist Shrub	45%	3.26	1	400	1,000	10%	5.33	1	400	2,000	1,000	-35%
021_02	Beaver Creek_Trib 01	5	815	1145/1146-Cool Moist Shrub	45%	3.26	1	800	3,000	0%	5.93	1	800	5,000	2,000	-45%
021_02	Beaver Creek_Trib 02	1	559	1145/1146-Cool Moist Shrub	32%	4.03	2	1,000	4,000	0%	5.93	2	1,000	6,000	2,000	-32%
021_02	Beaver Creek_Trib 02a	1	2845	1145/1146-Cool Moist Shrub	32%	4.03	2	6,000	20,000	0%	5.93	2	6,000	40,000	20,000	-32%
021_02	Beaver Creek_Trib 03	1	1595	1145/1146-Cool Moist Shrub	32%	4.03	2	3,000	10,000	0%	5.93	2	3,000	20,000	10,000	-32%
021_02	Beaver Creek_Trib 04	1	3680	1145/1146-Cool Moist Shrub	32%	4.03	2	7,000	30,000	0%	5.93	2	7,000	40,000	10,000	-32%
021_02	Beaver Creek_Trib 05	1	1792	1145/1146-Cool Moist Shrub	45%	3.26	1	2,000	7,000	0%	5.93	1	2,000	10,000	3,000	-45%
021_02	Beaver Creek_Trib 05	2	149	2606-Riparian	88%	0.71	1	100	70	10%	5.33	1	100	500	400	-78%
021_03	Beaver Creek_Trib 05	3	91	2606-Riparian	88%	0.71	1	90	60	20%	4.74	1	90	400	300	-68%
021_02	Beaver Creek_Trib 05	4	131	2606-Riparian	88%	0.71	1	100	70	0%	5.93	1	100	600	500	-88%
021_02	Beaver Creek_Trib 06	1	816	1145/1146-Cool Moist Shrub	45%	3.26	1	800	3,000	0%	5.93	1	800	5,000	2,000	-45%
021_02	Beaver Creek_Trib 06	2	588	1145/1146-Cool Moist Shrub	45%	3.26	1	600	2,000	50%	2.96	1	600	2,000	0	5%
021_02	Beaver Creek_Trib 06	3	2331	1145/1146-Cool Moist Shrub	32%	4.03	2	5,000	20,000	0%	5.93	2	5,000	30,000	10,000	-32%
021_02	Berry Creek	1	308	1149-Cool Forest	81%	1.13	1	300	300	60%	2.37	1	300	700	400	-21%
021_02	Berry Creek	2	319	1149-Cool Forest	81%	1.13	1	300	300	10%	5.33	1	300	2,000	2,000	-71%
021_02	Berry Creek	3	1020	1145/1146-Cool Moist Shrub	45%	3.26	1	1,000	3,000	0%	5.93	1	1,000	6,000	3,000	-45%
021_02	Berry Creek	4	401	1145/1146-Cool Moist Shrub	45%	3.26	1	400	1,000	10%	5.33	1	400	2,000	1,000	-35%
021_02	Berry Creek	5	432	1145/1146-Cool Moist Shrub	45%	3.26	1	400	1,000	0%	5.93	1	400	2,000	1,000	-45%
021_02	Berry Creek	6	539	1145/1146-Cool Moist Shrub	45%	3.26	1	500	2,000	10%	5.33	1	500	3,000	1,000	-35%
021_02	Berry Creek	7	383	1145/1146-Cool Moist Shrub	32%	4.03	2	800	3,000	0%	5.93	2	800	5,000	2,000	-32%
021_02	Berry Creek	8	319	1145/1146-Cool Moist Shrub	32%	4.03	2	600	2,000	10%	5.33	2	600	3,000	1,000	-22%
021_02	Berry Creek	9	2462	1145/1146-Cool Moist Shrub	32%	4.03	2	5,000	20,000	0%	5.93	2	5,000	30,000	10,000	-32%
021_02	Chicken Creek	1	1644	1149-Cool Forest	81%	1.13	1	2,000	2,000	60%	2.37	1	2,000	5,000	3,000	-21%
021_02	Chicken Creek	2	1062	2606-Riparian	88%	0.71	1	1,000	700	20%	4.74	1	1,000	5,000	4,000	-68%
021_02	Chicken Creek	3	3334	1145/1146-Cool Moist Shrub	32%	4.03	2	7,000	30,000	0%	5.93	2	7,000	40,000	10,000	-32%
021_02	East Modoc Creek	1	1028	1149-Cool Forest	81%	1.13	1	1,000	1,000	0%	5.93	1	1,000	6,000	5,000	-81%
021_02	East Modoc Creek	2	538	2606-Riparian	88%	0.71	1	500	400	10%	5.33	1	500	3,000	3,000	-78%
021_02	East Modoc Creek	3	119	2606-Riparian	88%	0.71	1	100	70	0%	5.93	1	100	600	500	-88%
021_02	East Modoc Creek	4	380	2606-Riparian	75%	1.48	2	800	1,000	10%	5.33	2	800	4,000	3,000	-65%
021_02	East Modoc Creek	5	85	2606-Riparian	75%	1.48	2	200	300	0%	5.93	2	200	1,000	700	-75%
021_02	East Modoc Creek	6	189	2606-Riparian	75%	1.48	2	400	600	50%	2.96	2	400	1,000	400	-25%
021_02	East Modoc Creek	8	493	2606-Riparian	75%	1.48	2	1,000	1,000	40%	3.56	2	1,000	4,000	3,000	-35%
021_02	East Modoc Creek	9	353	2606-Riparian	75%	1.48	2	700	1,000	30%	4.15	2	700	3,000	2,000	-45%
021_02	East Modoc Creek	10	126	2606-Riparian	75%	1.48	2	300	400	50%	2.96	2	300	900	500	-25%

Table C-21 (con't.). Existing and target solar loads for the 2nd-order assessment unit of Beaver Creek.

021_02	Horse Creek	1	798	1149-Cool Forest	81%	1.13	1	800	900	0%	5.93	1	800	5,000	4,000	-81%
021_02	Horse Creek	2	1035	1149-Cool Forest	81%	1.13	1	1,000	1,000	10%	5.33	1	1,000	5,000	4,000	-71%
021_02	Horse Creek	3	493	1149-Cool Forest	81%	1.13	1	500	600	10%	5.33	1	500	3,000	2,000	-71%
021_02	Horse Creek	4	584	2606-Riparian	88%	0.71	1	600	400	50%	2.96	1	600	2,000	2,000	-38%
021_02	Kettle Creek	1	409	1149-Cool Forest	81%	1.13	1	400	500	0%	5.93	1	400	2,000	2,000	-81%
021_02	Kettle Creek	2	222	1149-Cool Forest	81%	1.13	1	200	200	50%	2.96	1	200	600	400	-31%
021_02	Kettle Creek	3	938	1149-Cool Forest	81%	1.13	1	900	1,000	40%	3.56	1	900	3,000	2,000	-41%
021_02	Kettle Creek	4	560	1149-Cool Forest	81%	1.13	1	600	700	30%	4.15	1	600	2,000	1,000	-51%
021_02	Kettle Creek	5	185	1149-Cool Forest	81%	1.13	1	200	200	0%	5.93	1	200	1,000	800	-81%
021_02	Kettle Creek	6	351	1149-Cool Forest	80%	1.19	2	700	800	10%	5.33	2	700	4,000	3,000	-70%
021_02	Kettle Creek	7	540	1149-Cool Forest	80%	1.19	2	1,000	1,000	20%	4.74	2	1,000	5,000	4,000	-60%
021_02	Kettle Creek	8	418	1149-Cool Forest	80%	1.19	2	800	900	0%	5.93	2	800	5,000	4,000	-80%
021_02	Kettle Creek	9	418	2606-Riparian	75%	1.48	2	800	1,000	0%	5.93	2	800	5,000	4,000	-75%
021_02	Kettle Creek	10	508	2606-Riparian	75%	1.48	2	1,000	1,000	10%	5.33	2	1,000	5,000	4,000	-65%
021_02	Long Creek	2	359	1576-Cool Forest/Alpine	72%	1.66	1	400	700	0%	5.93	1	400	2,000	1,000	-72%
021_02	Long Creek	3	239	1149-Cool Forest	81%	1.13	1	200	200	40%	3.56	1	200	700	500	-41%
021_02	Long Creek	4	699	1149-Cool Forest	81%	1.13	1	700	800	70%	1.78	1	700	1,000	200	-11%
021_02	Long Creek	5	268	1149-Cool Forest	81%	1.13	1	300	300	60%	2.37	1	300	700	400	-21%
021_02	Long Creek	6	784	1149-Cool Forest	81%	1.13	1	800	900	70%	1.78	1	800	1,000	100	-11%
021_02	Long Creek	7	151	1149-Cool Forest	80%	1.19	2	300	400	60%	2.37	2	300	700	300	-20%
021_02	Long Creek	8	210	1149-Cool Forest	80%	1.19	2	400	500	0%	5.93	2	400	2,000	2,000	-80%
021_02	Long Creek	9	352	2606-Riparian	75%	1.48	2	700	1,000	60%	2.37	2	700	2,000	1,000	-15%
021_02	Long Creek	9	134	1149-Cool Forest	80%	1.19	2	300	400	60%	2.37	2	300	700	300	-20%
021_02	Long Creek	10	333	2606-Riparian	75%	1.48	2	700	1,000	20%	4.74	2	700	3,000	2,000	-55%
021_02	Long Creek	11	529	2606-Riparian	75%	1.48	2	1,000	1,000	10%	5.33	2	1,000	5,000	4,000	-65%
021_02	Long Creek	12	159	2606-Riparian	75%	1.48	2	300	400	0%	5.93	2	300	2,000	2,000	-75%
021_02	Long Creek	13	467	2606-Riparian	75%	1.48	2	900	1,000	20%	4.74	2	900	4,000	3,000	-55%
021_02	Long Creek	14	2416	1145/1146-Cool Moist Shrub	26%	4.38	3	7,000	30,000	0%	5.93	3	7,000	40,000	10,000	-26%
021_02	Long Creek	15	683	1145/1146-Cool Moist Shrub	20%	4.74	4	3,000	10,000	0%	5.93	4	3,000	20,000	10,000	-20%
021_02	Long Creek	16	849	2606-Riparian	58%	2.49	4	3,000	7,000	20%	4.74	4	3,000	10,000	3,000	-38%
021_02	Long Creek_Trib 01	1	220	1145/1146-Cool Moist Shrub	32%	4.03	2	400	2,000	0%	5.93	2	400	2,000	0	-32%
021_02	Long Creek_Trib 01a	1	361	1145/1146-Cool Moist Shrub	45%	3.26	1	400	1,000	0%	5.93	1	400	2,000	1,000	-45%
021_02	Long Creek_Trib 01a	2	380	1145/1146-Cool Moist Shrub	45%	3.26	1	400	1,000	10%	5.33	1	400	2,000	1,000	-35%
021_02	Long Creek_Trib 01a	3	673	1145/1146-Cool Moist Shrub	32%	4.03	2	1,000	4,000	0%	5.93	2	1,000	6,000	2,000	-32%
021_02	Long Creek_Trib 01b	1	1972	1145/1146-Cool Moist Shrub	45%	3.26	1	2,000	7,000	0%	5.93	1	2,000	10,000	3,000	-45%
021_02	Middle Modoc Creek	1	707	1149-Cool Forest	81%	1.13	1	700	800	10%	5.33	1	700	4,000	3,000	-71%
021_02	Middle Modoc Creek	2	331	1149-Cool Forest	81%	1.13	1	300	300	0%	5.93	1	300	2,000	2,000	-81%
021_02	Middle Modoc Creek	3	543	1149-Cool Forest	81%	1.13	1	500	600	10%	5.33	1	500	3,000	2,000	-71%
021_02	Middle Modoc Creek	4	214	2606-Riparian	75%	1.48	2	400	600	0%	5.93	2	400	2,000	1,000	-75%
021_02	Middle Modoc Creek	5	374	2606-Riparian	75%	1.48	2	700	1,000	40%	3.56	2	700	2,000	1,000	-35%
021_02	Middle Modoc Creek	6	456	2606-Riparian	75%	1.48	2	900	1,000	50%	2.96	2	900	3,000	2,000	-25%

Table C-21 (con't.). Existing and target solar loads for the 2nd-order assessment unit of Beaver Creek.

021_02	Modoc Creek	1	1305	2606-Riparian	65%	2.07	3	4,000	8,000	50%	2.96	3	4,000	10,000	2,000	-15%
021_02	Modoc Creek	2	880	2606-Riparian	65%	2.07	3	3,000	6,000	60%	2.37	3	3,000	7,000	1,000	-5%
021_02	Modoc Creek	3	256	2606-Riparian	65%	2.07	3	800	2,000	50%	2.96	3	800	2,000	0	-15%
021_02	Modoc Creek	4	441	2606-Riparian	65%	2.07	3	1,000	2,000	40%	3.56	3	1,000	4,000	2,000	-25%
021_02	Modoc Creek	5	791	2606-Riparian	65%	2.07	3	2,000	4,000	50%	2.96	3	2,000	6,000	2,000	-15%
021_02	Modoc Creek	6	1107	2606-Riparian	58%	2.49	4	4,000	10,000	40%	3.56	4	4,000	10,000	0	-18%
021_02	Modoc Creek	7	1284	2606-Riparian	58%	2.49	4	5,000	10,000	20%	4.74	4	5,000	20,000	10,000	-38%
021_02	Modoc Creek	8	534	2606-Riparian	58%	2.49	4	2,000	5,000	0%	5.93	4	2,000	10,000	5,000	-58%
021_02	Modoc Creek	9	528	2606-Riparian	58%	2.49	4	2,000	5,000	10%	5.33	4	2,000	10,000	5,000	-48%
021_02	Modoc Creek	10	1392	2606-Riparian	52%	2.84	5	7,000	20,000	50%	2.96	5	7,000	20,000	0	-2%
021_02	Modoc Creek	11	501	2606-Riparian	52%	2.84	5	3,000	9,000	40%	3.56	5	3,000	10,000	1,000	-12%
021_02	Modoc Creek	12	241	2606-Riparian	52%	2.84	5	1,000	3,000	30%	4.15	5	1,000	4,000	1,000	-22%
021_02	Modoc Creek	13	1008	1145/1146-Cool Moist Shrub	17%	4.92	5	5,000	20,000	0%	5.93	5	5,000	30,000	10,000	-17%
021_02	Modoc Creek	14	798	2606-Riparian	47%	3.14	6	5,000	20,000	60%	2.37	6	5,000	10,000	(10,000)	13%
021_02	Modoc Creek	15	176	2606-Riparian	47%	3.14	6	1,000	3,000	0%	5.93	6	1,000	6,000	3,000	-47%
021_02	Modoc Creek	16	567	2606-Riparian	47%	3.14	6	3,000	9,000	0%	5.93	6	3,000	20,000	10,000	-47%
021_02	Modoc Creek	17	1243	2606-Riparian	47%	3.14	6	7,000	20,000	0%	5.93	6	7,000	40,000	20,000	-47%
021_02	Modoc Creek_Trib 01	1	2897	1145/1146-Cool Moist Shrub	32%	4.03	2	4,000	20,000	0%	5.93	2	4,000	20,000	0	-32%
021_02	Modoc Creek_Trib 02	1	2819	1145/1146-Cool Moist Shrub	45%	3.26	1	3,000	10,000	0%	5.93	1	3,000	20,000	10,000	-45%
021_02	Modoc Creek_Trib 02	1	2819	2606-Riparian	88%	0.71	1	3,000	2,000	0%	5.93	1	3,000	20,000	20,000	-88%
021_02	Modoc Creek_Trib 03	1	1220	2606-Riparian	88%	0.71	1	1,000	700	0%	5.93	1	1,000	6,000	5,000	-88%
021_02	Modoc Creek_Trib 03	2	1165	2606-Riparian	88%	0.71	1	1,000	700	10%	5.33	1	1,000	5,000	4,000	-78%
021_02	Robbins Creek	1	1053	1149-Cool Forest	81%	1.13	1	1,000	1,000	40%	3.56	1	1,000	4,000	3,000	-41%
021_02	Robbins Creek	2	622	1145/1146-Cool Moist Shrub	32%	4.03	2	1,000	4,000	10%	5.33	2	1,000	5,000	1,000	-22%
021_02	Robbins Creek	3	2452	1145/1146-Cool Moist Shrub	26%	4.38	3	7,000	30,000	0%	5.93	3	7,000	40,000	10,000	-26%
021_02	Tenpin Gulch	1	252	1149-Cool Forest	81%	1.13	1	300	300	20%	4.74	1	300	1,000	700	-61%
021_02	Tenpin Gulch	2	607	1149-Cool Forest	81%	1.13	1	600	700	80%	1.19	1	600	700	0	-1%
021_02	Tenpin Gulch	3	179	1149-Cool Forest	81%	1.13	1	200	200	20%	4.74	1	200	900	700	-61%
021_02	Tenpin Gulch	4	490	1145/1146-Cool Moist Shrub	45%	3.26	1	500	2,000	0%	5.93	1	500	3,000	1,000	-45%
021_02	Tenpin Gulch	5	324	1145/1146-Cool Moist Shrub	45%	3.26	1	300	1,000	10%	5.33	1	300	2,000	1,000	-35%
021_02	Tenpin Gulch	6	628	1145/1146-Cool Moist Shrub	32%	4.03	2	1,000	4,000	0%	5.93	2	1,000	6,000	2,000	-32%
021_02	Tenpin Gulch	7	653	2606-Riparian	75%	1.48	2	1,000	1,000	10%	5.33	2	1,000	5,000	4,000	-65%
021_02	Tenpin Gulch	8	599	2606-Riparian	75%	1.48	2	1,000	1,000	0%	5.93	2	1,000	6,000	5,000	-75%
021_02	West Modoc Creek	1	324	1149-Cool Forest	81%	1.13	1	300	300	20%	4.74	1	300	1,000	700	-61%
021_02	West Modoc Creek	2	382	2606-Riparian	75%	1.48	2	800	1,000	50%	2.96	2	800	2,000	1,000	-25%
							Totals		520,000					910,000	390,000	

Table C-22. Existing and target solar loads for the 3rd-order assessment unit of Beaver Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
021_03	Beaver Creek	5	2300	2606-Riparian	58%	2.49	4	9,000	20,000	20%	4.74	4	9,000	40,000	20,000	-38%
021_03	Beaver Creek	6	828	2606-Riparian	52%	2.84	5	4,000	10,000	40%	3.56	5	4,000	10,000	0	-12%
021_03	Beaver Creek	7	1297	2606-Riparian	52%	2.84	5	6,000	20,000	70%	1.78	5	6,000	10,000	(10,000)	18%
021_03	Beaver Creek	8	932	2606-Riparian	47%	3.14	6	6,000	20,000	30%	4.15	6	6,000	20,000	0	-17%
021_03	Beaver Creek	9	790	2606-Riparian	42%	3.44	7	6,000	20,000	50%	2.96	7	6,000	20,000	0	8%
021_03	Beaver Creek	10	252	2606-Riparian	42%	3.44	7	2,000	7,000	20%	4.74	7	2,000	9,000	2,000	-22%
021_03	Beaver Creek	11	956	2606-Riparian	37%	3.73	8	8,000	30,000	50%	2.96	8	8,000	20,000	(10,000)	13%
021_03	Beaver Creek	12	248	2606-Riparian	37%	3.73	8	2,000	7,000	40%	3.56	8	2,000	7,000	0	3%
021_03	Beaver Creek	13	1011	2606-Riparian	34%	3.91	9	9,000	40,000	50%	2.96	9	9,000	30,000	(10,000)	16%
							Totals		170,000					170,000	0	

Table C-23. Existing and target solar loads for the 2nd-order assessment unit of Pleasant Valley Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
023_02	Brooks Canyon Creek	1	2107	1149-Cool Forest	81%	1.13	1	2,000	2,000	80%	1.19	1	2,000	2,000	0	-1%
023_02	Headquarters Creek	1	411	Cool Moist Shrub	45%	3.26	1	400	1,000	50%	2.96	1	400	1,000	0	5%
023_02	Headquarters Creek	2	710	Cool Moist Shrub	45%	3.26	1	700	2,000	30%	4.15	1	700	3,000	1,000	-15%
023_02	Headquarters Creek	3	705	Cool Moist Shrub	45%	3.26	1	700	2,000	20%	4.74	1	700	3,000	1,000	-25%
023_02	Headquarters Creek	4	942	2606-Riparian	88%	0.71	1	900	600	60%	2.37	1	900	2,000	1,000	-28%
023_02	Kite Canyon Creek	1	957	1149-Cool Forest	81%	1.13	1	1,000	1,000	80%	1.19	1	1,000	1,000	0	-1%
023_02	Kite Canyon Creek	2	1826	1149-Cool Forest	81%	1.13	1	2,000	2,000	70%	1.78	1	2,000	4,000	2,000	-11%
023_02	Kite Canyon Creek	3	743	1149-Cool Forest	80%	1.19	2	1,000	1,000	50%	2.96	2	1,000	3,000	2,000	-30%
023_02	Pleasant Valley Creek	1	2011	1597-Cool Forest	73%	1.60	1	2,000	3,000	80%	1.19	1	2,000	2,000	(1,000)	7%
023_02	Pleasant Valley Creek	2	1468	1597-Cool Forest	72%	1.66	2	3,000	5,000	70%	1.78	2	3,000	5,000	0	-2%
023_02	Pleasant Valley Creek	3	1751	2606-Riparian	65%	2.07	3	5,000	10,000	60%	2.37	3	5,000	10,000	0	-5%
023_02	Pleasant Valley Creek	4	2156	2606-Riparian	58%	2.49	4	9,000	20,000	70%	1.78	4	9,000	20,000	0	12%
023_02	Pleasant Valley Creek	5	663	2606-Riparian	58%	2.49	4	3,000	7,000	10%	5.33	4	3,000	20,000	10,000	-48%
023_02	Pleasant Valley Creek	6	515	2606-Riparian	52%	2.84	5	3,000	9,000	0%	5.93	5	3,000	20,000	10,000	-52%
023_02	Pleasant Valley Creek	7	308	2606-Riparian	52%	2.84	5	2,000	6,000	0%	5.93	5	2,000	10,000	4,000	-52%
023_02	Pleasant Valley Creek	8	1592	2606-Riparian	52%	2.84	5	8,000	20,000	40%	3.56	5	8,000	30,000	10,000	-12%
023_02	Pleasant Valley Creek	9	600	2606-Riparian	47%	3.14	6	4,000	10,000	40%	3.56	6	4,000	10,000	0	-7%
023_02	Pleasant Valley Creek	10	611	2606-Riparian	47%	3.14	6	4,000	10,000	0%	5.93	6	4,000	20,000	10,000	-47%
023_02	Pleasant Valley Creek	11	970	2606-Riparian	47%	3.14	6	6,000	20,000	40%	3.56	6	6,000	20,000	0	-7%
023_02	Pleasant Valley Creek	12	398	Cool Moist Shrub	47%	3.14	6	2,000	6,000	0%	5.93	6	2,000	10,000	4,000	-47%
023_02	Pleasant Valley Creek Trib 01	1	950	1149-Cool Forest	81%	1.13	1	1,000	1,000	50%	2.96	1	1,000	3,000	2,000	-31%
023_02	Pleasant Valley Creek Trib 01	2	689	Cool Moist Shrub	45%	3.26	1	700	2,000	0%	5.93	1	700	4,000	2,000	-45%
023_02	Pleasant Valley Creek Trib 02	1	283	2606-Riparian	88%	0.71	1	300	200	0%	5.93	1	300	2,000	2,000	-88%
023_02	Ramshorn Creek	1	321	1149-Cool Forest	81%	1.13	1	300	300	60%	2.37	1	300	700	400	-21%
023_02	Ramshorn Creek	2	2353	1149-Cool Forest	81%	1.13	1	2,000	2,000	70%	1.78	1	2,000	4,000	2,000	-11%
023_02	Ramshorn Creek	3	1724	Cool Moist Shrub	32%	4.03	2	3,000	10,000	40%	3.56	2	3,000	10,000	0	8%
023_02	Ramshorn Creek	4	216	2606-Riparian	75%	1.48	2	400	600	60%	2.37	2	400	900	300	-15%
023_02	School Section Creek	1	776	Cool Moist Shrub	45%	3.26	1	800	3,000	70%	1.78	1	800	1,000	(2,000)	25%
023_02	School Section Creek	2	634	Cool Moist Shrub	45%	3.26	1	600	2,000	50%	2.96	1	600	2,000	0	5%
023_02	School Section Creek	3	2152	Cool Moist Shrub	45%	3.26	1	2,000	7,000	60%	2.37	1	2,000	5,000	(2,000)	15%
023_02	School Section Creek	4	988	2606-Riparian	75%	1.48	2	2,000	3,000	0%	5.93	2	2,000	10,000	7,000	-75%
023_02	Swampy Draw Creek	1	431	1149-Cool Forest	81%	1.13	1	400	500	60%	2.37	1	400	900	400	-21%
023_02	Swampy Draw Creek	2	856	1149-Cool Forest	81%	1.13	1	900	1,000	0%	5.93	1	900	5,000	4,000	-81%
023_02	Swampy Draw Creek	3	854	1149-Cool Forest	80%	1.19	2	2,000	2,000	70%	1.78	2	2,000	4,000	2,000	-10%
023_02	White Pine Canyon Creek	1	2166	1149-Cool Forest	81%	1.13	1	2,000	2,000	80%	1.19	1	2,000	2,000	0	-1%
023_02	White Pine Canyon Creek	2	1180	1149-Cool Forest	81%	1.13	1	1,000	1,000	60%	2.37	1	1,000	2,000	1,000	-21%
							Totals		180,000					250,000	73,000	

Table C-24. Existing and target solar loads for the 2nd-order assessment unit of Huntley Canyon Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
024_02	Huntley Canyon Creek	1	1232	1149-Cool Forest	81%	1.13	1	1,000	1,000	70%	1.78	1	1,000	2,000	1,000	-11%
024_02	Huntley Canyon Creek	2	816	1149-Cool Forest	81%	1.13	1	800	900	0%	5.93	1	800	5,000	4,000	-81%
024_02	Huntley Canyon Creek	3	3828	1149-Cool Forest	80%	1.19	2	8,000	9,000	50%	2.96	2	8,000	20,000	10,000	-30%
024_02	Huntley Canyon Creek	4	843	2606-Riparian	65%	2.07	3	3,000	6,000	70%	1.78	3	3,000	5,000	(1,000)	5%
024_02	Huntley Canyon Creek	5	628	2606-Riparian	65%	2.07	3	2,000	4,000	0%	5.93	3	2,000	10,000	6,000	-65%
024_02	Huntley Canyon Creek Trib 01	1	837	1149-Cool Forest	81%	1.13	1	800	900	0%	5.93	1	800	5,000	4,000	-81%
024_02	Huntley Canyon Creek Trib 01	2	1110	1145/1146-Cool Moist Shrub	45%	3.26	1	1,000	3,000	0%	5.93	1	1,000	6,000	3,000	-45%
							Totals		25,000					53,000	27,000	

Target, Existing, and Deficit Shade Figures

Upper Beaver Creek

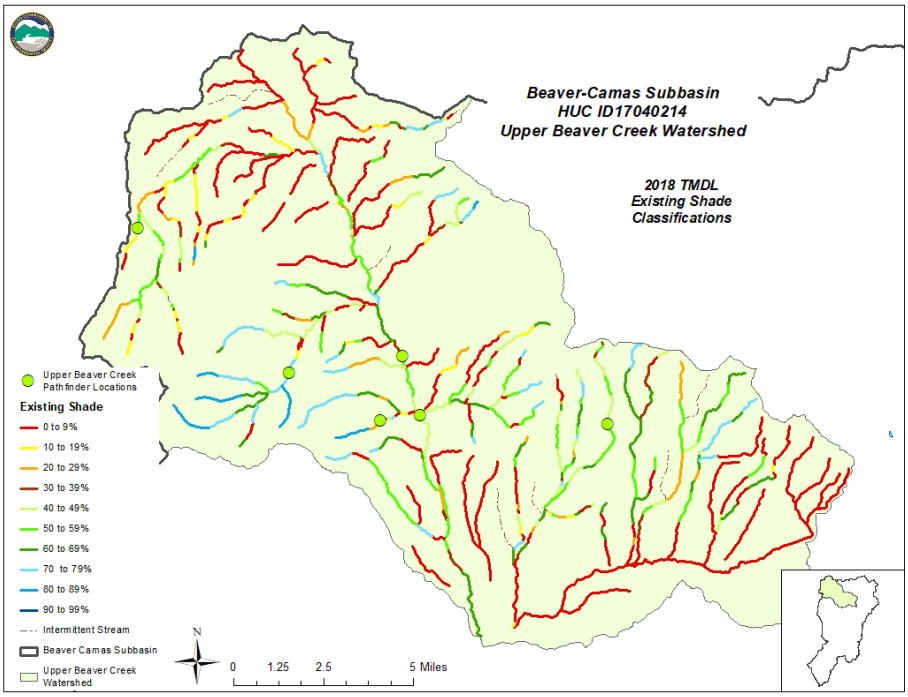


Figure C-28. Existing shade estimated for the Upper Beaver Creek watershed by aerial photo interpretation.

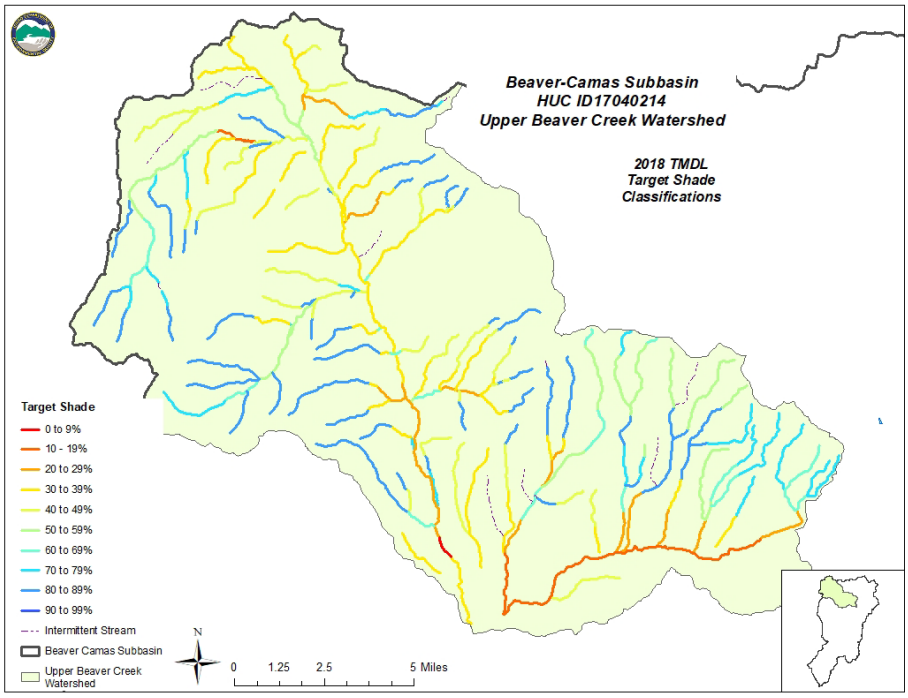


Figure C-29. Target shade for the Upper Beaver Creek watershed.

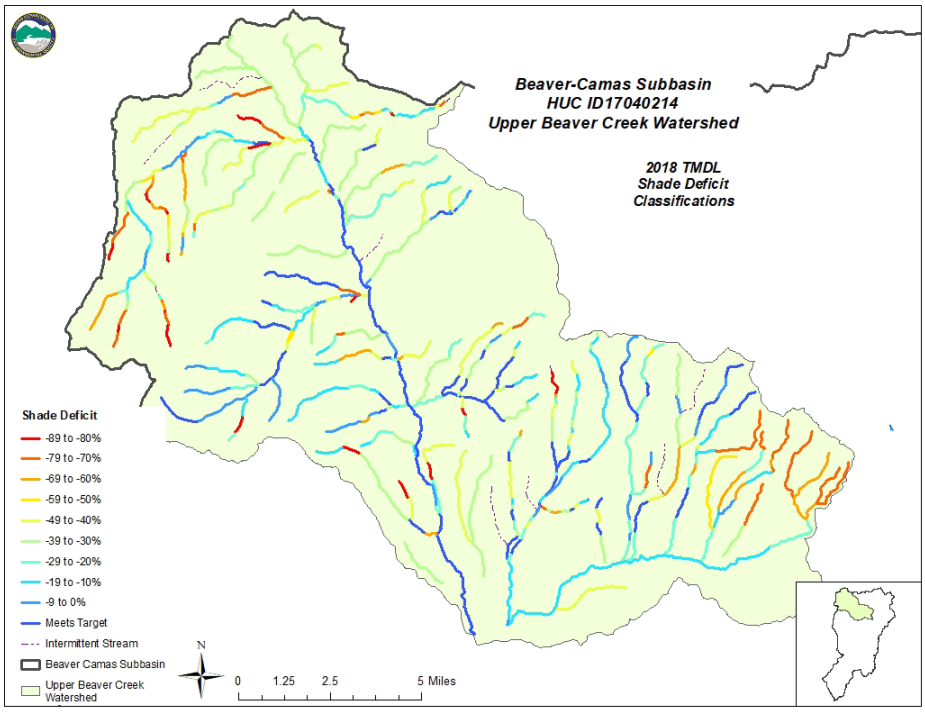


Figure C-30. Shade deficit for the Upper Beaver Creek watershed.

Upper Camas Creek

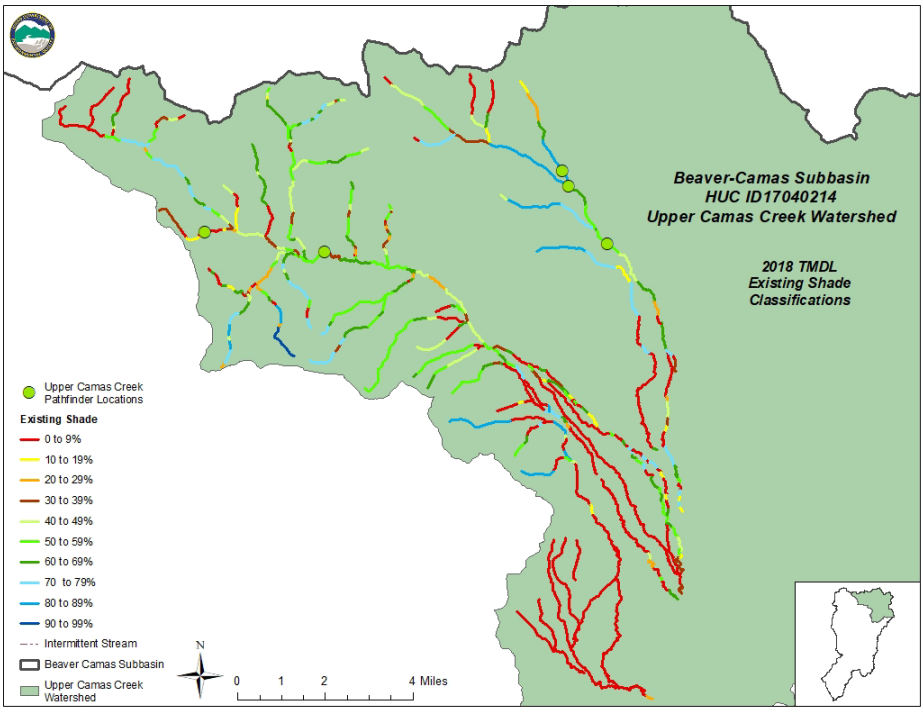


Figure C-31. Existing shade for the Upper Camas Creek watershed by aerial photo interpretation.

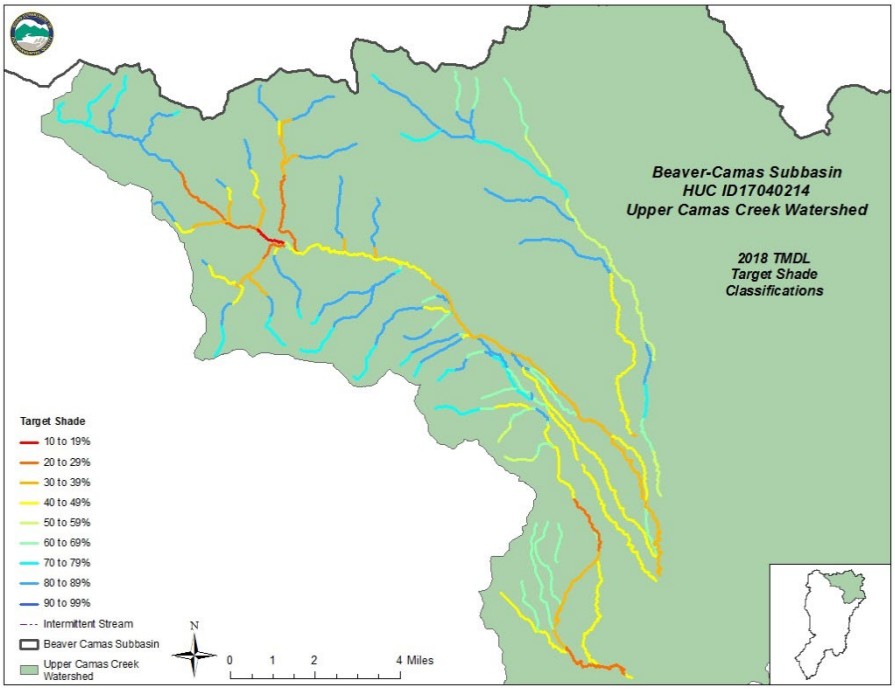


Figure C-32. Target shade for the Upper Camas Creek watershed.

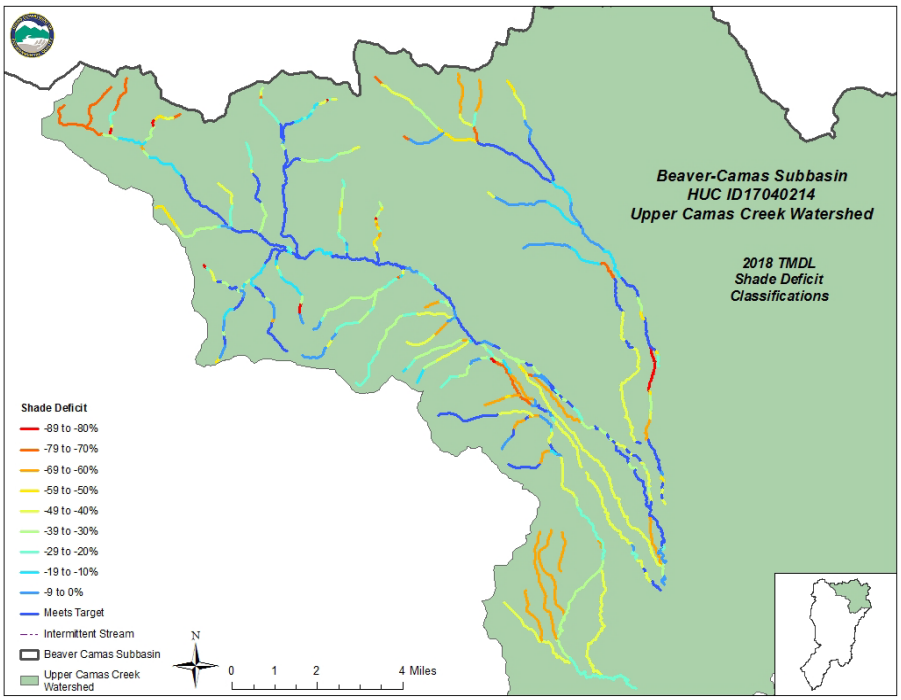


Figure C-33. Shade deficit for the Upper Camas Creek watershed.

Lower Beaver and Camas Creeks

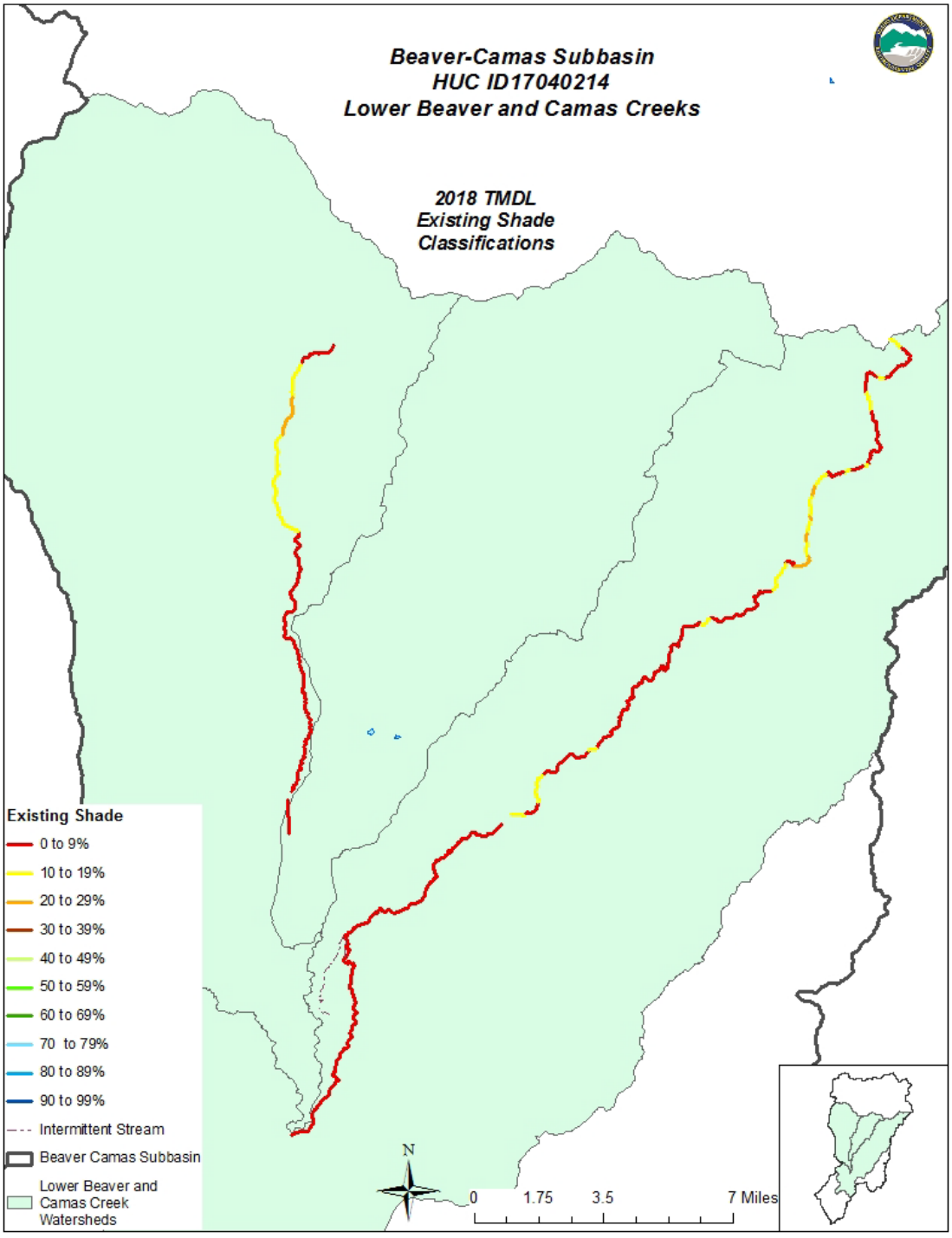


Figure C-34. Existing shade for the Lower Beaver Creek and Camas Creek watersheds by aerial photo interpretation.

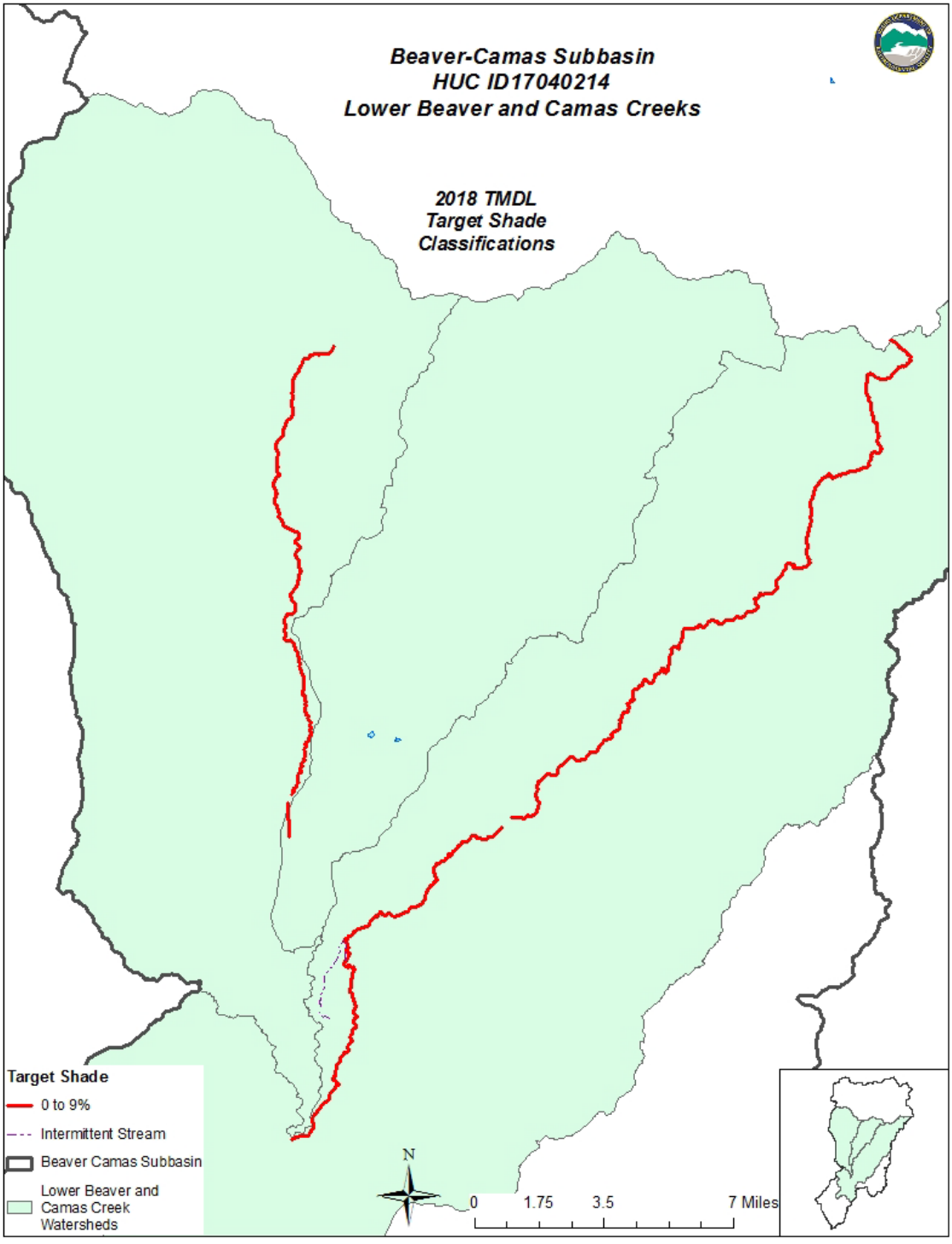


Figure C-35. Target shade for the Lower Beaver Creek and Camas Creek watersheds.

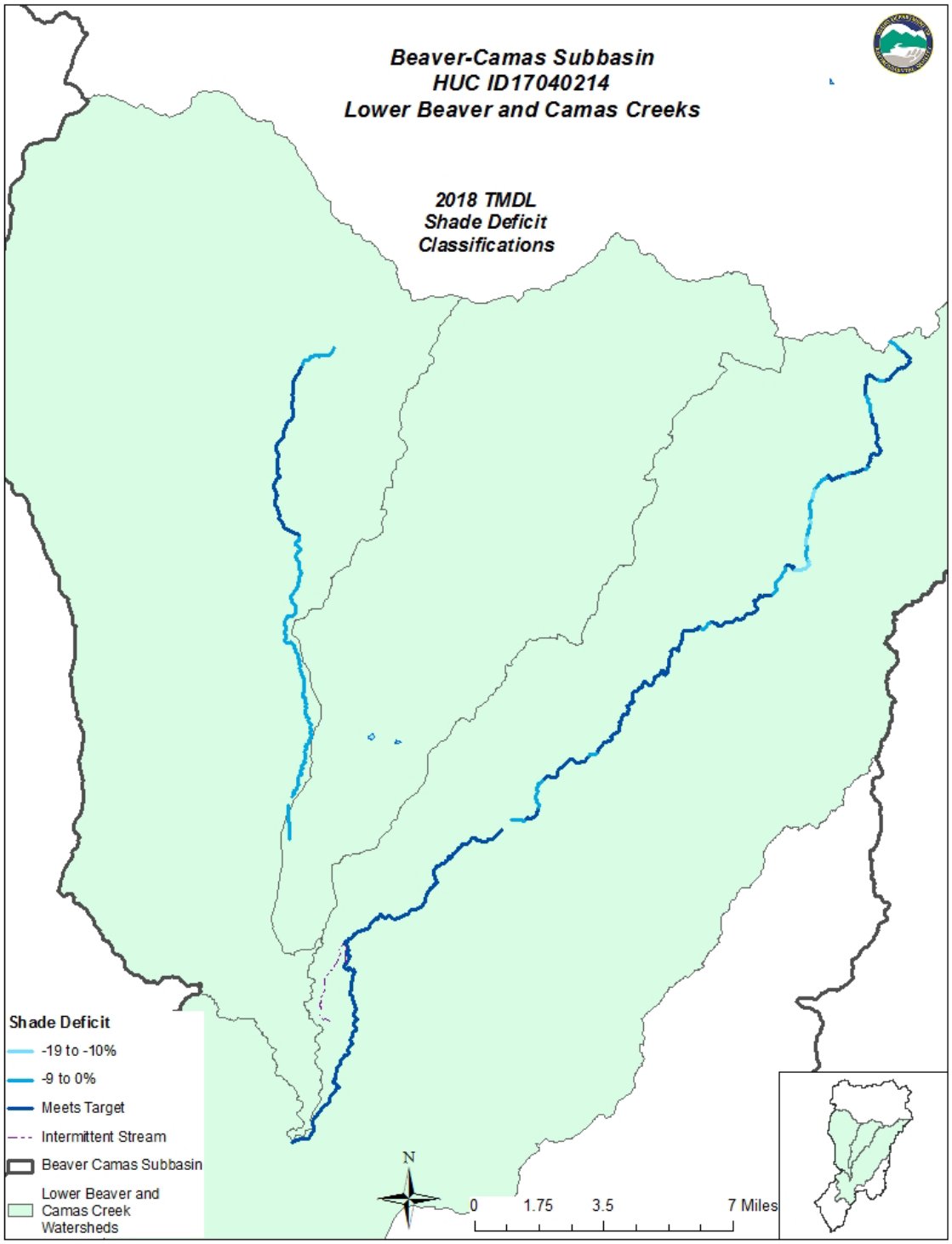


Figure C-36. Shade deficit for the Lower Beaver Creek and Camas Creek watersheds.

Beaver-Camas Subbasin 2018 SEI Data Sheets

Table C-25. SEI calculation worksheet for Ching Creek (ID17040214SK006_03).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Ching Creek	**Stream Segment Location (DD)**	
Assessment Unit:	006_03	***Upstream N***	44.452670
Segment Inventoried:		***W***	-111.871520
Total Reach:	3,441 ft.	***Downstream N***	44.445900
Date Collected:	19-Jul-18	***W***	-111.873650
Field Crew:	Cory Sandow , Genene Lehotsky	**Notes:**	Trampling, grazing and recreation.
Data Reduced By:	Genene Lehotsky		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	3441.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	10,980	ft	Total Reach
Estimated Distance inventoried	6882.00	ft	"
Total Erosive Bank Length	429.97	ft	"
Percent Erosive Bank	6.2	%	"
Eroding Area (AE)	583.86	ft^2	"
Lateral Recession Rate (RLR)	0.055		"
Bank Erosion (E)	1.36	tons/year	"
Total Bank Erosion Rate (ER)	2.09	tons/mile/year	Reach and Segment
Total Bank Erosion	4.35	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	1	0.5
Bank Stability Condition (0 to 3)	1	0
Bank Cover/Vegetation(0 to 3)	1	0.5
Lateral Channel Stability (0 to 3)	1	0.5
Channel Bottom Stability (0 to 2)	0.5	0.5
In-Channel Deposition (-1 to 1)	0	-0.5
Total = Slight (0-4); Moderate (4-8); Severe (>8)	4.5	1.5
Lateral Recession Rate (RLR) (ft/yr)	**0.055**	**0.025**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	1869.03	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	1.99	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	3.05	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	6.34	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
2.1	**4.4**	**3.0**	**6.3**	**No**	**1**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**

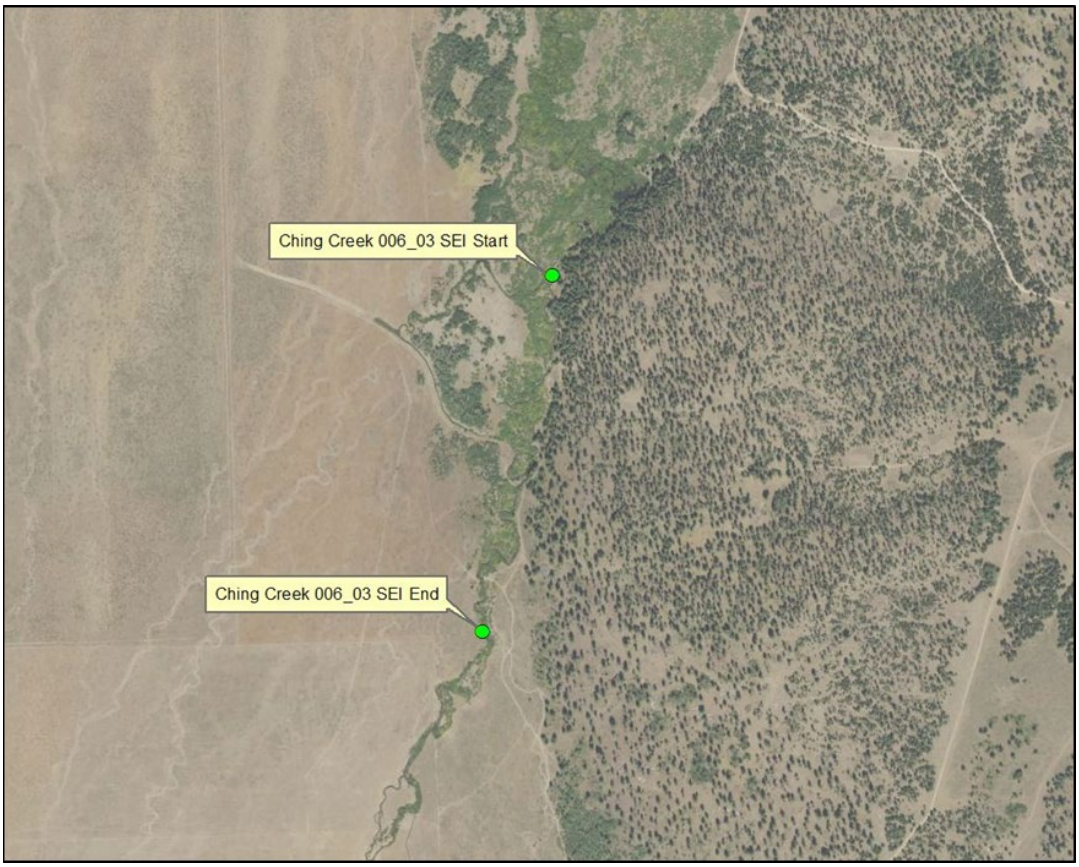

Ching Creek 006_03 SEI Start
Ching Creek 006_03 SEI End



Table C-26. SEI calculation worksheet for Crooked/Crab Creek (ID17040214SK008_03).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Crab Creek	**Stream Segment Location (DD)**	
Assessment Unit:	008_03	***Upstream N***	44.421610
Segment Inventoried:		***W***	-111.950430
Total Reach:	818 ft.	***Downstream N***	44.421200
Date Collected:	14-Aug-18	***W***	-111.948280
Field Crew:	Hannah Harris, Genene Lehotsky	**Notes:**	Mucky in areas of trampling, grazing, flood irrigation. Banks were overgrown with willows along the bank. Ended at an irrigation diversion.
Data Reduced By:	Genene Lehotsky		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	818.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	80	lb/ft^3	Total Reach
Length of Similar Stream	5,921	ft	Total Reach
Estimated Distance inventoried	1636.00	ft	"
Total Erosive Bank Length	76.37	ft	"
Percent Erosive Bank	4.7	%	"
Eroding Area (AE)	190.06	ft^2	"
Lateral Recession Rate (RLR)	0.035		"
Bank Erosion (E)	0.27	tons/year	"
Total Bank Erosion Rate (ER)	1.72	tons/mile/year	Reach and Segment
Total Bank Erosion	1.93	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	1	0.5
Bank Stability Condition (0 to 3)	0.5	0
Bank Cover/Vegetation(0 to 3)	0	0
Lateral Channel Stability (0 to 3)	0.5	0.5
Channel Bottom Stability (0 to 2)	0.5	0.5
In-Channel Deposition (-1 to 1)	0	-0.5
Total = Slight (0-4); Moderate (4-8); Severe (>8)	2.5	1
Lateral Recession Rate (RLR) (ft/yr)	**0.035**	**0.02**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	814.28	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	0.65	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	4.20	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	4.72	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
1.7	**1.9**	**4.2**	**4.7**	**No**	**0**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


08/13/2018

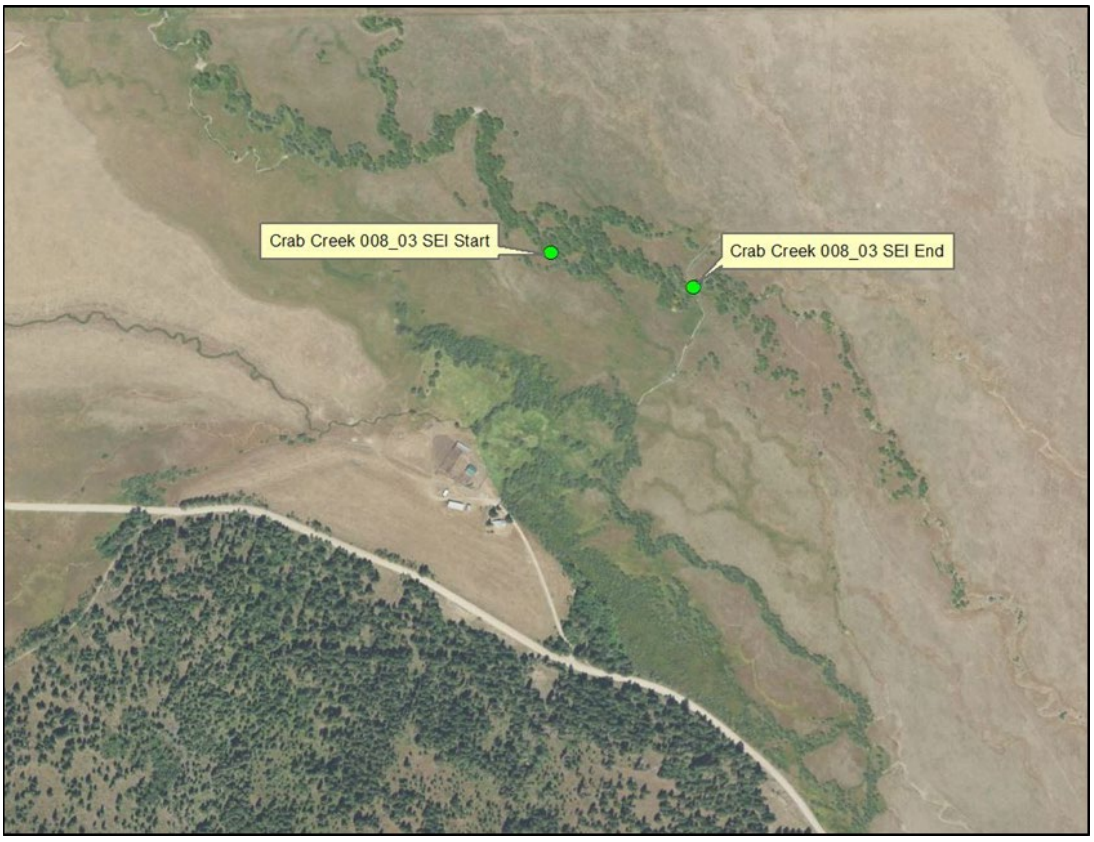

Crab Creek 008_03 SEI Start
Crab Creek 008_03 SEI End

Table C-27. SEI calculation worksheet for West Camas Creek (Pass Creek) (ID17040214SK013_02).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Pass Creek	**Stream Segment Location (DD)**	
Assessment Unit:	013_02	***Upstream N***	44.484040
Segment Inventoried:		***W***	-112.111640
Total Reach:	1,096 ft.	***Downstream N***	44.484700
Date Collected:	19-Jul-18	***W***	-112.107900
Field Crew:	Cory Sandow , Genene Lehotsky	**Notes:**	Very small stream (1 ft. to 1.5 ft. wide) with minimal flow. Mostly silt bottom with some cobbles, however, no erosion evident at all. Willows
Data Reduced By:	Genene Lehotsky		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	1096.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	6,293	ft	Total Reach
Estimated Distance inventoried	2192.00	ft	"
Total Erosive Bank Length	0.00	ft	"
Percent Erosive Bank	0.0	%	"
Eroding Area (AE)	0.00	ft^2	"
Lateral Recession Rate (RLR)	0.02		"
Bank Erosion (E)	0.00	tons/year	"
Total Bank Erosion Rate (ER)	0.00	tons/mile/year	Reach and Segment
Total Bank Erosion	0.00	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	0	0
Bank Stability Condition (0 to 3)	0	0
Bank Cover/Vegetation(0 to 3)	0	0
Lateral Channel Stability (0 to 3)	0	0
Channel Bottom Stability (0 to 2)	1	0.5
In-Channel Deposition (-1 to 1)	0	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	1	0.5
Lateral Recession Rate (RLR) (ft/yr)	**0.02**	**0.015**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	0.00	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	0.00	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	0.00	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	0.00	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
0.0	**0.0**	**0.0**	**0.0**	**No**	**0**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Pass Creek 013_02 SEI End
Pass Creek 013_02 SEI Start





Table C-28. SEI calculation worksheet for Rattlesnake Creek (West Fork Rattlesnake Creek (ID17040214SK016_02).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Rattlesnake Creek	**Stream Segment Location (DD)**	
Assessment Unit:	016_02	***Upstream N***	44.405170
Segment Inventoried:		***W***	-112.071590
Total Reach:	1,216 ft.	***Downstream N***	44.402290
Date Collected:	18-Jul-18	***W***	-112.073280
Field Crew:	Cory Sandow , Andy Olson, Genene Lehotsky	**Notes:**	Overgrown stream with cobbles. Did not appear to be sediment impaired. Banks were stable. Vegetation was too dense to continue downstream.
Data Reduced By:	Genene Lehotsky		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	1216.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	13,847	ft	Total Reach
Estimated Distance inventoried	6317.00	ft	"
Total Erosive Bank Length	64.00	ft	"
Percent Erosive Bank	2.6	%	"
Eroding Area (AE)	270.00	ft^2	"
Lateral Recession Rate (RLR)	0.0225		"
Bank Erosion (E)	0.26	tons/year	"
Total Bank Erosion Rate (ER)	1.12	tons/mile/year	Reach and Segment
Total Bank Erosion	2.94	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	0.5	0
Bank Stability Condition (0 to 3)	0	0
Bank Cover/Vegetation(0 to 3)	0	0
Lateral Channel Stability (0 to 3)	0.5	0
Channel Bottom Stability (0 to 2)	0	0
In-Channel Deposition (-1 to 1)	0.25	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	1.25	0
Lateral Recession Rate (RLR) (ft/yr)	**0.0225**	**0.01**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	2052.00	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	0.87	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	3.79	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	9.93	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
1.1	**2.9**	**3.8**	**9.9**	**No**	**1**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


Rattlesnake Creek 016_02 SEI Start
Rattlesnake Creek 016_02 SEI End


07/18/2018


07/18/2018

Table C-29. SEI calculation worksheet for Threemile Creek (East Threemile Creek) (ID17040214SK017_02).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	East Threemile Creek	**Stream Segment Location (DD)**	
Assessment Unit:	017_02	***Upstream N***	44.386750
Segment Inventoried:		***W***	-112.110340
Total Reach:	1,560 ft.	***Downstream N***	44.383500
Date Collected:	14-Aug-18	***W***	-112.113590
Field Crew:	Hannah Harris, Genene Lehotsky	**Notes:**	Many active beaver dams and channels up and down stream. Several breached beaver dams and voluminous macrophytes were noted
Data Reduced By:	Genene Lehotsky		

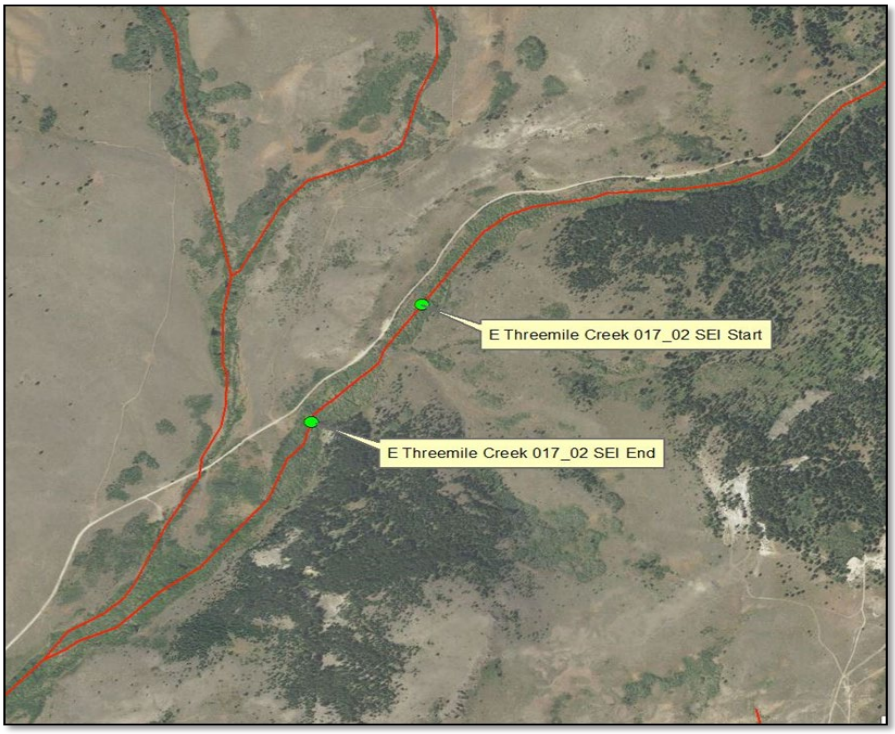
Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	1560.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	15973	ft	Total Reach
Estimated Distance inventoried	3120.00	ft	"
Total Erosive Bank Length	80.02	ft	"
Percent Erosive Bank	2.6	%	"
Eroding Area (AE)	186.37	ft^2	"
Lateral Recession Rate (RLR)	0.045		"
Bank Erosion (E)	0.36	tons/year	"
Total Bank Erosion Rate (ER)	1.21	tons/mile/year	Reach and Segment
Total Bank Erosion	3.65	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	1	0.5
Bank Stability Condition (0 to 3)	0.5	0.25
Bank Cover/Vegetation(0 to 3)	0	0
Lateral Channel Stability (0 to 3)	1	0.5
Channel Bottom Stability (0 to 2)	0.5	0.5
In-Channel Deposition (-1 to 1)	0.5	0
Total = Slight (0-4); Moderate (4-8); Severe (>8)	3.5	1.75
Lateral Recession Rate (RLR) (ft/yr)	**0.045**	**0.0275**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	1453.31	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	1.70	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	5.75	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	17.39	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
1.2	**3.6**	**5.7**	**17.4**	**No**	**2**

Percent Erosion Reduction (%)	**0**
Total Erosion Reduction (tons/yr)	**0**


E Threemile Creek 017_02 SEI Start
E Threemile Creek 017_02 SEI End




08/14/2018

Table C-30. SEI calculation worksheet for Beaver Creek (Van Noy Canyon Creek) (ID17040214SK018_02).

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:	Van Noy Canyon Creek	**Stream Segment Location (DD)**	
Assessment Unit:	018_02	***Upstream N***	44.409690
Segment Inventoried:		***W***	-112.219770
Total Reach:	1,064 ft.	***Downstream N***	44.411000
Date Collected:	19-Jul-18	***W***	-112.217160
Field Crew:	Hannah Harris, Andy Olson	**Notes:**	Trampling, grazing and recreation. Very small stream and little bank development. Streambed is mainly silt. Stream is dry above reach where
Data Reduced By:	Genene Lehotsky		

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	1	Single Bank	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	1064.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	80	lb/ft^3	Total Reach
Length of Similar Stream	10,028	ft	Total Reach
Estimated Distance inventoried	1064.00	ft	"
Total Erosive Bank Length	254.76	ft	"
Percent Erosive Bank	23.9	%	"
Eroding Area (AE)	1206.08	ft^2	"
Lateral Recession Rate (RLR)	0.0325		"
Bank Erosion (E)	1.57	tons/year	"
Total Bank Erosion Rate (ER)	7.78	tons/mile/year	Reach and Segment
Total Bank Erosion	14.78	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	1	0.5
Bank Stability Condition (0 to 3)	0.5	0.25
Bank Cover/Vegetation(0 to 3)	0.75	0.25
Lateral Channel Stability (0 to 3)	0.25	0.25
Channel Bottom Stability (0 to 2)	0	0
In-Channel Deposition (-1 to 1)	-0.25	-0.5
Total = Slight (0-4); Moderate (4-8); Severe (>8)	2.25	0.75
Lateral Recession Rate (RLR) (ft/yr)	**0.0325**	**0.0175**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	1007.44	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	0.71	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	3.50	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	6.65	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
7.8	**14.8**	**3.5**	**6.6**	**YES**	**1**

Percent Erosion Reduction (%)	**57**
Total Erosion Reduction (tons/yr)	**9**


Van Noy Creek 018_02 SEI End
Van Noy Creek 018_02 SEI Start


07/19/2018

Appendix D. Standard Operating Procedures for Streambank Erosion Inventory to Measure Instream Stability and Estimate Annual Sediment Loads in Wadeable Streams

SOP WTR-4.011, Version 2



State of Idaho
Department of Environmental Quality

May 2014

Approval Signatures

Darcy D. Sharp, Author	Date
Michael McIntyre, Surface Water Program Manager	Date
Barry Burnell, Water Quality Division Administrator	Date

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1 Purpose and Applicability

This document details the Idaho Department of Environmental Quality (DEQ) standard operating procedure (SOP) for collecting and analyzing streambank stability data using the streambank erosion inventory (SEI) method for determining beneficial use support of the narrative sediment standard in streams apparently impaired by instream erosion.[1]

Streambank stability data collection and analysis results in a sediment loading rate, or mass per unit time (tons per year). These data and the sediment loading rate can then be used to determine the total current sediment load and load capacity, which DEQ considers as the achievable natural background condition.

The SEI evaluation presumes that beneficial uses of cold water aquatic life and salmonid spawning will be supported at natural background sediment loading rates but should also be applicable to warm water and seasonal cold water beneficial uses. Annual loads are estimated using the SEI. This SEI load (tons/year) can be paired with a flow-duration curve to develop daily loads and load allocations—an additional analysis that is not addressed in this document.

This SOP applies to all DEQ staff collecting streambank erosion data for determining sediment loading rates, such as for the development of a sediment total maximum daily load (TMDL) where streambank erosion is the apparent source and stressor to water quality. The goal of sediment analysis is to determine the natural background sediment loading rates that need to be achieved through restoration of streambank stability. The science, assumptions, and relevant supporting literature provided in this SOP supply defensibility to the SEI method.

2 Summary of Method

The SEI method described in this document is used to estimate erosion rates and sediment loads into streams. While no direct load targets are presented in this document, load capacity is considered to be met when streambank stability is 80%. This 80% stability level is identified in the “User’s Guide to Fish Habitat: Descriptions that Represent Natural Conditions in the Salmon River Basin, Idaho” (Overton et al. 1995) and is deemed to be protective of stream habitat. “An unstable streambank shows evidence of active erosion and/or slumping; undercut banks are considered stable until tension fractures show on the ground surface at the back of the undercut” (Overton et al. 1995).

[1] The narrative sediment standard is set forth in IDAPA 58.01.02.200.08: Sediment shall not exceed quantities specified in Sections 250 and 252, or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Section 350. (4-5-00)

The SEI follows methods outlined in proceedings from the Channel Evaluation Workshop (SCS 1983).[2] Using a direct volume method, watersheds are surveyed to determine the extent of chronic bank erosion and estimate the needed reductions. The SEI is a field-based methodology that measures streambank/channel stability, length of active eroding banks, and bank geometry (Stevenson 1994).

SEIs are used to estimate long-term streambank lateral recession rates. The recession rate is determined from field evaluation of six streambank characteristics that are assigned field stability scores ranging from -1 to 3 recorded in 0.25 increments. Corresponding erosion rates and target erosion rates are calculated using a spreadsheet. Data and information should be collected in a manner that can be used to determine and justify the development of a TMDL or provide supporting documentation that the stream supports its beneficial uses.

This SEI method has been modified to incorporate a target stability score to be used when excessive erosion rate indications are present, even if the 80% stability is or will be met, such as when the streambanks are prone to very severe erosion rates and need to be less erosive or the channel may anastomose (i.e., form multiple channels), braid, or shift outside of the current riparian corridor. The goal of this target stability score is to further promote options to meet an in-channel substrate of less than 28% fine sediments (<6.3 millimeters), which is approximately the median range to support salmonid egg and fry survival in redds throughout Idaho (McNeil and Ahnell 1964; DEQ 2003).

3 Definitions

Beneficial use: Any of the various uses which may be made of the water of Idaho, including, but not limited to, domestic water supplies, industrial water supplies, agricultural water supplies, navigation, recreation in and on the water, wildlife habitat, and aesthetics.

Nickpoint: A stream or channel location with an abrupt change in channel slope or gradient.

Salmonid: Fish in the family Salmonidae, such as salmon or trout.

Thalweg: The deepest continuous portion of a stream bed or valley, defining its deepest channel.

4 Health and Safety Warnings

Hazards are inherent to field work. Precautions should be taken to meet safety protocols set forth by individual regional offices or the State Office. Occupational exposure risk prevention is

[2] The Soil Conservation Service (SCS) was later renamed the Natural Resources Conservation Service (NRCS) in 1994.

the responsibility of all staff and each DEQ regional office. Developed health and wellness plans (or similar) will supersede statements in this SOP.

5 Cautions

There are no known cautions that are not inherent to the health and safety warnings. However, per Idaho DEQ recommended protocols, wading equipment should be treated/disinfected to limit the spread of noxious or invasive species between water bodies.

6 Interferences

There are no known interferences.

7 Personnel Qualifications

All personnel collecting SEI data from surface waters are required to read this SOP. Personnel should be field trained by a staff member experienced with collecting streambank erosion data under this SOP.

8 Apparatus and Materials

The following supplies should be taken into the field for SEI data collection:

- Camera
- GPS unit
- Datasheets (see examples in 0)—available in TRIM record 2013AKL22
  - Stability Score Datasheet
  - Erosion Measurement Datasheet
  - Photo Documentation Datasheet
- Field notebook
- Writing instruments (pens, permanent markers, and pencils)
- Maps
- Stadia rod (or equivalent)—English or metric units
- Personal protective equipment:
  - Neoprene or rubber gloves
  - Waders
  - Polarized sunglasses (recommended)
  - Sunblock (recommended)
  - Bug spray (recommended)
- Optional equipment
  - Measuring tape (50 yard or meter)
  - Ruler/particle size indicator

- Laser distance rangefinder
- Clinometer

9 Sample Collection

9.1 In-Office Presampling Activities and Considerations

Reach Identification, Mapping, and Logistics

1. Using aerial photo interpretation and other Geographic Information System (GIS) tools, identify representative reach options and/or points (GPS location) to initiate SEI and access points from roadways (trails down into canyons, across private land, etc.).

   Note that multiple reaches may be required to adequately determine streambank stability and erosion rates due to factors such as land-use, Rosgen channel type, geology, nickpoints/head cuts, or multiple tributaries combined in one assessment unit (AU).
2. Determine if access to private land is required.
   a. Use the procedures developed for the DEQ Beneficial Use Reconnaissance Program (BURP) monitoring on private lands (see DEQ 2007).
3. Make sure the inventoried stream length (thalweg distance) is representative of the AU or target stream reach.
   a. Set a goal to measure at least 10% of the representative stream reach or AU length once in the field, but picking a representative location is more important than the total length.
   b. Using GIS analysis and maps, it may be necessary to estimate how much of the 1st-order stream length has the potential stream power to erode (between 50 to 75% of the total length—and/or based on channel slope). The length/slope parameters in the revised universal soil loss equation (RUSLE) for hillslope erosion may be used as a guide (Haan et al. 1994) to estimate the contributing stream distance.

Supplies and Preparation

Before doing fieldwork, prepare with the following tasks:

1. Gather equipment needed and print datasheets onto Write-in-the-Rain paper from the Excel spreadsheet in TRIM (see section 0).
2. Review needs for SEI data calculation (bank material, etc.—see 0).
3. Become familiar with identifying bank stability/instability (see 0).

9.2 Field Methods

This section contains instructions about taking notes, documenting field observations, and taking and recording measurements on the Erosion Measurement, Stability Score, and Photo

Documentation Datasheets. Note that multiple SEI reaches may need to be inventoried if an AU has multiple noncontinuous tributaries, a change in land-use, or a nickpoint that divides the AU. Some of these features may not have been apparent through aerial photo interpretation made during office preparations.

Taking detailed notes about field observations is imperative. Do not assume that field crews will remember all the details. Remember that someone else may be using this field data to develop load calculations for a sediment TMDL. Assume that any information gathered should be paired with observations and interpretations that would aid in writing a TMDL or showing full support that warrants delisting an AU from the Integrated Report. Detailed information is required for delisting.

After arriving in the field, perform the following general tasks:

1. Confirm access before entering private lands, using the procedures developed for BURP monitoring on private lands (DEQ 2007).
2. Perform a reconnaissance of potential safety hazards (e.g., trees, stream stage and velocity, weather).
3. Record required identifying information on the Erosion Measurement, Stability Score, and Photo Documentation Datasheets (see 0 for an example).
4. Identify locations of bank instability/erosion potential. See 0 for resources on determining stability/instability. Note any observations and stability factors that might need to be accounted for in the SEI field stability scores. Record this periodically in the “comments/photo number” column of the Erosion Measurement Datasheet (discussed below) while working in channel.
5. Photograph and record GPS location at start of each reach.
    a. Also take photos while working in the reach (upstream, downstream, banks, panorama, streambed, etc.), in particular at any location where later examination might be needed (note GPS coordinates also); use stadia rod for scale.
    b. Document all photos on the Photo Documentation Datasheet (0).
6. Measure total study reach length (thalweg flow path)—include eroding and noneroding segments—and record on Erosion Management and Stability Score Datasheets, making sure to include units; confirm distance meets representative requirements for the AU.
    a. Attempt to measure at least 10% of the AU length to be representative, but picking a representative location is more important than total length.
    b. Some AUs may have 10 or more miles of stream channel; therefore, measuring 10% may not be feasible.
7. Note average mobile particle size of bank material on the Erosion Management and Stability Score Datasheets.
8. Note adjacent land use and record on the Erosion Management and Stability Score Datasheets.

Take the necessary measurements and observations to fill out the remaining fields in the **Erosion Measurement Datasheet**:

1. Determine bank-full width and record
2. Record units (height and length in feet and inches, decimal feet, meters, yards, paces, etc.)—if paces, include conversion factor (e.g., 11 paces equals 10 yards).
3. Record if bank stability measurements are made on either left or right bank—facing downstream—or are measured on both banks. Stream size, access, and significant differences in bank stability should be used to identify if one or both banks should be measured for streambank stability.
    a. For measurements on one bank, the assumption is that due to sinuosity and lengths applied, there will be mirrored instability that will be averaged over the entire AU and for both banks.
    b. However, overall rate observations are from the entire reach and both banks—this is incorporated in the equation for erosion rates in the SEI spreadsheet.
    c. Make note of any measurement inconsistencies for quality assurance / quality control.
4. Measure length of the zone with instability, or eroding length.
5. Measure eroding height along the erodible slope, from baseflow to bank-full height; this may not be vertical. The measured eroding height may extend above bank-full height if prone to mass slumping.
6. Record the dominant bank vegetation type.
7. Note the type of instability (bare and erodible, slump, fracture, etc.). Record any notes and/or take and document photos. See 0 for resources about bank instability.
    a. Bare is not necessarily unstable if the material is primarily composed of bedrock and/or cobbles or some other similar configuration.
    b. Grasses or annuals may stabilize streambanks, but rooting depth is important. If high water marks indicate the area is flood prone, annuals may not stabilize.
8. Note additional data, if applicable, in the “comment/photo number” column:
    a. Sinuosity
    b. Deposition/point bars and size
    c. High water marks (flood indicators)
    d. Flood plain size
    e. Substrate material and particle size
    f. General observations (e.g., footsteps stir up silt clouds)
    g. Large woody debris and size and portion in water
    h. Potential causes for streambank instability (e.g., livestock grazing, spring flooding, culvert replacement, recent fires)
    i. Rip-rap, culverts, and other human additions (e.g., trails through river)
    j. Bank/hillslopes prone to mass wasting/landslides (above bank-full stage)—photo documentation and estimated heights may aid in allocations and/or setting target stability scores
    k. Any areas of concern that could alter interpretations or aid in explanation/recommendations:
        i. Incision/downcutting

ii. Channel shifts/oxbow development
iii. Flood scour

Take the necessary measurements and observations to fill out the remaining fields in the **Stability Score Datasheet**:

1. Note the primary geology of the area.
2. Note Rosgen stream type.
3. Record the channel slope.
4. Note the primary factors contributing to erosion.
5. Note whether measurements are starting upstream or downstream.
6. Record field stability scores in 0.25 increments. The final load calculations are very sensitive to the stability scores. The overall field stability score is determined by assigning scores in the following six categories, which are described in detail in 0:
   a. Bank erosion evidence
   b. Bank stability condition
   c. Bank cover/vegetation
   d. Lateral channel stability
   e. Channel bottom stability
   f. In-channel deposition
7. The total field stability score and recession rate are calculated automatically in the spreadsheet when the six scores are entered.

At the end of the reach and before leaving the site, do the following:

1. Photograph and record GPS location at end of reach.
2. Make sure all identifying information on the Stability Score, Erosion Measurement, and Photo Documentation Datasheet is completely filled out, including any duplicate header information on subsequent pages.
3. Insert page numbers and total page count to ensure site information can be maintained in a group.
4. Organize the datasheets so the Stability Score Datasheet comes first, followed by the Erosion Measurement Datasheet then the Photo Documentation Datasheet.

10 Data Analysis

After field data have been gathered, use the Streambank Erosion Inventory Spreadsheet (TRIM record 2013AKL23) for data analysis and calculations. The spreadsheet consists of three different worksheets (see 0 for examples):

1. **SEI Calculation Worksheet**—the bulk of the calculations are performed here, ultimately estimating current loads and load capacities.
   a. A single SEI Calculation Worksheet should be used to calculate streambank erosion for similar stream segments within an AU.
   b. If streambank monitoring reveals significant differences in stream characteristics within an AU (for example, geomorphology, channel type, lateral recession rate, etc.), a separate erosion worksheet should be completed for each unique segment to calculate a unique erosion field stability score.

2. **Field Data Entry Worksheet**—most of the raw field measurement data pertaining to streambank erosion is entered here.
3. **Recession Rates Worksheet**—these are interpolated measures of lateral recession that correspond to the field stability score that is determined in the field for each stream segment.

10.1 Entering General Stream Information (Peach-Shaded Cells)

Begin by entering information into the peach-shaded cells on the SEI Calculation Worksheet and the Field Data Entry Worksheet. These cells record important site-specific information to identify the stream segment that was inventoried. This information is not used to calculate streambank erosion.

1. Fill in the following fields on the SEI Calculation Worksheet:
    a. Stream: the stream name recognized in the Assessment Database (ADB) (for example, Birch Creek)
    b. Assessment Unit (AU): the assessment unit number recognized in ADB (for example, ID17050103SW016_03)
    c. Segment Inventoried: the particular segment of stream that was inventoried (for example, Poison Creek to Snake River)
    d. Total Reach: the segment of the AU that the streambank erosion calculations will be extrapolated to (for example, headwaters to the Snake River). Be sure to enter the length in feet.
    e. Date Collected: date the streambank inventory data were collected
    f. Field Crew: names of personnel who collected the streambank inventory data
    g. Data Reduced By: name of individual entering data into the SEI Calculation and Field Data Entry Worksheets.
    h. Stream Segment Location (DD) (latitude/longitude):
        i. Upstream N, W: the most upstream sampling coordinates for that segment
        ii. Downstream N, W: the most downstream sampling coordinates for that segment
    i. Elevation (feet): the elevations corresponding to the upstream and downstream sampling coordinates
    j. Notes: any additional information pertaining to the streambank inventory
2. Fill in the following fields on the Field Data Entry Worksheet:
    a. Stream Name: the stream name recognized in the updated ADB (for example, Birch Creek)
    b. Segment: the particular subsegment of stream that was inventoried (for example, A = Poison Creek to Poison Creek Road; B = Poison Creek Road to Snake River)
    c. Bank: Right or left bank
    d. Date: date the streambank inventory data were collected

10.2 Entering Streambank Erosion Data (Light Blue-Shaded Cells)

Continue by entering information into the light blue-shaded cells on the SEI Calculation and Field Data Entry Worksheets. These cells record important site-specific information that is used to calculate streambank erosion. Formulas are included in 0.

1. Fill in the following fields on the SEI Calculation Worksheet:
    a. Right, Left, or Both Bank Measurements: indicate if one bank or both banks were measured for streambank stability (enter a 1 or 2). If one bank is examined in the field, the assumption is that both banks have equivalent erosion and the spreadsheet automatically accounts for both banks based on this entry.
    b. Inventory/Thalweg Length: the measurement of the segment in stream length (feet) that is representative of one bank length, or the length of the thalweg in the inventoried reach. Formulas and calculations are adapted to account for erosion/instability measurement for one or two banks, based upon the entry in step A, above.
    c. TMDL Margin of Safety: entered as a percentage, additional load that is required to fulfill the loading reductions to ensure meeting beneficial uses and account for uncertainty
    d. Bulk Density (BD): the bulk density of soils in the watershed, typically using a standard number for that region. See 0 for BD estimates by soil type.
    e. Length of Similar Stream (feet): the total length of similar stream within the AU for which the streambank inventory segment calculations will be extrapolated
    f. Field Stability Score: the scores as identified in the field during the streambank inventory (discussed in section 0)
    g. Erosion Stability Reduction: Field Stability scores exceeding 8.0 should automatically be examined for overall decreases in RLR by decreasing the Erosion Severity Reduction score, regardless of percent erosive bank. Field Stability scores less than 8.0 should be entered as developed in the field into this section. It is assumed that no erosion scores meeting TMDL should fall into the Severe category. Moderate to slight Field Stability scores can have decreased Erosion Severity Reduction scores developed at the discretion of the user, or entered equal to the Field Stability score. Caution is advised if a thorough understanding of the geomorphology, channel type and hydrology is not available.
2. Fill in the following fields on the Field Data Entry Worksheet:
    a. Erosive Bank Height (feet): each cell represents the bank height for a corresponding erosive bank length
    b. Erosive Bank Length (feet): each cell represents the length of erosive bank for a corresponding erosive bank height

11 Data Acquisition, Calculations, and Data Reduction

In the field, data are to be recorded on hard copy or electronic datasheets (see 0 for samples). Datasheets are located in one Excel spreadsheet available in TRIM at 2013AKL22.

Data calculations should be completed in the Excel SEI spreadsheet described in section 0 (TRIM record 2013AKL23).

12 Computer Hardware and Software

This procedure requires a computer with Microsoft Excel capable of opening and adapting an xlsx file extension. Additional information available from GIS system files may facilitate data acquisition required for developing annual loads.

13 Data and Records Management

Data from sample collection datasheets are to be entered into the centralized database to be stored with other site data (in TRIM).

14 Quality Assurance and Quality Control

14.1 Quality Assurance Objectives

Quality assurance relies upon the field skills and interpretations of the field crew. Checks and discussion among the crew are essential to measurements and interpretations that may be required. Additionally, data entry should be double checked to ensure proper entry and avoid problems. Since subjective interpretations are possible in the field, in particular in the stability scores, examination and concurrence among the field crew is essential. The stability scores can be done in 0.25 increments to allow for variation in the interpretation. If in doubt, estimate on the higher side of instability to ensure that beneficial uses are supported.

14.2 Quality Control Field Operations

Photo documentation may be the most effective tool to ensure quality control of field data. Photos should be taken with a digital camera, including the stadia rod or other measurement indicator. Supporting metadata should be provided as to the location and implications of the image along with interpretations. This photo documentation can be used in the office to analyze or supplement interpretations to the calculated sediment loads from the streambanks. These photos can also be used to help estimate the margin of safety required if a TMDL is deemed necessary. Additional quality control should include rounding values up so the measurements include an automatic margin of safety to ensure beneficial uses are being met.

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Appendix A. Sample Field Datasheets

The field datasheets can be found in TRIM (2013AKL22) and are included here for reference:

- Stability Score Datasheet
- Erosion Measurement Datasheet
- Photo Documentation Datasheet

Datasheets have been developed to allow for double-sided printing.

Stability Score Datasheet

STREAMBANK EROSION INVENTORY
STABILITY SCORE DATASHEET

Page of

Water Body Name: _____ HUC: _____
Assessment Unit: _____ Reach: _____
Inventory Length: _____ (Thalweg length) Bank Material: _____ (see below)
GPS Coordinates: Start N: _____ End N: _____
W: _____ W: _____
Primary Geology: _____ Rosgen Type: _____
Adjacent Land Use: _____ Channel Slope: _____
Factors contributing to erosion (animal access/trampling, grazing impacts, fire, return flows, roads, bridges, culverts):

Field Crew: _____
Date/Time: _____ Start: (Upstream/Downstream)

BANK EROSION EVIDENCE		Rank	Stability Score (0.25 scale)
	Does not appear to be eroding	0	
	Erosion evident	1	
	Surface of Bank is eroding and top of bank has cracking present	2	
	Slumps and clumps sloughing off into stream (Note size of clumps)	3	
BANK STABILITY CONDITION	(Ability to withstand peak streamflows)		
	Very little unprotected bank, no undercut vegetation-OR-bank materials non-erosive	0	
	Predominantly bare and unprotected, some rills, moderate undercut vegetation	1	
	Almost bare, unprotected bank, rills, severely undercut vegetation, exposed roots	2	
	Bare, numerous rills/gullies, severely undercut vegetation, trees or fences falling	3	
BANK COVER/VEGETATION			
	Predominantly covered with perennials AND/OR stable rock/bedrock	0	
	40% or < bare/erodible, AND/OR cover is annual and perennials mixed	1	
	40% to 70% bare/erodible, AND/OR cover is mostly annual vegetation	2	
	Predominantly bare and erodible/no cover	3	
LATERAL CHANNEL STABILITY			
	No evidence of significant lateral movement of channel	0	
	Minimal/slight active lateral movement of channel	1	
	Older Channel shift, developing riparian vegetation on one or both banks	2	
	Recent channel shift, no riparian vegetation present (oxbows, braided/anastomosed)	3	
CHANNEL BOTTOM STABILITY			
	Channel in bedrock or not eroding (stable)	0	
	Minor Channel bed degradation/downcutting	1	
	Significant evidence of downcutting, active headcuts	2	
IN-CHANNEL DEPOSITION			
	Deposition is stable and/or vegetated (more than this growing season), channel is aggrading	-1	
	No evidence of recent deposition (includes all sizes of bedload type materials)	0	
	Mobile material in recent deposition, deposits will probably move down channel in next high flow	1	
SUM OF STABILITY SCORES	**Summation by fractional 0.25 units**		

Other Notes: _____

Dominant Particle Size Identification	
Clay	<0.002 mm
Silt	0.004 mm to 0.06mm, 0.03 mm median
Sand	0.06 mm (fine) to 2 mm
Gravel	4 mm (pea size) to 64 mm (tennis ball size)
Cobbles	64 mm to 250 mm (volleyball size)
Boulders	> 250 mm
Bedrock	

Adapted from NRCS Idaho Worksheet Adapted from T. Stevenson, 6/20/2001

Erosion Measurement Datasheet

STREAMBANK EROSION INVENTORY
EROSION MEASUREMENT DATASHEET

Page of

Water Body Name: _____ HUC: _____
Assessment Unit: _____ Reach: _____
Inventory Length: _____ Avg Bankfull Width: _____
Bank Material: _____
Measurement Units: Length: _____ Height: _____
Adjacent Land Use: _____ Inventory Bank(s): Left/Right/Both (Facing Downstream)
Field Crew: _____
Date/Time: _____

Left/Right Bank - Segment Number	Eroding Length Unit_____	Eroding Height Unit_____	Bank Vegetation Type	Type of Instability*	Comments / Photo Number

* Common types of instability include: Bare soil, Slump, Fracture, Slough, downcutting, lateral erosion, etc

Photo Documentation Datasheet

STREAMBANK EROSION INVENTORY
PHOTO DOCUMENTATION DATASHEET

Page of

Water Body Name: _____ HUC: _____
Assessment Unit: _____ Reach: _____
GPS Coordinates: Start N: _____ End N: _____
W: _____ W: _____
Field Crew: _____
Date/Time: _____

Photo ID: Time: Start/End/Misc
Photo Description:

Photo ID: Time: Start/End/Misc
Photo Description:

Photo ID: Time: Start/End/Misc
Photo Description:

Photo ID: Time: Start/End/Misc
Photo Description:

Photo ID: Time: Start/End/Misc
Photo Description:

Appendix B. Streambank Erosion Inventory Method Description and Background

1. Streambank Erosion Inventory Method Development

The streambank erosion inventory (SEI) calculations presented in this standard operating procedure (SOP) have been adapted and developed from a variety of sources and have been modified to better acquire the data needed by the Idaho Department of Environmental Quality (DEQ). The SEI method is used to determine bank stability and erosion levels with an end goal of determining if channel stability supports beneficial uses. The following material is included to illustrate where the methods were developed and to supply additional information to support the DEQ decision-making processes.

The SEI follows methods outlined in the proceedings from the Soil Conservation Service—now called the Natural Resources Conservation Service—Channel Evaluation Workshop (SCS 1983). The SEI method is a field-based methodology that measures streambank/channel stability, length of active eroding banks, and bank geometry (Stevenson 1994).

2. Streambank Stability—Lateral Recession Rate

The SEI method is used to estimate the long-term lateral recession rate. The recession rate is determined from field evaluation of six streambank characteristics that are assigned a categorical rating from -1 to 3 in 0.25 increments. The six scores are then summed for a total field stability score and corresponding lateral recession rate. The categories and rating scores are as follows:

Bank Erosion Evidence:

- Do not appear to be eroding—0
- Erosion evident—1
- Surface of bank is eroding and top of bank has cracking present—2
- Slumps and clumps sloughing off into stream (note size of clumps)—3

Bank Stability Condition:

- Very little unprotected bank, no undercut vegetation; **or** bank materials nonerosive—0
- Predominantly bare and unprotected, some rills, moderate undercut vegetation—1
- Almost bare, unprotected bank, rills, severely undercut vegetation, exposed roots—2
- Bare, numerous rills/gullies, severely undercut vegetation, trees or fences falling—3

Bank Cover/Vegetation:

- Predominantly covered with perennials **and/or** stable rock/bedrock—0
- 40% or less bare/erodible **and/or** cover is annual and perennials mixed—1
- 40% to 70% bare/erodible **and/or** cover is mostly annual vegetation—2
- Predominantly bare and erodible/no cover—3

Lateral Channel Stability:

- No evidence of significant lateral movement of channel—0
- Minimal/slight active lateral movement of channel—1
- Older channel shift, developing riparian vegetation on one or both banks—2
- Recent channel shift, no riparian vegetation present (oxbows, braided/anastomosed)—3

Channel Bottom Stability:

- Channel in bedrock/noneroding—0
- Soil bottom, gravels or cobbles, minor erosion—1
- Silt bottom, evidence of active downcutting—2

In-Channel Deposition:

- Deposition is stable and/or vegetated (more than this growing season), channel is aggrading— -1
- No evidence of recent deposition (includes all sizes of bedload-type materials)—0
- Mobile material in recent deposition, deposits will probably move down channel in next high flow—1

Score Summation

Erosion	Lateral Recession Rate
Slight (0–4)	0.01–0.05 feet per year
Moderate (4.25–8)	0.06–0.15 feet per year
Severe (8.25–11.75)	0.16–0.3 feet per year
Very Severe (12+)	0.31--0.5+ feet per year

The original method uses a "Score Summation" in broad categories as shown above as a descriptive estimation of lateral recession rate. Other streambank stability estimation methods exist, such as the simplified modification of Platts et al. (1983, p. 13) as stated in *Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams* (Bauer and Burton 1993). This method uses more descriptive terms of bank condition as an effort to make the assignment of lateral recession rate more objective.

However, DEQ prefers to calculate lateral recession rate directly from the stability scores identified in the field for more accurate results. Each total field score from 0 through 15 in 0.25 increments corresponds with a specific lateral recession rate ranging from 0.01 through 0.84 feet per year. The full recession rate table is included in the streambank erosion inventory spreadsheet at TRIM 2013AKL23, but a summary is given here:

Recession Rate Field Score	Lateral Recession Rate	Recession Rate Field Score	Lateral Recession Rate
0	0.01	8	0.15
1	0.02	9	0.16
2	0.03	10	0.27
3	0.04	11	0.38
4	0.05	12	0.5
5	0.06	13	0.61
6	0.09	14	0.73
7	0.12	15	0.84

The calculation process is the preferred choice by DEQ, as it is better suited to determine loading and reduction allocations necessary for total maximum daily load development.

Target stability scores, as opposed to field stability scores, are based on the need for additional erosion reductions beyond the overall 80% streambank stability. This additional parameter is to be used when there are excessive erosion rate indications, such as when the streambanks are prone to very severe erosion rates and need to be less erosive or the channel may anastomose or shift channels outside the current riparian corridor. The goal of this target stability score is to further promote options to meet an in-channel substrate of less than 28% fine sediments.

3. SEI—Total Bank Erosion Calculations

The direct volume method is used to calculate average annual erosion rates for a given stream segment based on the lateral recession rate determined in the survey (SCS 1983). The erosion rate (tons/mile/year) is used to estimate the total bank erosion of the selected stream corridor.

The direct volume method is summarized in the following equations:

$$E = [A_E \times R_{LR} \times _{BD}]/2{,}000 \text{ (pounds/ton)}$$

Where:

E = bank erosion over sampled stream reach (tons/year/sample reach)

A_E = eroding area (square feet)

R_{LR} = lateral recession rate (feet/year)

$_{BD}$ = bulk density of bank material (pounds per cubic feet)

The bank erosion rate (E_R) is calculated by dividing the sampled bank erosion (E) by the total stream length sampled:

$$E_R = E/L_{BB}$$

Where:

E_R = bank erosion rate (tons/mile/year)

E = bank erosion over sampled stream reach (tons/year/sample reach)

L_{BB} = inventory/thalweg length

Total bank erosion is expressed as an annual average. However, the frequency and magnitude of bank erosion events are greatly a function of soil moisture and stream discharge (Leopold et al. 1964). Because channel erosion events typically result from above average flow events, the annual average bank erosion value should be considered a long-term average. For example, a 50-year flood event might cause 5 feet of bank erosion in 1 year, and over a 10-year period, this event accounts for the majority of bank erosion. These factors have less of an influence where bank trampling is the major cause of channel instability.

The *eroding area* (A_E) is the product of linear horizontal bank distance and average bank slope height. Bank length and slope heights are measured while walking along the stream channel. Laser distance rangefinders, paces, tape measures, or other tools are used to measure horizontal distance. Bank slope heights are continually measured and recorded over a given reach or site. The horizontal length is the length of the right or left bank or thalweg. Typically, one bank along the stream channel is actively eroding (e.g., the bank on the outside of a meander). However, both banks of channels with severe head cuts (i.e., nickpoints) or gullies will be eroding and are to be measured separately and will be eventually summed. The spreadsheet (as shown in 0) automatically accounts for sediment contributions based upon inventoried segment inputs.

Soil *bulk density* (BD) is the weight of material divided by its volume, including the volume of its pore spaces. The BD of bank material can be measured visually in the field or estimated using methods similar to a Wolman pebble count to determine average particle size. Alternatively, a table of typical soil bulk densities can be used (see below), or soil samples can be collected and soil bulk density measured in the laboratory.

Soil Bulk Density Estimation Table

Soil Texture	Bulk Density (lb/ft^3)
Sands, loamy sands	110
Sandy loam	105
Fine sandy loam	100
Loams, sandy clay loams, sandy clay	90
Silt loam	85
Silty clay loam, silty clay	80
Clay loam	75
Clay	70
Organic	22

Note: Adapted from MDEQ (1999)

References

Bauer, S. and T. Burton. 1993. *Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams*. Seattle, WA: US Environmental Protection Agency, Region 10. Report 910/R-93-017.

Leopold, L.B., M.G. Wolman, and J.P. Miller. 1964. *Fluvial Processes in Geomorphology*. San Francisco, CA: Freeman.

MDEQ (Michigan Department of Environmental Quality). 1999. *Pollutants Controlled Calculation and Documentation for Section 319 Watersheds Training Manual*. Lansing, MI: MDEQ, Water Division. Available at *http://www.michigan.gov/documents/deq/deq-wb-nps-POLCNTRL_250921_7.pdf*.

Platts, W.S., W.F. Megahan, and G.W. Minshall. 1983. *Methods for Evaluating Stream, Riparian, and Biotic Conditions.* Ogden, UT: US Department of Agriculture, Forest Service, Intermountain Forest and Range Experiment Station. 70 p. General Technical Report INT-138.

SCS (Soil Conservation Service). 1983. Channel Evaluation Workshop. Ventura, California, November 14–18, 1983. Presented at US Army Corps of Engineers Hydrologic Engineering Center training session by Lyle J. Steffen, Geologist, Soil Conservation Service.

Stevenson, T.K. 1994. USDA-NRCS, Idaho. Channel erosion condition inventory description. Memorandum to Paul Shelton, District Conservationist, Montpelier Field Office, Idaho, describing estimation of streambank, road and gully erosion. May 24, 1994.

Appendix C. Examples of Bank Instability

Several documents (Platts et al. 1983, Leopold et al. 1964, Overton et al., 1995) contain material suitable to identify streambank stability and potential types of erosion. The recent US Bureau of Land Management (BLM) Multiple Indicator Monitoring (MIM) guide (Burton et al. 2011) contains written descriptions and photos of many types of streambank erosion found in Idaho. This MIM document is not comprehensive nor is it directly comparable to this streambank erosion inventory (SEI) method, but the streambank erosion/stability section is an excellent reference.

As with all reference material, all the potential variations and scales are not documented, and training by a person experienced in the SEI method is essential to identifying streambank stability and erosion issues. Overton et al. (1995) provides the following general guidance: "A stable streambank, as viewed at the steepest sloped portion of the channel between the bankfull and existing water level, shows no evidence of active erosion, breakdown, tension cracking, or shearing. An unstable streambank shows evidence of active erosion and/or slumping; undercut banks are considered stable until tension fractures show on the ground surface at the back of the undercut."

Basic terminology and descriptions from the MIM include:

Bare soil: indicates the exposed soil may have the potential to be eroded

Fracture: on the bank top (floodplain), a crack is visible so that a portion of the bank is susceptible to falling into the stream/river

Slump or false bank: a portion of the streambank has collapsed into the stream channel

Slough: typically from steep and bare slope so that soil material has accumulated at the base of the bank

Downcutting: also described as an incising, where the streambed is being eroded

Lateral erosion: a more generic term to describe streambank erosion, often used in conjunction with outside bends in streams and rivers

Breakdown: obvious blocks of bank broken away and lying adjacent to the bank breakage

Vertical and eroding: the bank is mostly uncovered and the bank angle is steeper than 80 degrees from the horizontal

Head cut/nickpoint: a point in a channel where there is an abrupt erosional drop in the substrate, usually incising and migrating up the channel

Resources

Burton, T.A., S.J. Smith, and E.R. Cowley. 2011. *Riparian Area Management: Multiple Indicator Monitoring (MIM) of Stream Channels and Streamside Vegetation.* Denver, CO: US Department of the Interior, Bureau of Land Management, National Operations Center. Technical Reference 1737-23. BLM/OC/ST-10/003+1737.

Overton, C.K, J.D. McIntyre, R. Armstrong, S.L. Whitwell, and K.A. Duncan. 1995. *User's Guide to Fish Habitat: Descriptions that Represent Natural Conditions in the Salmon River Basin, Idaho*. Ogden, UT: US Department of Agriculture, Forest Service, Intermountain Research Station. Gen. Tech. Rep. INT-GTR-322.E

Appendix D. Sample Streambank Erosion Inventory Spreadsheets

The Streambank Erosion Inventory Spreadsheet can be found in TRIM (2013AKL23). Examples of the associated worksheets are included here for reference:

- SEI Calculation Worksheet
- Field Data Entry Worksheet

SEI Calculation Worksheet

STREAMBANK EROSION INVENTORY CALCULATION WORKSHEET

Stream:		**Stream Segment Location (DD)**	
Assessment Unit:		***Upstream N***	
Segment Inventoried:		***W***	
Total Reach:		***Downstream N***	
Date Collected:		***W***	
Field Crew:		**Notes:**	
Data Reduced By:			

Current Load Streambank Erosion Calculations		Unit	Area Applied
Right, left or both bank measurements	2	Both Banks	Inventoried Segment
Inventory/Thalweg Length (LBB) (stream flow path distance)	3960.00	ft	Inventoried Segment
TMDL Margin of Safety	10	%	Total Reach
Bulk Density (BD)	85	lb/ft^3	Total Reach
Length of Similar Stream	15840	ft	Total Reach
Estimated Distance inventoried	7920.00	ft	"
Total Erosive Bank Length	1320.00	ft	"
Percent Erosive Bank	16.7	%	"
Eroding Area (AE)	1320.00	ft^2	"
Lateral Recession Rate (RLR)	0.27		"
Bank Erosion (E)	15.15	tons/year	"
Total Bank Erosion Rate (ER)	20.20	tons/mile/year	Reach and Segment
Total Bank Erosion	60.59	tons/year	"

Recession Rate Calculations		
Factor	**Field Stability Score**	**Erosion Severity Reduction**
Bank Erosion Evidence (0 to 3)	2	1.5
Bank Stability Condition (0 to 3)	2	1.5
Bank Cover/Vegetation(0 to 3)	2	1.5
Lateral Channel Stability (0 to 3)	2	1.5
Channel Bottom Stability (0 to 2)	1	1
In-Channel Deposition (-1 to 1)	1	1
Total = Slight (0-4); Moderate (4-8); Severe (>8)	10	8
Lateral Recession Rate (RLR) (ft/yr)	**0.27**	**0.15**

Load Capacity Streambank Erosion Calculations for Total Reach		Unit	Area Applied
Eroding Area at Load Capacity (AE)	1584.00	ft^2	Inventoried Segment
Bank Erosion at Load Capacity (E)	10.10	tons/year	"
Total Bank Erosion Rate at Load Capacity (ER)	13.46	tons/mile/year	Reach and Segment
Total Bank Erosion at Load Capacity for Reach	40.39	tons/year	Total Reach

Summary of Loads					
Current Load		**Load Capacity**			
Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Total Bank Erosion Rate (tons/mile/yr)	Total Bank Erosion (tons/yr)	Load Reduction Required?	Margin of Safety (tons/yr)
20.2	**60.6**	**13.5**	**40.4**	**YES**	**6**

Percent Erosion Reduction (%)	**39**
Total Erosion Reduction (tons/yr)	**26**

Field Data Entry Worksheet

Stream Name:		
Segment:		
Bank:		
Date:		
Erosive Bank Height (ft)	Erosive Bank Length A (ft)	Erosive Bank Area A (ft^2)
		0
		0
		0
		0
5	20	100
10	20	200
5	20	100
10	20	200
5	20	100
10	10	100
2	10	20
1	10	10
1	10	10
1	10	10
1	10	10
1	20	20
1	20	20
		0
		0
		0

Appendix E. Managing Stormwater

Municipal Separate Storm Sewer Systems

Polluted stormwater runoff is commonly transported through municipal separate storm sewer systems (MS4s), from which it is often discharged untreated into local water bodies. An MS4, according to 40 CFR 122.26(b)(8), is a conveyance or system of conveyances that meets the following criteria:

- Owned by a state, city, town, village, or other public entity that discharges to waters of the US
- Designed or used to collect or convey stormwater (including storm drains, pipes, ditches, etc.)
- Not a combined sewer
- Not part of a publicly owned treatment works (sewage treatment plant)

To prevent harmful pollutants from being washed or dumped into an MS4, operators must obtain a National Pollutant Discharge Elimination System (NPDES) permit from the US Environmental Protection Agency (EPA), implement a comprehensive municipal stormwater management program (SWMP), and use best management practices (BMPs) to control pollutants in stormwater discharges to the maximum extent practicable.

Industrial Stormwater Requirements

Stormwater runoff picks up industrial pollutants and typically discharges them into nearby water bodies directly or indirectly via storm sewer systems. When facility practices allow exposure of industrial materials to stormwater, runoff from industrial areas can contain toxic pollutants (e.g., heavy metals and organic chemicals) and other pollutants such as trash, debris, and oil and grease. This increased flow and pollutant load can impair water bodies, degrade biological habitats, pollute drinking water sources, and cause flooding and hydrologic changes, such as channel erosion, to the receiving water body.

Multi-Sector General Permit and Stormwater Pollution Prevention Plans

In Idaho, if an industrial facility discharges industrial stormwater into waters of the US, the facility must be permitted under EPA's most recent Multi-Sector General Permit (MSGP). To obtain an MSGP, the facility must prepare a stormwater pollution prevention plan (SWPPP) before submitting a notice of intent for permit coverage. The SWPPP must document the site description, design, and installation of control measures; describe monitoring procedures; and summarize potential pollutant sources. A copy of the SWPPP must be kept on site in a format that is accessible to workers and inspectors and be updated to reflect changes in site conditions, personnel, and stormwater infrastructure.

Industrial Facilities Discharging to Impaired Water Bodies

Any facility that discharges to an impaired water body must monitor all pollutants for which the water body is impaired and for which a standard analytical method exists (40 CFR 136).

Also, because different industrial activities have sector-specific types of material that may be exposed to stormwater, EPA grouped the different regulated industries into 29 sectors, based on their typical activities. Part 8 of EPA's MSGP details the stormwater management practices and monitoring that are required for the different industrial sectors. DEQ anticipates including specific requirements for impaired waters as a condition of the 401 certification. The MSGP will detail the specific monitoring requirements.

TMDL Industrial Stormwater Requirements

When a stream is on Idaho's §303(d) list and has a TMDL developed, DEQ may incorporate a wasteload allocation for industrial stormwater activities under the MSGP. However, most load analyses developed in the past have not identified sector-specific numeric wasteload allocations for industrial stormwater activities. Industrial stormwater activities are considered in compliance with provisions of the TMDL if operators obtain an MSGP under the NPDES program and implement the appropriate BMPs. Typically, operators must also follow specific requirements to be consistent with any local pollutant allocations. The next MSGP will have specific monitoring requirements that must be followed.

Construction Stormwater

The CWA requires operators of construction sites to obtain permit coverage to discharge stormwater to a water body or municipal storm sewer. In Idaho, EPA has issued a general permit for stormwater discharges from construction sites.

Construction General Permit (CGP) and Stormwater Pollution Prevention Plans

If a construction project disturbs more than 1 acre of land (or is part of a larger common development that will disturb more than 1 acre), the operator is required to apply for a CGP from EPA after developing a site-specific SWPPP. The SWPPP must provide for the erosion, sediment, and pollution controls they intend to use; inspection of the controls periodically; and maintenance of BMPs throughout the life of the project. Operators are required to keep a current copy of their SWPPP on site or at an easily accessible location.

TMDL Construction Stormwater Requirements

When a stream is on Idaho's §303(d) list and has a TMDL developed, DEQ may incorporate a gross wasteload allocation for anticipated construction stormwater activities. Most loads developed in the past did not have a numeric wasteload allocation for construction stormwater activities. Construction stormwater activities are considered in compliance with provisions of the TMDL if operators obtain a CGP under the NPDES program and implement the appropriate BMPs. Typically, operators must also follow specific requirements to be consistent with any local pollutant allocations. The CGP has monitoring requirements that must be followed.

Postconstruction Stormwater Management

Many communities throughout Idaho are currently developing rules for postconstruction stormwater management. Sediment is usually the main pollutant of concern in construction site stormwater. DEQ's *Catalog of Stormwater Best Management Practices for Idaho Cities and Counties* (DEQ 2005b) should be used to select the proper suite of BMPs for the specific site,

soils, climate, and project phasing in order to sufficiently meet the standards and requirements of the CGP to protect water quality. Where local ordinances have more stringent and site-specific standards, those are applicable.

Appendix F. Pollutant Trading

Pollutant trading (also known as water quality trading) is a contractual agreement to exchange pollution reductions between two parties. Pollutant trading is a business-like way of helping to solve water quality problems by focusing on cost-effective, local solutions to problems caused by pollutant discharges to surface waters. Pollutant trading is one of the tools available to meet reductions called for in a TMDL where point and nonpoint sources both exist in a watershed.

The appeal of trading emerges when pollutant sources face substantially different pollutant reduction costs. Typically, a party facing relatively high pollutant reduction costs compensates another party to achieve an equivalent, though less costly, pollutant reduction.

Pollutant trading is voluntary. Parties trade only if both are better off because of the trade, and trading allows parties to decide how to best reduce pollutant loadings within the limits of certain requirements.

Pollutant trading is recognized in IDAPA 58.01.02.055.06. DEQ allows for pollutant trading as a means to meet TMDLs, thus restoring water quality limited water bodies to compliance with water quality standards. DEQ's *Water Quality Pollutant Trading Guidance* establishes the procedures for pollutant trading (DEQ 2016b).

Trading Components

The major components of pollutant trading are trading parties (buyers and sellers) and credits (the commodity being bought and sold). Ratios are used to ensure environmental equivalency of trades on water bodies covered by a TMDL. All trading activity must be recorded in the trading database by DEQ or its designated party.

Both point and nonpoint sources may create marketable credits, which are a reduction of a pollutant beyond a level set by a TMDL:

- Point sources create credits by reducing pollutant discharges below NPDES effluent limits set initially by the wasteload allocation.
- Nonpoint sources create credits by implementing approved BMPs that reduce the amount of pollutant runoff. Nonpoint sources must follow specific design, maintenance, and monitoring requirements for that BMP; apply discounts to credits generated, if required; and provide a water quality contribution to ensure a net environmental benefit. The water quality contribution also ensures the reduction (the marketable credit) is surplus to the reductions the TMDL assumes the nonpoint source is achieving to meet the water quality goals of the TMDL.

Watershed-Specific Environmental Protection

Trades must be implemented so that the overall water quality of the water bodies covered by the TMDL is protected. To do this, hydrologically based ratios are developed to ensure trades between sources distributed throughout TMDL water bodies result in environmentally

equivalent or better outcomes at the point of environmental concern. Moreover, localized adverse impacts to water quality are not allowed.

Trading Framework

For pollutant trading to be authorized, it must be specifically mentioned within a TMDL document. After adoption of an EPA-approved TMDL, DEQ, in concert with the WAG, must develop a pollutant trading framework document. The framework would mesh with the implementation plan for the watershed that is the subject of the TMDL. The elements of a trading document are described in DEQ's pollutant trading guidance (DEQ 2016b).

Appendix G. Public Participation and Public Comments

This TMDL was developed with participation from the Clark Soil Conservation District, who act as the watershed advisory group (WAG) for the Beaver-Camas watershed. The WAG was presented with the pre-public comment draft on March 5, 2020. Additionally, the Upper Snake Basin Advisory Group supported the start of public comment on April 5, 2021. There were no public comments submitted during the comment period.

Clark County Soil Conservation District Board Members/Watershed Advisory Group

Andy Wagoner (Chairman)

David Ward (Vice-Chairman)

Richard Savage (Treasurer)

Norman Tavenner (Supervisor)

Russ Stoddard (Supervisor)

Robbie Taylor (District Manager)

Upper Snake Basin Advisory Group

Matt Woodard (Environmental)

Brian Olmstead (Agricultural)

Richard Savage (Livestock)

Greg Shenton (Local Government)

Carlyle Miller (Mining)

Roger Blew (Representative at Large)

Hunter Osborne (Shoshone-Bannock Tribes)

Steve Lundberg (Non-Municipal Permittee)

Justin Hayes (Recreation)

Ralph Myers (Hydropower)

Laurie Stone (Forestry)

Appendix H. Distribution List

[To be inserted following public comment period.]

Appendix I. Biotic Integrity

Using stream macroinvertebrate data to assess biotic integrity of impaired streams in the Beaver-Camas subbasin

Introduction

In the 2018/2020 Integrated Report, DEQ listed 11 impaired assessment units (AUs) within the Beaver-Camas HUC as Category 5 with combined biota/habitat bioassessments as a cause of impairment (Table I-1). These waters require specific causes of impairment to be identified, in order for an EPA-approved TMDL to be conducted. Many of these AUs have been monitored several times as part of the Beneficial Use Reconnaissance Program (BURP) and the data collected include several macroinvertebrate and habitat that may provide insight into likely causes of impairment in these AUs.

There were two primary objectives of reviewing these biological and habitat metrics: (1) to assess streamflow duration; and (2) to determine if temperature or sedimentation are likely sources of impairment.

Methods

Streamflow permanence

The streamflow duration of each AU was assessed following the rapid assessment method outlined in Nadeau (2015). This method uses three macroinvertebrate indicators to distinguish between perennial and intermittent streams: (1) presence of macroinvertebrates, (2) presence of six or more Ephemeroptera (mayfly) individuals, and (3) presence of perennial indicator taxa (Table I-4).

Assessing potential impairment causes

The primary macroinvertebrate metric used to assess impairment due to sedimentation was the fine sediment biotic index (Relyea et al. 2012). To calculate the fine sediment biotic index (FSBI), sensitive macroinvertebrate taxa are assigned a sensitivity score and all taxa scores are summed for a given sample. This index provides diagnostic evidence for the existence of potential sedimentation impairment. In addition, habitat metrics from BURP monitoring data were also used in this review; including modified Wolman pebble counts (which provide an estimate of percent fine sediment and the number of Wolman size classifications) and stream bank stability/bank coverage.

Temperature impairment was assessed primarily by evaluating the abundances of cold-water indicator macroinvertebrate taxa from the most recent BURP monitoring sites. The taxa lists used for this review were derived from a review of published literature (Lester and Robinson 2000, summarized in Table I-5) and from an empirical study that analyzed the relationship between macroinvertebrate species occurrence and stream temperatures using BURP data (Richards et al. 2013, summarized in Table I-6).

ID17040214SK006_03: Ching Creek

Streamflow permanence

The macroinvertebrate sample collected in 2013 (2013SIDFA003) contained many mayfly individuals from several species (e.g., *Baetis alius*, *Drunella coloradensis, Epeorus longimanus,* etc.) and numerous perennial-associated taxa (i.e. *Arctopsyche, Glossosoma, Hesperoperla pacifica*). This AU is perennial.

Cause of impairment

All macroinvertebrate index scores calculated for this AU since 1996 have been passing, which indicates that the macroinvertebrate assemblage is not impaired (Table I-2). There were several individuals of sediment-intolerant taxa from the most recent sample collected in 2013 (e.g., *Arctopsyche grandis, Brachycentrus americanus,* Drunella coloradensis/flavilinea) which resulted in a high sediment tolerance score for the site (Table I-3). The stream substrate data paint a more complicated picture; the substrate size was fairly heterogeneous while the percent fine sediment estimated in the wetted width was moderately high (FS=28.4%, Table I-3). Although the overall habitat index score was reduced by the high estimated percent fines (Table I-3), the score was also reduced by several other poor habitat metrics from the 2013 data. For instance, several riparian metrics that play an important role in regulating stream temperatures were poor (canopy, zone of influence, disruptive pressures; see Figure I-1). In addition, there were surprisingly few cold-water associated taxa in the otherwise healthy macroinvertebrate assemblage sampled in 2013. Only four taxa from the empirically-derived list and a single taxon (*Doroneuria*) from the literature-derived cold-water associated list were present.

In 2019, most habitat metrics were similar or better than those in 2013 (Figure I-1). This resulted in a passing habitat index score and an overall passing score for the site (see 2019SIDFA036, Table I-2). Similar to the 2013 sample, there were several sediment-intolerant taxa, which resulted in a high FSBI score (Table I-3). There was also a low abundance of cold-water taxa; only a few individuals from either cold-water list were present. Given the robust community of sediment-intolerant macroinvertebrate taxa and adequate substrate metrics, it does not seem likely that sedimentation is the main driver of impairment in this AU. Overall, the poor biological metrics in this reach are primarily driven down by two non-macroinvertebrate factors: degraded riparian habitat (see riparian associated metrics Figure I-1) and an oversimplified fish community overrun by non-native brook trout (i.e. low SFI score; Table I-2). Poor riparian habitat condition (e.g., poor canopy shading) may relate to the regulation of stream temperatures, so it is possible that temperature may play a role in the impairment of this AU. However, given the robust community of aquatic macroinvertebrates and presence of cold-water salmonids (i.e. Brook Trout), the magnitude of this impairment appears to be low.

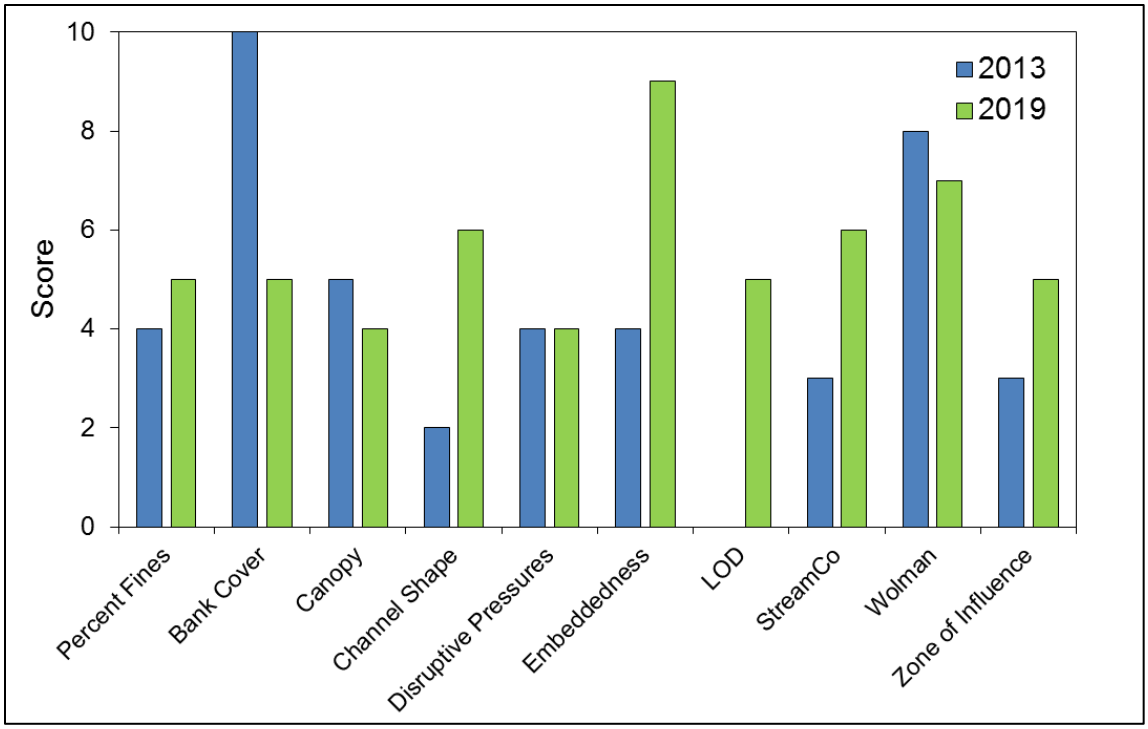


Figure I-1. Habitat metric scores used in habitat index calculation for Ching Creek (ID17040214SK006_03) from 2013 (blue bars) and 2019 (green bars). Individual habitat metric scores have values ranging from 1-10 and higher scores are associated with less degraded habitat conditions.

ID17040214SK008_02: Crooked/Crab Creek

Streamflow permanence

This AU has been visited several times but stream conditions (dry stream and/or marshy habitat) have prevented monitoring at all visits except for a successful sampling event in 1998 (1998SIDFA032, Table I-2). The presence of numerous ephemeropteran individuals (e.g., *Acentrella insignificans, Cinygmula sp., Epeorus longimanus,* etc.) and a single perennially-associated taxon (*Rhyacophila angelita gr.*) in the 1998 macroinvertebrate sample provides some evidence that streamflow may have been more permanent in the late 1990's. However, several subsequent monitoring attempts in nearby reaches have clearly determined that this AU is intermittent.

Cause of impairment

The macroinvertebrate index score for 1998 was very low (Table I-2). There was only a single literature-derived cold-water taxon were present (i.e. *Prosimulium sp.)* and two from the empirically-derived list were in the 1998 sample. Similarly, few sediment-intolerant taxa were collected and all but one species (i.e., *Epeorus longimanus*) have merely weak sediment sensitivities. As a result, the fine sediment index score was very low (FSBI=35, Table I-3). In fact, a majority of the substrate in the wetted width was in the silt/sand category (FS=70.34%, Table I-3). Most of the in-channel habitat was classified as either run or glide and several taxa

collected are associated with slower moving water or lentic habitats (i.e., *Hyalella azteca*, *Helobdella stagnalis*, and Dytiscidae). It therefore seems that using BURP multimetric biological indices to assess beneficial use may not be appropriate, given the marshy, intermittent streamflow status that has been repeatedly documented by several monitoring attempts.

ID17040214SK008_03: Crooked/Crab Creek

Streamflow permanence

There have been three monitoring attempts in this AU, but dry stream conditions have prevented monitoring for all visits except for a successful sampling event in 1998 (1998SIDFA033, Table I-2). The macroinvertebrate sample from BURP site 1998SIDFA033 is very similar in composition to the sample collected at 1998SIDFA032, in the 02 AU of this stream. Much like the 02 AU, there were numerous ephemeropteran individuals (e.g., *Acentrella insignificans, Cinygmula sp., Centroptilum sp.,* etc.) and a single perennially-associated taxon (*Rhyacophila angelita gr.*), providing some evidence for a perennial condition of streamflow. Again, much like the 02 AU of this stream, subsequent monitoring attempts have clearly determined that this AU is intermittent.

Cause of impairment

The macroinvertebrate index score from 1998 was low (SMI=47, SMI score=1, Table I-2). No literature-derived cold-water taxa were present and only two from the empirically-derived list were present. Similarly, few sediment-sensitive taxa were collected and the fine sediment index score was low (FSBI=35, Table I-3). This is unsurprising, given the high percentage of fine sediment in the wetted width (FS=46.5%, Table I-3). If there are still reaches of this AU that are perennial, the primary driver of impairment is unclear, given the low species diversity and overall lack of sensitive macroinvertebrate taxa. It is also likely that the intermittent nature of this AU makes proper bioassessment impossible, at least when using current DEQ multimetric biological indices.

ID17040214SK009_02: Warm Creek

Streamflow permanence

This AU consists of Saw Creek and an unnamed stream, both tributaries of East Camas Creek. Saw Creek has been sampled twice (1998SIDFA036 and 2012SIDFA009, Table I-2) and most the recent macroinvertebrate sample contained very few mayfly individuals (<10 in total) from five different taxa as well as a single perennial associated taxon (i.e., *Rhyacophila angelita*). Although genera of the free-living family of caddisflies (Rhyacophilidae) are typically associated with perennial streamflow, *Rhyacophila angelita* has been collected in several AUs in this HUC known to be intermittent (see ID17040214SK008_02, ID17040214SK008_03). In addition, monitoring was prevented in 2004, because the stream was dry. Altogether, these data provide weak evidence of stream permanence and it therefore seems that many reaches of this AU are intermittent.

Cause of impairment

The macroinvertebrate index scores were very low from the only samples collected in this AU (Table I-2). The most recent sample from 2012 contained a lone cold-water taxon from the literature-derived list (i.e., Capniidae) and only three taxa from the empirically derived cold water taxa list (i.e. *Cinygmula sp., Enchytraeidae, Polycelis sp.*). Strikingly, there was only a single sediment-sensitive taxa present (*Cinygmula sp.*) and this genus is very common in the region and only slightly sensitive to fine sediment. The lack of sampled sensitive taxa is reflected in the very low fine sediment index score (FSBI=15, Table I-3). However, substrate metrics did not capture any significant evidence of sedimentation impairment; the percent of fine sediment was low (FS=14.3%) and there were a moderate number of wolman size classes (Table I-3). However, ~20% of the surveyed banks appeared to be unstable in 2012 (Table I-3).

The intermittent nature of this AU seems to be the most likely explanation of the poor state of the macroinvertebrate community (i.e., lack of sensitive species and/or long-lived perennial-associated taxa). Otherwise, sedimentation seems to be another likely potential cause of impairment, given the lack of sediment-intolerant taxa. Additional monitoring data would help determine the cause of impairment for this AU.

ID17040214SK013_02 West Camas Creek –source to Targhee National Forest Boundary

Streamflow permanence

This AU is listed as Category 5 for sedimentation and has an approved TMDL for temperature. The AU is made up of numerous tributaries of West Camas Creek, many of which have been monitored several times. The most recent monitoring event was in 2018 (2018SIDFA004) in Alex Draw, an upper tributary that has had flowing water during the only two sampling events. The 2018 sample contained few mayfly individuals from five different taxonomic groups (e.g., *Baetis tricaudatus*, *Cinygmula, Leptophlebiidae,* etc.) as well as two perennial-associated taxa (i.e. *Hesperoperla pacifica and Rhyacophila*) in low abundance; this suggests that the AU is perennial. However, several tributaries in this AU have been documented to be periodically dry. In fact, one tributary that was dry in 2003 (Pete Creek, 2003SIDFA079) was sampled successfully in 2008 (2008SIDFA171) and the macroinvertebrate assemblage sampled that year included taxa that would suggest perennial status. Based on these macroinvertebrate data, it seems that many reaches of this AU undergo an intermittent cycle that allows for the establishment of perennial-associated taxa.

Cause of impairment

Many of the macroinvertebrate index scores from BURP monitoring in this AU have not been passing, including the most recent site in 2018 (2018SIDFA004, Table I-2). The 2018 macroinvertebrate sample contained few cold water associated taxa; only four taxa from the empirically-derived list and a single literature-derived cold water taxon (*Prosimulium sp*). Similarly, there were only two strongly sediment-intolerant taxa (*Drunella coloradensis/flavilinea* and *Hesperoperla pacifica*) in the 2018 sample as well as several

individuals of *Ephemerella tibialis,* a taxon that is only *slightly* sensitive to fine sediment. This low abundance of sediment-intolerant taxa explains the low fine sediment index score for the site (FSBI=45). The habitat metrics for fine sediment and substrate heterogeneity do not suggest major impairment (FS=10.5%, #wolman=9, Table I-3) while metrics such has embeddedness, canopy cover, LOD, and zone of influence all drove down the overall habitat score.

A similar reach in Alex Draw was monitored in 2002 (2002SIDFA004) and the macroinvertebrate index score from that sample was passing (Table I-2). The 2002 sample contained more individuals from a greater number of sediment-intolerant taxa, which resulted in a much higher fine sediment index score for the site (FSBI=75). The percent of fine sediment in the wetted width of Alex Draw was estimated to be much higher in 2002 (%FS=26.2) while number of substrate size classes was similar (Table I-3). The poor habitat score of 2002 was primarily driven by percent fine sediment, low canopy (score=2), and lack of large woody debris (LOD score=0). The number of cold water associated taxa was nearly identical between the two sampling events; only one more empirically derived cold-water taxon was found in 2002.

Given the apparent decline of sediment-sensitive taxa observed in this AU, it seems probable that sedimentation plays a role in the impairment of this AU. In addition, this AU is still likely temperature impaired, given the low abundance of cold-water associated taxa in both recent and historical macroinvertebrate samples.

ID17040214SK016_02: Rattlesnake Creek – source to mouth

Streamflow permanence

The 16_02 AU is made up of numerous tributaries of the 16_03 Rattlesnake Creek AU. The most recent sampling event took place in 2018 (2018SIDFA011, Table I-2); this macroinvertebrate sample contained many mayfly individuals from several genera (e.g., *Baetis tricaudatus*, *Cinygmula, Drunella doddsii,* etc.) as well as two perennial-associated taxa (i.e. *Doroneuria* and *Rhyacophila*). In addition, this AU has also received high fish scores from nearly all monitoring events. Although these data suggest this AU is perennial, a previous monitoring attempt in 2003 noted this reach was dry (2003SIFA094). Therefore, like other 02 AUs, certain reaches of this AU may be periodically intermittent and on a schedule that allows for the establishment of perennial-associated taxa.

Cause of impairment

The macroinvertebrate community sampled in 2018 was not impaired (SMI=57, SMI rating=2, Table I-2); there was a single literature derived cold-water taxa (i.e., *Doroneuria*) as well as five taxa from the empirically derived list. There were three very sediment-sensitive taxa, two slightly sensitive taxa, and the resulting sediment index score was relatively high (FSBI=75). Habitat metrics also suggest favorable sediment conditions; there were many substrate sizes, fine sediment was very low (FS=5%), and all survey banks appeared to be stable (Table I-3). If this reach is representative of the AU, then the monitoring data from 2018 would suggest that this AU is no longer impaired.

The most recent monitoring data that shows impairment of the macroinvertebrate community was in 2008 (2008SIDFA168), in spring creek. The 2008 sample lacked taxa from the literature-derived list and contained a single empirically-derived cold-water taxon: *Polycelis*. These are very common flatworms in this region of Idaho and may not be the strongest indicator of cold-water status. Similarly, there were only two individuals of sediment-intolerant taxa. Similar to the 2018 monitoring data, the substrate metrics from 2008 did not reveal clear evidence of sedimentation impairment; the fine sediment was low (%FS=11.4), there were relatively diverse substrate sizes (wolman score=7), and the surveyed banks were stable (Table I-3). The habitat metrics that may explain macroinvertebrate impairment include lack of canopy cover (canopy cover score=0), lack of channel complexity (channel shape score=1), lack of large woody debris (LOD score=0), and low riparian metrics (disruptive pressures score=3, zone of influence=3). These data suggest impairment in 2008 was likely driven by degraded or scarce riparian habitat. Based on these data, it seems most likely that this AU is impaired by temperature, which is influenced, in part, by the available shading provided by riparian vegetation. The seemingly improved macroinvertebrate and habitat index scores of 2018 may simply be an artifact of monitoring site location; the upper reaches of this AU likely have more complex riparian habitat than the shrub-dominated lowlands, which are also more likely to be impacted by cattle grazing. This should be considered when determining future monitoring sites or assessment outcomes.

ID17040214SK016_03: Rattlesnake Creek

Streamflow permanence

This AU has not been sampled since 1998 (1998SIDFA012, Table I-2)—subsequent monitoring events were unsuccessful because the stream was dry (see 2003SIDFA092) or because of access issues (see 2018SIDFA008). Although there were several mayfly individuals from multiple genera (*Acentrella insignificans, Epeorus longimanus, Cinygmula*, etc.), the sample did not contain any perennial stream associated taxa. The taxonomic diversity and richness were extremely low; for instance, black fly larvae (*Simulium*) accounted approximately 70% of the total individual abundance. Based on the taxonomic assemblage sampled in 1998, this AU is very likely to be intermittent or ephemeral. This intermittent status is likely the cause of beneficial use impairment; using BURP multimetric biological indices to assess beneficial uses may not be appropriate in this AU.

ID17040214SK017_02: Threemile Creek

Streamflow permanence

This AU is listed as Category 5 for Combined Biota/Habitat Bioassessments and has an approved TMDL for temperature. The most recent monitoring data for this AU was collected in 2018 at BURP site 2018SIDFA015 (Table I-2). This sample contained many mayfly individuals from several taxa (e.g., *Baetis tricaudatus*, *Cinygmula, Epeorus longimanus,* etc.) and three perennial-associated taxonomic groups (i.e. *Hesperoperla pacifica,* Glossosomatidae*, and Rhyacophila*) and all monitoring sites in the East Threemile Creek, including site 2018SIDFA015, have had flowing water. These data suggest this reach in AU is perennial. Other reaches in this AU,

however, have been documented to be periodically dry (see BURP sites 2003SIDFA088 and 2003SIDFA091).

Cause of impairment

The overall index score from BURP site 2018SIDFA015 was passing but the macroinvertebrate index indicated the macroinvertebrate community was impaired (Table I-2). The sediment index score was surprisingly high for this site (FSBI=75), given the overall low macroinvertebrate score; indeed, several sediment-intolerant taxa were collected (i.e., *Epeorus longimanus, Drunella coloradensis/flavilinea*). Substrate metrics from 2018 were also favorable; fine sediment was low (%FS=9), substrate size diversity was adequate, and 100% of the banks in the survey reach appeared to be stable (Table I-3). Conversely, there were no taxa from the literature-derived cold-water list and three from the empirically-derived list. This is fewer than the abundances of cold-water associated taxa collected in a similar reach in 1998 (see 1998SIDFA007). Given the existing community of sediment-intolerant taxa and the evidence of an apparent decline of cold-water associated taxa over time, it seems that this AU is primarily impaired by temperature.

ID17040214SK018_02: Beaver Creek—Miners Creek to Rattlesnake Creek

Streamflow permanence

This AU is made up of several tributaries of Beaver Creek from Miners Creek to Rattlesnake Creek and is listed as Category 5 for Combined Biota/Habitat Bioassessments and has an approved TMDL for temperature. Failed monitoring attempts in four different reaches were due to dry stream conditions—but these all occurred in the same year: 2003. This AU was sampled twice in 2018 (see 2018SIDFA013, 2018SIDFA014, Table I-2). The 2018SIDFA013 macroinvertebrate sample contained several mayfly individuals but there was only a single perennial indicator taxon. The 2018SIDFA014 similarly contained many mayfly individuals from several species and a greater number of perennial associated taxa. Based on the macroinvertebrate data, the larger tributaries (i.e., Stoddard Creek and Dairy Creek) seem to generally possess yearlong flows but many of the smaller tributaries are likely periodically intermittent.

Cause of impairment

The macroinvertebrate metrics from 2018SIDFA013 were marginally superior to the 2018SIDFA014 sample, but it was enough to surpass the conditional rating threshold that defines *passing* index scores (Table I-2). The 2018SIDFA014 sample contained few sediment-intolerant species and the corresponding fine sediment index score was very low (FSBI=20). The stream substrate metrics were a mixed-bag; the percent fines were not very high (%FS=14.2), substrate size classes were relatively complex (# wolman size classes = 7)—but only ~20% of surveyed banks in the reach appeared to be stable and only 74% of the banks had cover (Table I-3). There were also very few cold water-associated taxa; only two taxa, one from each cold-water list, were present in the 2018SIDFA014 sample. In comparison, the 2018SIDFA013 site in

Stoddard Creek had marginally more sediment-tolerant species (4 sediment intolerant taxa, FSBI=30) while having slightly higher fine sediment (%FS=16.5). The estimated bank stability was also poor but better than the 2018SIDFA014 reach (Table I-3). There was also a greater amount of cold-water associated taxa (4 different species altogether). These data suggest a moderate degree of impairment that may be due to elevated stream temperature, which has already been identified as a cause in this AU, as well as sedimentation.

ID17040214SK019_03: Miner's Creek

Streamflow permanence

This AU is listed as category 5 combined biota/habitat bioassessments in the 2018-2020 Integrated report draft. The most recent monitoring data for this AU was collected in 2017 (see 2017SIDFA002); although there were numerous mayfly individuals, there were no perennial-associated taxa present in the sample, which suggests that this AU is intermittent. Indeed, the stream was dry when monitoring was first attempted in this AU, as well as in 2017, when visited later in the season.

The macroinvertebrate index score was very low in 2017 (SMI=29, Table I-2) and both cold water associated and sediment-intolerant taxa were in low abundance in the macroinvertebrate sample. The fine sediment index score was particularly low (FSBI=10). Similarly, habitat metrics indicate degradation; fine sediment was high (%FS=31) and stream banks in the survey reach were poorly covered and unstable (Table I-2). In addition, the stream temperature was 21 C at the time of sampling, which is above DEQs allowable temperature for electrofishing.

The macroinvertebrate sample collected in 2012 (2012SIDFA006) had many more intolerant taxa and the macroinvertebrate index score was very high (SMI=64, SMI rating=3, Table I-2). There were numerous sediment-intolerant taxa, including some taxa that are extremely sensitive to fine sediment (i.e., *Megacys sp.*); the fine sediment index, as a result, was much higher in 2012 (FSBI=85) than 2017. Moreover, several species of cold-water associated taxa (from both empirically-derived and literature-derived cold water taxa lists) and perennial-associated taxa (i.e. *Hydropsyche sp*.) were present in the sample. Although the macroinvertebrate data from 2012 indicate the healthy macroinvertebrate assemblage, many of the habitat metrics tell a different story. Percent fines in the wetted width were extremely high (%FS=88.2), substrate complexity was low (#wolman=4) and bank coverage was even poor (Table I-3); indeed, the overall habitat index score was very low (SHI=3, SHI rating=1, Table I-3).

This may mean that conditions of impairment were emerging at the time of the 2012 sample, allowing for a lag effect in the macroinvertebrate community. If this is the case, given the poor sediment metrics and the low fine sediment score in 2017, it seems that this AU is likely impaired by sedimentation. However, the intermittent nature of this AU should also be considered when assessing beneficial use attainment; cold water aquatic life in Miner’s Creek may be more directly affected by the flow dynamics of this system than by specific pollutants/pollution.

ID17040214SK020_02: Beaver Creek

Streamflow permanence

This AU is composed of four tributaries of Beaver creek between Idaho Creek and Miners Creek. Sampling in the largest tributary, Sheep Creek, has been attempted four times in total, with a single successful sampling event in 1998 (1998SIDFA023, Table I-2). All other monitoring attempts were unsuccessful due to dry or marshy stream site conditions. The 1998 macroinvertebrate sample contained several mayfly individuals and a single perennial-associated taxon (i.e., *Rhyacophila* sp.), which provides some evidence that this AU was perennially watered, at least at the time of sampling. Given that all attempted sampling sites were dry or marshy since the 1998 sample, it is clear that this AU is currently intermittent.

The macroinvertebrate score from the 1998 data was very poor (SMI=35, SMI rating =1, Table I-2). The quantity of sediment-intolerant taxa (e.g., *Epeorus longimanus*) and a moderate fine sediment index (FSBI=45) are surprising given the overall macroinvertebrate index score, high percentage of fine sediment estimated in the wetted width (34.8%), and nearly all the surveyed banks appeared to be unstable (Table I-2). There were also few cold-water associated taxa; three from the empirical list and two from the literature-derived list. Given the poor sediment metrics and general degradation of the macroinvertebrate community, sedimentation would seem a likely cause of impairment. However, the intermittent nature of this AU is likely the most influential factor that controls the macroinvertebrate assemblage.

ID17040214SK023_02: Pleasant Valley

The 23_02 AU contains the main stem of Pleasant Valley Creek and several 1st order tributaries; reaches of this AU have been monitoring numerous times since the first sampling event in 1996. The most recent monitoring data was collected in 2019 (see BURP site 2019SIDFA006, Table I-2). All recent macroinvertebrate samples collected in the main stem of this AU contained several mayfly taxa as well as perennial-associated taxa (i.e., *Glossosoma sp.*). Several monitoring events in the smaller tributaries of this AU have been prevented due to dry conditions but the main stem of this AU is perennial.

Based on the WBAG-III index calculation methods, only three monitoring sites have yielded two passing macroinvertebrate index scores since 2001 (Table I-2). The score in 2019 was not passing and was driven down by low total taxa, the number of clinger taxa, %EP / EPT taxa, and few long-lived sensitive species. There were unexpectedly several sediment-sensitive taxa--given the otherwise degraded assemblage—which resulted in an adequate FSBI score (Table I-3). The last few FSBI scores from 2019 and 2013 actually seem to suggest improved sediment conditions (Table I-3). The sediment-related metrics show little / moderate potential for sedimentation issues; the percent of fine sediment in the wetted width was relatively low, the number of wolman size classes was within a normal range, and most of the surveyed banks were covered and stable (Table I-3). Habitat metrics were also relatively robust; the LOD score was the only metric that was poorly scored (Figure I-2).

These data suggest temperature is the more likely cause of impairment, but additional monitoring data is required in this AU to more clearly determine the identity of degradation.

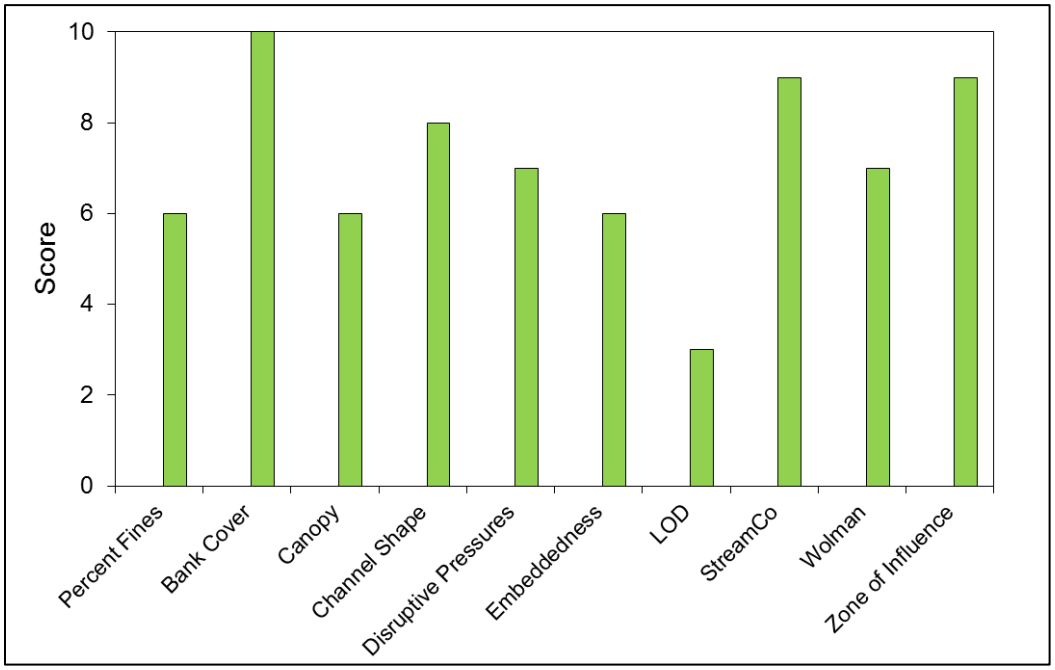


Figure I-2. Habitat metric scores used in habitat index calculation for Pleasant Valley Creek (ID17040214SK023_02) from 2019. Individual habitat metric scores have values ranging from 1-10; higher scores are associated with less degraded habitat conditions.

A note about WBAG III fish metrics

There are a total of fifty-six BURP sites in the Beaver-Camas subbasin that have associated fish data in the IDASA2 database at the time of writing. Of these, fifty percent have failing fish metric scores (Table I-7). This subbassin has several degraded AUs, but there is more than degradation that explains this trend. The current method to calculate fish multimetric indices uses two related metrics: the non-native percent of taxa score and the native taxa score. In this subbasin, the total number of taxa collected at a given site infrequently surpasses two species—which is not necessarily a sign of impairment. However, often the only species collected is non-native brook trout (*Salvelinus fontinalis*), a species commonly found throughout Idaho. For many sites, this fish community that is dominated by a non-native species is the primary factor that drives down the fish metric score. However, the current method to calculate fish index scores does not treat the presence of non-native fish consistently across all site types.

The metrics considered for each muiltimetric index is different based on the bioregion classification used in Jessup 2011: Mountains, Foothills, and Plains/Plateaus/Broad Valleys (PPBV). Segregating sites by region for analysis is a common practice and can help increase efficacy of predictive models. However, the Foothills bioregion index entirely omits the non-native and native taxa. Additionally, because this model considers brook trout to be benthic, lithophilic, and moderately tolerant (i.e., other metrics used in the Foothills MMI), the presence or complete dominance of brook trout in a fish sample actually improves the index score in the

Foothills site classes. There isn't a single failing fish index score for any Foothills site from this subbasin in the entire database (Table I-7). At the same time, the fish index calculations in Mountains and PPBV site classes are heavily weighted against presence of non-native fish, which for this region, means brook trout. In this way, the most important factor that determines whether or not a site will have a passing fish index score, at least in the Beaver-Camas subbasin, appears to be the presence/absence of brook trout.

There is a clear bias of the directional effect of this single species based on bioregion classification. For example, the fish sample from BURP site 2001SIDFA049 (ID17040214SK024_02) is in the Foothills bioregion contained a total of six brook trout; the resulting index score was 99 (the highest score is 100). Conversely, BURP site 2019SIDFA006 is located in Mountains ecoregion of the nearby ID17040214SK023_02 AU and the fish sample from this site contained 41 brook trout and 5 shorthead sculpin; the resulting fish index score was 57, which is failing.

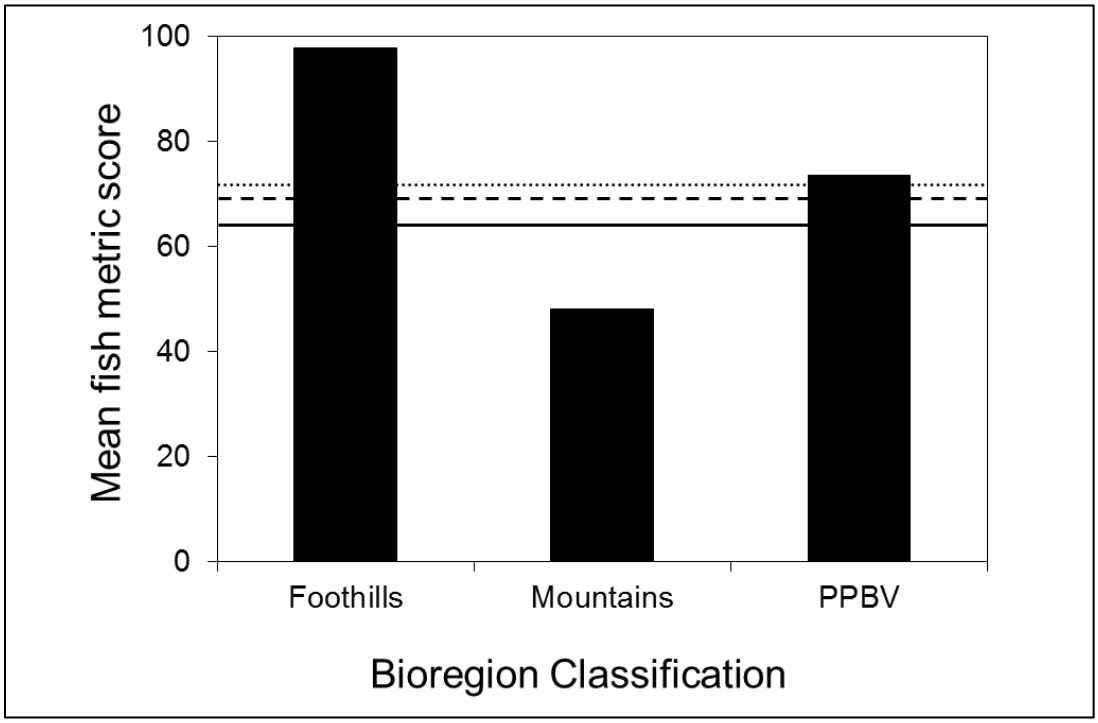


Figure I-3. Average fish metric scores of all BURP sites from the Beaver-Camas subbasin with fish data, separated by bioregion. Each line shows the conditional rating threshold value for a conditional rating of 1 (i.e., less than the 10th quantile of reference condition). Any value below each bioregional line receives a failing score. Dotted line=Mountains site class, dashed line=PPBV site class, and solid line=Foothills site class. Foothills n=20; Mountains n=26, and PPBV n=10.

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Table I-1. All Category 5 listed AUs in the Beaver-Camas subbasin from the 2018/2020 Integrated Report

AU ID	AU NAME	Size (miles)	Category	CAUSE
ID17040214SK006_03	Ching Creek - source to mouth	11.93	Category 5	COMBINED BIOTA/HABITAT BIOASSESSMENTS
ID17040214SK008_02	Crooked/Crab Creek - source to mouth	30.04	Category 5	COMBINED BIOTA/HABITAT BIOASSESSMENTS
ID17040214SK008_03	Crooked/Crab Creek - source to mouth	10.83	Category 5	COMBINED BIOTA/HABITAT BIOASSESSMENTS
ID17040214SK009_02	Warm Creek - Cottonwood Cr. to mouth and East Camas Creek	11.69	Category 5	COMBINED BIOTA/HABITAT BIOASSESSMENTS
ID17040214SK016_02	Rattlesnake Creek - source to mouth	56.84	Category 5	COMBINED BIOTA/HABITAT BIOASSESSMENTS
ID17040214SK016_03	Rattlesnake Creek - source to mouth	10.51	Category 5	COMBINED BIOTA/HABITAT BIOASSESSMENTS
ID17040214SK017_02	Threemile Creek - source to mouth	23.1	Category 5	COMBINED BIOTA/HABITAT BIOASSESSMENTS
ID17040214SK018_02	Beaver Creek - Miners Creek to Rattlesnake Creek	40.25	Category 5	COMBINED BIOTA/HABITAT BIOASSESSMENTS
ID17040214SK019_03	Miners Creek - source to mouth	0.97	Category 5	COMBINED BIOTA/HABITAT BIOASSESSMENTS
ID17040214SK020_02	Beaver Creek - Idaho Creek to Miners Creek	12.84	Category 5	COMBINED BIOTA/HABITAT BIOASSESSMENTS
ID17040214SK023_02	Pleasant Valley Creek - source to mouth	23.67	Category 5	COMBINED BIOTA/HABITAT BIOASSESSMENTS

Table I-2. BURP monitoring sites and associated index scores for sites in the Beaver-Camas HUC listed as Category 5. All scores were calculated following WBAG III. SMI=macroinvertebrate index, SFI= fish index, and SHI= habitat index. Bold/red values indicate failing scores and bold/green values are passing scores.

Assessment Unit	BURP ID	Site condition	SMI2 score	SMI2 rating	SFI2 score	SFI2 rating	SHI2 score	SFI2 rating	Average rating
ID17040214SK006_03	1998SIDFA034	Sampled	69	3	67	1	47	2	2.00
	2003SIDFA095	Sampled	78	3	70	2	54	2	2.33
	2013SIDFA003	Sampled	83	3	67	1	43	1	1.67
	2019SIDFA036	Sampled	76	3	67	1	56	2	2.00
ID17040214SK008_02	1998SIDFA032	Sampled	45	1	76	2	33	1	1.33
	2003SIDFA099	NO FLOW	-	-	-	-	-	-	-
	2015SDEQA234	Dry	-	-	-	-	-	-	-
	2018SIDFA009	Marshland	-	-	-	-	-	-	-
ID17040214SK008_03	1998SIDFA033	Sampled	47	1	74	2	39	1	1.33
	2003SIDFA100	DRY	-	-	-	-	-	-	-
	2018SIDFA010	Dry	-	-	-	-	-	-	-
ID17040214SK009_02	1998SIDFA036	Sampled	11	1	68	1	19	1	1.00
	2004SIDFA039	NO FLOW	-	-	-	-	-	-	-
	2012SIDFA009	Sampled	40	1	-	-	58	1	1.00
ID17040214SK013_02	2001SIDFA057	Sampled	40	1	-	-	61	1	1.00
	2002SIDFA001	DRY	-	-	-	-	-	-	-
	2002SIDFA002	DRY	-	-	-	-	-	-	-
	2002SIDFA003	Sampled	49	1	-	-	57	1	1.00
	2002SIDFA004	Sampled	60	2	49	1	57	1	1.33
	2002SIDFA007	NO FLOW	-	-	-	-	-	-	-
	2002SIDFA008	Sampled	40	1	-	-	61	1	1.00
	2002SIDFA025	Sampled	37	1	47	1	57	1	1.00
	2003SIDFA078	NO FLOW	-	-	-	-	-	-	-
	2003SIDFA079	NO FLOW	-	-	-	-	-	-	-
	2008SIDFA171	Sampled	48	1	-	-	68	2	1.50
	2018SIDFA004	Sampled	48	1	67	1	61	1	1.00
ID17040214SK016_02	1998SIDFA009	Sampled	41	1	-	-	18	1	1.00
	1998SIDFA010	Sampled	56	2	93	3	33	1	2.00
	1998SIDFA011	Sampled	73	3	-	-	68	2	2.50
	1998SIDFA014	Sampled	69	3	99	3	42	1	2.33
	1998SIDFA015	Sampled	70	3	93	2	83	3	2.67
	1998SIDFA016	Sampled	45	1	-	-	69	3	2.00
	1998SIDFA017	Sampled	29	1	-	-	49	1	1.00
	1998SIDFA018	Sampled	69	3	100	3	57	2	2.67
	1998SIDFA019	Sampled	72	3	100	3	33	1	2.33
	2003SIDFA090	NO DATA COLLECTED	-	-	-	-	-	-	-
	2003SIDFA093	NO FLOW	-	-	-	-	-	-	-
	2003SIDFA094	DRY	-	-	-	-	-	-	-
	2008SIDFA167	Sampled	54	2	99	3	68	2	2.33
	2008SIDFA168	Sampled	47	1	99	3	44	1	1.67
	2018SIDFA007	Inaccessible	-	-	-	-	-	-	-
	2018SIDFA011	Sampled	57	2	98	3	71	3	2.67
ID17040214SK016_03	1998SIDFA012	Sampled	54	2	-	-	45	2	2.00
	2003SIDFA092	DRY	-	-	-	-	-	-	-
	2018SIDFA008	Inaccessible	-	-	-	-	-	-	-

Assessment Unit	BURP ID	Site condition	SMI2 score	SMI2 rating	SFI2 score	SFI2 rating	SHI2 score	SFI2 rating	Average rating
ID17040214SK017_02	1998SIDFA005	Sampled	34	1	94	2	61	2	1.67
	1998SIDFA006	Sampled	64	3	94	2	79	3	2.67
	1998SIDFA007	Sampled	57	2	96	2	61	2	2.00
	1998SIDFA008	Sampled	60	2	92	2	66	2	2.00
	2003SIDFA088	NO FLOW	-	-	-	-	-	-	-
	2003SIDFA089	NO DATA COLLECTED	-	-	-	-	-	-	-
	2003SIDFA091	NO FLOW	-	-	-	-	-	-	-
	2018SIDFA015	Sampled	40	1	99	3	64	2	2.00
ID17040214SK018_02	1998SIDFA020	Sampled	54	2	98	3	67	2	2.33
	1998SIDFA021	Sampled	45	1	85	2	67	2	1.67
	1998SIDFA035	Sampled	15	1	-	-	43	1	1.00
	2003SIDFA071	NO FLOW	-	-	-	-	-	-	-
	2003SIDFA072	NO FLOW	-	-	-	-	-	-	-
	2003SIDFA073	DRY	-	-	-	-	-	-	-
	2003SIDFA074	NO FLOW	-	-	-	-	-	-	-
	2008SIDFA169	Sampled	52	1	98	3	28	1	1.67
	2008SIDFA170	Sampled	56	2	-	-	41	1	1.50
	2008SIDFA173	Sampled	59	2	-	-	44	1	1.50
	2018SIDFA012	Marshland	-	-	-	-	-	-	-
	2018SIDFA013	Sampled	55	2	-	-	43	1	1.50
	2018SIDFA014	Sampled	52	1	98	3	53	2	2.00
ID17040214SK019_03	2003SIDFA075	DRY	-	-	-	-	-	-	-
	2012SIDFA006	Sampled	64	3	-	-	33	1	2.00
	2017SIDFA002	Sampled	29	1	-	-	46	1	1.00
ID17040214SK020_02	1998SIDFA023	Sampled	35	1	-	-	35	1	1.00
	2003SIDFA077	NO FLOW	-	-	-	-	-	-	-
	2013SIDFA006	Dry	-	-	-	-	-	-	-
	2018SIDFA006	Marshland	-	-	-	-	-	-	-
ID17040214SK023_02	2001SIDFA048	Sampled	62	3	-	-	38	1	2.00
	2002SIDFA017	Sampled	42	1	-	-	62	1	1.00
	2002SIDFA018	Sampled	51	1	-	-	54	1	1.00
	2002SIDFA019	Sampled	51	1	-	-	61	1	1.00
	2002SIDFA020	Sampled	49	1	61	1	54	1	1.00
	2003SIDFA065	NO FLOW	-	-	-	-	-	-	-
	2003SIDFA066	NO FLOW	-	-	-	-	-	-	-
	2003SIDFA067	NO DATA COLLECTED	-	-	-	-	-	-	-
	2003SIDFA068	NO FLOW	-	-	-	-	-	-	-
	2003SIDFA069	NO FLOW	-	-	-	-	-	-	-
	2003SIDFA070	NO FLOW	-	-	-	-	-	-	-
	2012SIDFA008	Sampled	29	1	-	-	60	2	1.50
	2013SIDFA005	Sampled	48	1	57	1	66	2	1.33
	2013SIDFA034	Sampled	64	2	39	1	62	1	1.33
	2019SIDFA006	Sampled	49	1	54	1	71	2	1.33

Table I-3. Macroinvertebrate and sediment metrics from all successfully sampled BURP sites in Beaver-Camas assessments units listed as category 5 in the 2018/2020 Integrated Report.

Assessment Unit	BURP ID	SMI2 score	SMI2 rating	FSBI	Fine Sediment (%)	Wolman Raw	Bank Coverage (%)	Bank Stability (%)
ID17040214SK006_03	1998SIDFA034	69	3	80	31.5	7	90	78
	2003SIDFA095	78	3	55	22	7	82	90.5
	2013SIDFA003	83	3	125	28.4	8	97.5	76.9
	2019SIDFA036	76	3	105	22.8	7	77	93
ID17040214SK008_02	1998SIDFA032	45	1	35	70.3	5	100	18
ID17040214SK008_03	1998SIDFA033	47	1	35	46.5	7	96.5	76.5
ID17040214SK009_02	1998SIDFA036	11	1	20	91.9	4	91	96
	2012SIDFA009	40	1	15	14.3	7	83	79
ID17040214SK013_02	2001SIDFA057	40	1	25	34.7	9	91.5	91.5
	2002SIDFA003	49	1	50	10.1	7	100	100
	2002SIDFA004	60	2	75	26.2	8	94.5	94.5
	2002SIDFA008	40	1	45	24.6	8	97	98
	2002SIDFA025	37	1	45	21.3	7	91.5	93.5
	2008SIDFA171	48	1	40	28.8	9	100	100
	2018SIDFA004	48	1	45	10.5	9	99.5	82
ID17040214SK016_02	1998SIDFA009	41	1	5	52.5	6	47.5	12
	1998SIDFA010	56	2	50	18.9	7	57	72.5
	1998SIDFA011	73	3	100	23.7	8	100	94.5
	1998SIDFA014	69	3	90	23.5	8	99	62
	1998SIDFA015	70	3	100	9.2	10	97.5	97.5
	1998SIDFA016	45	1	45	18.8	10	95.5	98
	1998SIDFA017	29	1	0	10.9	9	98.5	97
	1998SIDFA018	69	3	80	15.6	9	88.5	21
	1998SIDFA019	72	3	65	21.1	7	19	20
	2008SIDFA167	54	2	45	1.2	9	100	100
	2008SIDFA168	47	1	30	11.3	7	95	95
	2018SIDFA011	57	2	75	5	11	100	100
ID17040214SK016_03	1998SIDFA012	54	2	20	24.6	10	69	65
ID17040214SK017_02	1998SIDFA005	34	1	20	19.2	7	95.5	95.5
	1998SIDFA006	64	3	65	10.9	8	74.5	89
	1998SIDFA007	57	2	60	19.3	9	74	70.5
	1998SIDFA008	60	2	75	30	9	73	54.5
	2018SIDFA015	40	1	75	9	7	93	100
ID17040214SK018_02	1998SIDFA020	54	2	60	7.6	10	90.5	82.5
	1998SIDFA021	45	1	60	21.6	6	98	94
	1998SIDFA035	15	1	15	44.2	8	99	88
	2008SIDFA169	52	1	0	90.8	4	93	79
	2008SIDFA170	56	2	15	77	8	90	74
	2008SIDFA173	59	2	70	38.2	8	98.5	61.5
	2018SIDFA013	55	2	30	16.5	8	74	42.5
	2018SIDFA014	52	1	20	14.2	7	95	20.5
ID17040214SK019_03	2012SIDFA006	64	3	85	88.2	4	63.5	92
	2017SIDFA002	29	1	10	31	9	71	71
ID17040214SK020_02	1998SIDFA023	35	1	45	34.8	9	97.5	6.5
ID17040214SK023_02	2001SIDFA048	62	3	25	41.1	7	98	68.5
	2002SIDFA017	42	1	40	12.4	6	97.5	98.5
	2002SIDFA018	51	1	75	18.9	6	97	100
	2002SIDFA019	51	1	50	22.2	7	99	99
	2002SIDFA020	49	1	65	15.8	8	94.5	92
	2012SIDFA008	29	1	40	17.4	7	100	99.5
	2013SIDFA005	48	1	85	11.6	7	93.5	79
	2013SIDFA034	64	2	100	10.1	8	89.4	65.3
	2019SIDFA006	49	1	70	12.3	7	96	100

Table I-4. Perennial indicator macroinvertebrate taxa, modified from Nadeau 2015.

Larvae, nymphs, pupae of:	
Scientific Name	*Common Name*
Rhyacophilidae	Freeliving caddisfly
Philopotamidae	Finger-net caddisfly
Hydropsychidae	Net-spinning caddisfly
Glossosomatidae	Saddle case-maker caddisfly
Pteronarcyidae	Giant stonefly
Perlidae	Golden stonefly
Gomphidae	Clubtail dragonfly
Cordulegastridae	Spiketail dragonfly
Calopterygidae	Broadwinged damselflies
Elmidae*	Riffle beetle*
Psephenidae	Water penny
Corydalidae	Dobsonflies/fishflies
any life stage of:	
Scientific Name	*Common Name*
Pleuroceridae (Juga spp.)	Pleurocerid snails
Ancylidae	Freshwater limpets
Hydrobiidae	Mud snails
Unionidae/Margaritiferidae	Freshwater mussels

Table I-5. Macroinvertebrate taxa identified as cold-water taxa, based on a scientific literature review (adapted from the Water Body Assessment Guidance, 3rd edition [DEQ 2016])

Literature-derived cold water taxa list			
Agathon	Despaxia	Moselia infuscata	Prostoia besametsa
Agathon sp.	Despaxia augusta	Neothremma	Prostoia sp.
Allocosmoecus partitus	Despaxia sp.	Neothremma sp.	Psilometriocnemus
Allomyia	Deuterophlebia	Oligophlebodes	Rhabdomastix
Allomyia sp.	Deuterophlebia sp.	Oligophlebodes sp.	Rhabdomastix fascigera
Amphicosmoecus canax	Deuterophlebiidae	Oliveridia sp.	Rhabdomastix setigera
Amphicosmoecus	Diplocladius	Oreogeton	Rhabdomastix sp.
Amphicosmoecus sp.	Diplocladius sp.	Oreogeton sp.	Rhyacophila alberta
Anagapetus	Doddsia occidentalis	Paraboreochlus	Rhyacophila tucula
Anagapetus sp.	Doroneuria	Paraboreochlus sp.	Rhyacophila vagrita
Apatania	Doroneuria baumanni	Paracapnia	Rhyacophila verrula
Apatania sp.	Doroneuria sp.	Paracapnia sp.	Rhyacophila vofixa
Baetis bicaudatus	Doroneuria theodora	Parachaetocladius	Rickera
Bibiocephala	Drunella spinifera	Parachaetocladius sp.	Rickera sorpta
Bibiocephala sp.	Eocosmoecus schmidi	Paraleuctra	Rickera sp.
Blepharicera	Eocosmoecus sp.	Paraleuctra sp.	Sericostriata sp.
Blepharicera sp.	Epeorus grandis	Parameletus	Sericostriata surdickae
Blephariceridae	Ephemerella infrequens	Parameletus sp.	Setvena
Boreochlus	Erpobdellidae	Parapsyche elsis	Setvena bradleyi
Boreochlus sp.	Farula sp.	Parasimulium	Setvena sp.
Boreoheptagyia	Frisonia picticeps	Parasimulium sp.	Soliperla
Boreoheptagyia sp.	Goeracea	Parochlus	Soliperla sp.
Brundiniella	Goeracea sp.	Parochlus sp.	Taenionema
Capnia	Heleniella	Peltoperlidae	Taenionema pallidum
Capnia sp.	Heleniella sp.	Perlinodes aurea	Taenionema sp.
Capniidae	Hesperoconopa	Perlomyia	Taeniopterygidae
Cascadoperla sp.	Hesperoconopa sp.	Perlomyia sp.	Visoka
Caudatella	Homophylax	Philocasca sp.	Visoka cataractae
Caudatella edmundsi	Homophylax sp.	Philorus	Visoka sp.
Caudatella hystrix	Krenopelopia	Philorus sp.	Yoraperla
Caudatella sp.	Krenopelopia sp.	Pictetiella expansa	Yoraperla brevis
Caurinella idahoensis	Leuctridae	Pisidium casertanum	Yoraperla mariana
Caurinella sp.	Megaleuctra sp.	Prosimulium	Yoraperla sp.
Chyranda centralis	Megarcys	Prosimulium sp.	Zapada columbiana
Chyranda sp.	Megarcys sp.	Prostoia	Zavrelimyia sp.

Table I-6. Macroinvertebrate taxa identified as obligate cold-water taxa, based on an analysis of BURP macroinvertebrate data (adapted from the Water Body Assessment Guidance, 3rd edition [DEQ 2016])

Empirically-derived cold water taxa list	
Ameletus similior	Paraphaenocladius n. sp.
Anagapetus sp.	Parapsyche elsis
Annelida	Parapsyche sp.
Baetis bicaudatus	Parorthocladius sp.
Bryelmis idahoensis	Polycelis coronata
Caudatella hystrix	Polycelis sp.
Cinygmula sp.	Pseudodiamesa sp.
Cryptochia sp.	Psychodidae
Despaxia augusta	Rhithrogena robusta
Drunella coloradensis/flavilinea	Rhyacophila alberta gr.
Drunella coloradensis	Rhyacophila betteni gr.
Enchytraeidae	Rhyacophila iranda gr.
Epeorus deceptivus	Rhyacophila narvae
Epeorus deceptivus/hesperus	Rhyacophila pellisa
Epeorus grandis/permagnus	Rhyacophila pellisa/valuma
Epeorus grandis	Rhyacophila sibirica gr.
Epeorus sp.	Rhyacophila valuma
Ephemerellidae	Rhyacophila verrula gr.
Eukiefferiella tirolensis	Rhyacophila verrula
Haplotaxis sp.	Rhyacophila vofixa
Hydrobaenus sp.	Sericostriata surdickae
Hydryphantidae	Setvena sp.
Krenopelopia sp.	Stilocladius sp.
Krenosmittia sp.	Taeniopterygidae
Leuctridae	Testudacarus sp.
Neothremma alicia	Tokunagaia sp.
Neothremma sp.	Visoka cataractae
Oligophlebodes sp.	Yoraperla brevis
Oreogeton sp.	Yoraperla sp.
Paraleuctra sp.	Zapada columbiana
Paraperla sp.	Zapada oregonensis gr.

Table I-7. Fish metric scores and ratings from all BURP sites with fish data in the Beaver-Camas subbasin.

Bioregion	Assessment Unit	BURP ID	SFI2 Score	SFI2 Rating	Overall BURP Score
Foothills	ID17040214SK016_02	1998SIDFA014	99	3	2.33
	ID17040214SK016_02	1998SIDFA015	93	2	2.67
	ID17040214SK016_02	1998SIDFA018	100	3	2.67
	ID17040214SK016_02	1998SIDFA019	100	3	2.33
	ID17040214SK016_02	2008SIDFA167	99	3	2.33
	ID17040214SK016_02	2008SIDFA168	99	3	1.67
	ID17040214SK016_02	2018SIDFA011	98	3	2.67
	ID17040214SK017_02	1998SIDFA005	94	2	1.67
	ID17040214SK017_02	1998SIDFA006	94	2	2.67
	ID17040214SK017_02	1998SIDFA007	96	2	2
	ID17040214SK017_02	1998SIDFA008	92	2	2
	ID17040214SK017_02	2018SIDFA015	99	3	2
	ID17040214SK018_02	1998SIDFA020	98	3	2.33
	ID17040214SK018_02	2008SIDFA169	98	3	1.67
	ID17040214SK018_02	2018SIDFA014	98	3	2
	ID17040214SK018_04	2012SIDFA007	100	3	2
	ID17040214SK018_04	2017SIDFA001	100	3	2
	ID17040214SK021_02	1998SIDFA027	100	3	2.67
	ID17040214SK021_03	2019SIDFA007	100	3	1.67
	ID17040214SK024_02	2001SIDFA049	99	3	2
Mountains	ID17040214SK006_02	1998SIDFA037	63	1	1.67
	ID17040214SK006_02	1998SIDFA038	62	1	1.33
	ID17040214SK006_02	2018SIDFA003	52	1	1.67
	ID17040214SK009_02	1998SIDFA036	68	1	1
	ID17040214SK009_03	2005SIDFA076	35	1	1.33
	ID17040214SK010_03	2001SIDFA059	22	1	1.67
	ID17040214SK010_03	2012SIDFA005	27	1	1.67
	ID17040214SK010_03	2017SIDFA003	33	1	1.67
	ID17040214SK012_02	2001SIDFA058	52	1	2
	ID17040214SK013_02	2002SIDFA004	49	1	1.33
	ID17040214SK013_02	2002SIDFA025	47	1	1
	ID17040214SK013_02	2018SIDFA004	67	1	1
	ID17040214SK013_03	2001SIDFA056	26	1	1.33
	ID17040214SK013_03	2003SIDFA080	28	1	1.33
	ID17040214SK013_03	2007SIDFA050	19	1	1.33
	ID17040214SK013_03	2008SIDFA172	27	1	1.33
	ID17040214SK013_03	2012SIDFA002	46	1	1.33
	ID17040214SK013_03	2013SIDFA004	30	1	1.67
	ID17040214SK013_03	2019SIDFA008	50	1	1
	ID17040214SK018_02	1998SIDFA021	85	2	1.67
	ID17040214SK021_02	1998SIDFA029	81	2	1.33
	ID17040214SK021_02	2017SIDFA005	70	1	1
	ID17040214SK023_02	2002SIDFA020	61	1	1
	ID17040214SK023_02	2013SIDFA005	57	1	1.33
	ID17040214SK023_02	2013SIDFA034	39	1	1.33
	ID17040214SK023_02	2019SIDFA006	57	1	1.33
PPBV	ID17040214SK006_03	1998SIDFA034	67	1	2
	ID17040214SK006_03	2003SIDFA095	70	2	2.33
	ID17040214SK006_03	2013SIDFA003	67	1	1.67
	ID17040214SK006_03	2019SIDFA036	67	1	2
	ID17040214SK008_02	1998SIDFA032	76	2	1.33
	ID17040214SK008_03	1998SIDFA033	74	2	1.33
	ID17040214SK012_03	2005SIDFA077	62	1	1.33
	ID17040214SK016_02	1998SIDFA010	93	3	2
	ID17040214SK021_02	1998SIDFA028	74	2	2
	ID17040214SK025_03	1998SIDFA024	87	2	2