Middle Salmon River-Chamberlain Creek Subbasin and Crooked Creek Total Maximum Daily Load

2017 Temperature TMDL and Five-Year Review

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Acknowledgments

Cover photo of the 3rd-order segment of Crooked Creek (DEQ 2013). The authors thank John Cardwell, Daniel Stewart, and Sujata Connell of the Idaho Department of Environmental Quality, Lewiston Regional Office, for assistance with field monitoring.

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Abbreviations, Acronyms, and Symbols

§303(d)	refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section
AU	assessment unit
BAG	basin advisory group
BMP	best management practice
BURP	Beneficial Use Reconnaissance Program
C	Celsius
CFR	Code of Federal Regulations
CGP	Construction General Permit
CWA	Clean Water Act
DEQ	Department of Environmental Quality
EPA	United States Environmental Protection Agency
GIS	geographic information systems
IDAPA	Refers to citations of Idaho administrative rules
kWh	kilowatt-hour
LA	load allocation
LC	load capacity
MOS	margin of safety
MS4	municipal separate storm sewer systems
MSGP	Multi-Sector General Permit
NB	natural background
NPDES	National Pollutant Discharge Elimination System
NREL	National Renewable Energy Laboratory
PNV	potential natural vegetation
SWMP	stormwater management program
SWPPP	Stormwater Pollution Prevention Plan
TMDL	total maximum daily load
US	United States
U.S.C.	United States Code
WAG	watershed advisory group
WLA	wasteload allocation

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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 Section 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 (DEQ 2014). For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards. This document addresses the 5-year review of one watershed (four assessment units [AUs]) in the Middle Salmon River-Chamberlain Creek subbasin originally placed in Category 5 of Idaho's 1998 federally approved Integrated Report) and updates shade targets based on the potential natural vegetation (PNV) approach.

This TMDL and 5-year review describes the key physical and biological characteristics of the subbasin; water quality concerns and status; pollutant sources; and recent pollution control actions in the Middle Salmon River-Chamberlain Creek subbasin, located in central Idaho. For more detailed information about the subbasin, see the *Middle Salmon River-Chamberlain Creek Subbasin Assessment and Crooked Creek Total Maximum Daily Load* (DEQ 2002).

The TMDL analysis established 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.

Subbasin at a Glance

The Middle Salmon River-Chamberlain Creek subbasin is located in north-central Idaho east of Riggins. Crooked Creek is located within this subbasin on the north side of the Salmon River. The creek originates near the South Fork Red River divide, extends through Dixie, enters the Gospel Hump Wilderness Area, and eventually reaches the Salmon River north of Warren (Figure A). Crooked Creek includes four AUs including its headwaters and associated tributaries (ID17060207SL068_02), the willow meadows area near the Dixie work center and airstrip (ID17060207SL068_03), a narrow canyon area between Big Creek and Lake Creek (its largest tributaries) (ID17060207SL068_04), and a long, Salmon River face drainage that was burned by wildfires in recent years (ID17060207SL067_05) (Figure B).

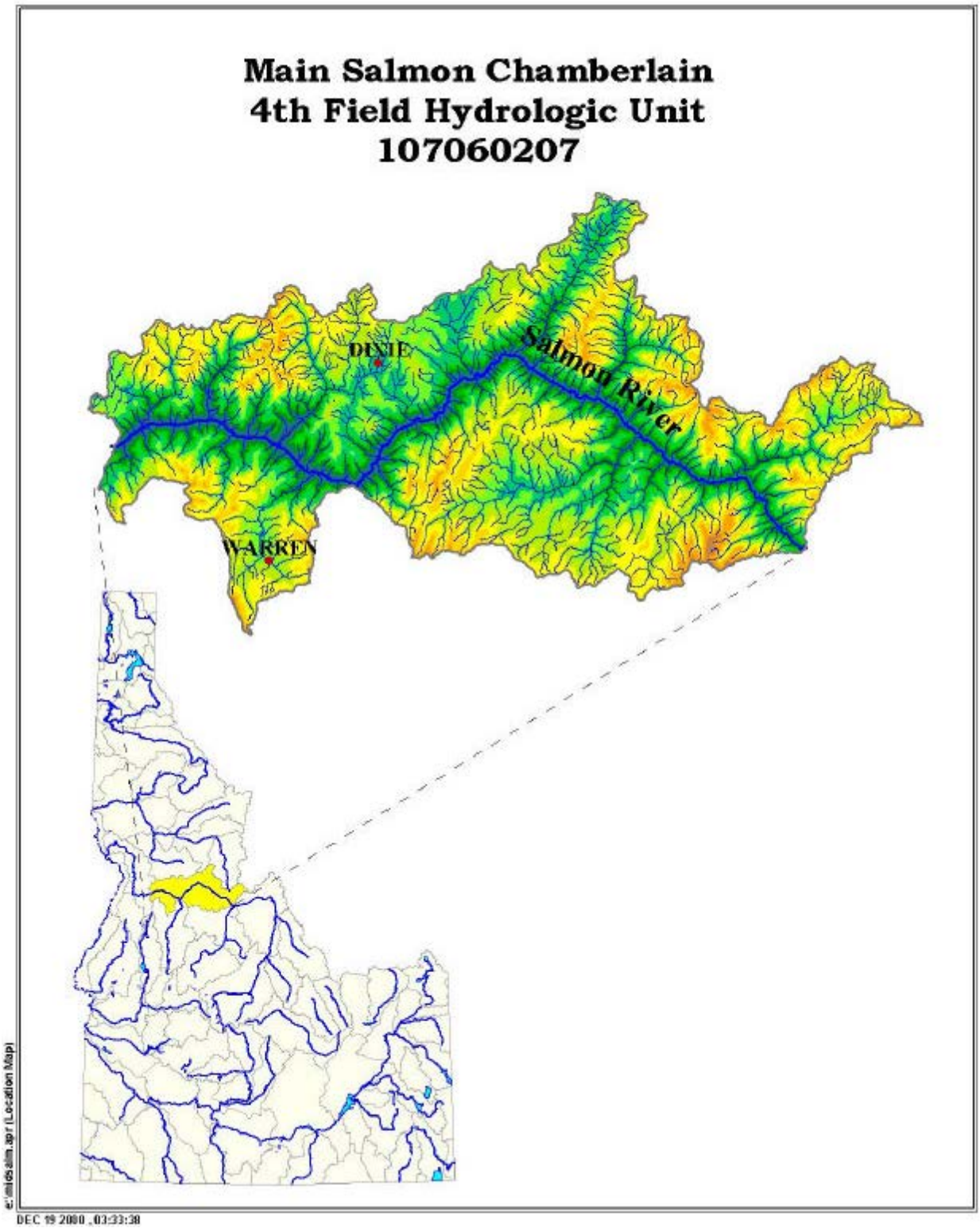


Figure A. Middle Salmon River-Chamberlain Creek subbasin.

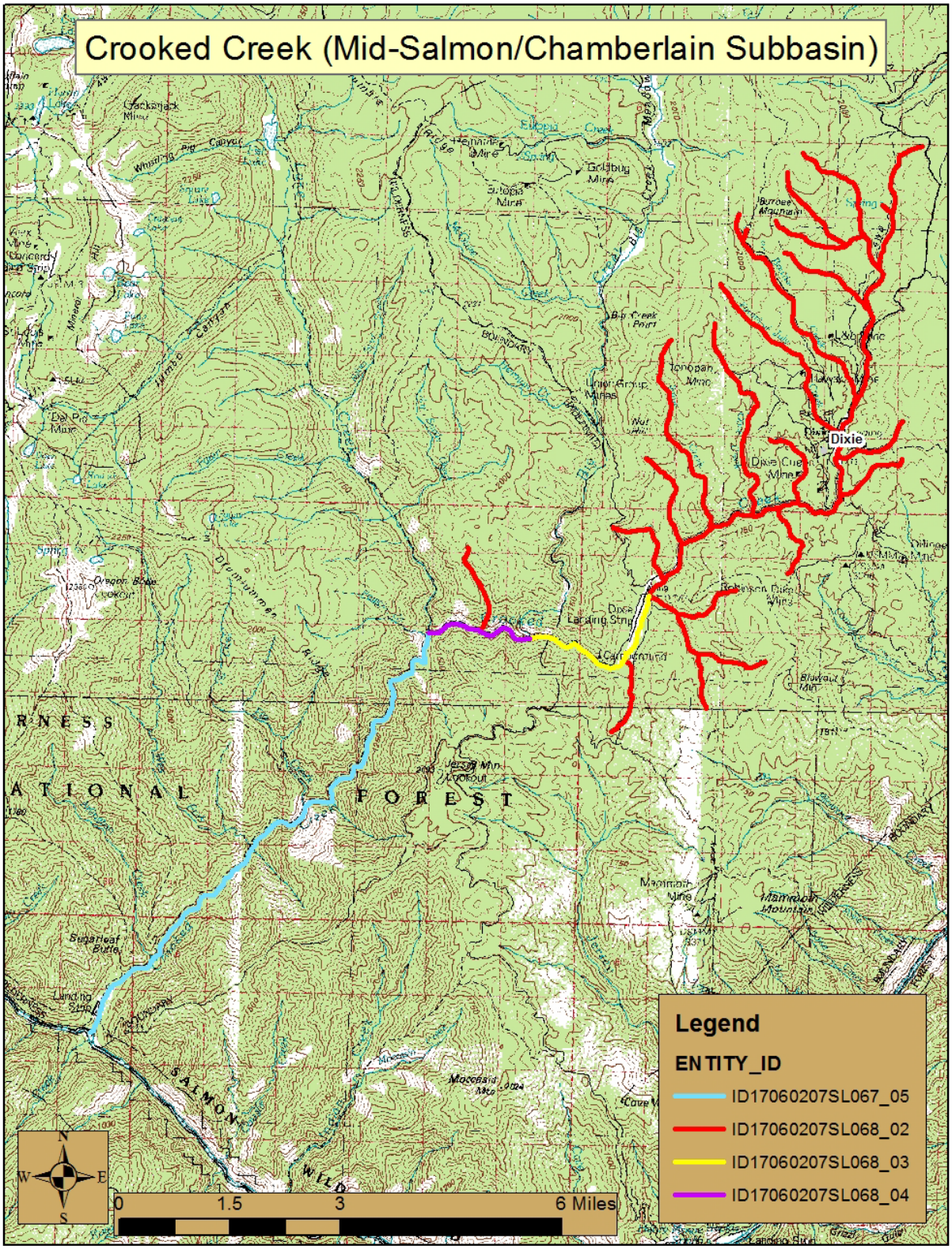


Figure B. Crooked Creek (Middle Salmon River-Chamberlain Creek subbasin).

Key Findings

Crooked Creek was placed on the 1998 §303(d) list of impaired waters for sediment pollution. In 2002, the Idaho Department of Environmental Quality (DEQ) determined that sediment was not the cause of impairment, but stream temperatures were likely elevated, and temperature TMDLs were developed for the mainstem of these waters (DEQ 2002) (Table A).

As part of the 5-year review of the existing, approved temperature TMDL, new effective target shade levels were established for all portions (including tributaries) of the four AUs 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 the amount of shade needed to bring water bodies into compliance with temperature criteria in Idaho's water quality standards (IDAPA 58.01.02). For the existing TMDLs in the subbasin, no additional assessment outcomes are reported in the 5-year review.

The 2002 temperature TMDL addressed shade from stream-side vegetation as the principal source of thermal load to the stream, but it did not accurately reflect the current state of knowledge about Idaho riparian plant communities and the stream shade they produce. In this TMDL, new shade targets are developed based on Idaho plant communities, the quantity of existing shade on the stream is reassessed, and new shade deficits and loads are established using the PNV method. In the 2002 temperature TMDL, the 5th-order segment of Crooked Creek in the wilderness area was believed to be the priority problem area for thermal load. In this 5-year review, it was determined that region, although extensively burned in wildfires, is not the most important area with shade deficits. In fact, due to its wide channel and dry forest type, the lower portion of Crooked Creek would have relatively low natural shade levels. The 2nd-order AU around Dixie is the area where the most perturbation from mining and settlement has occurred over the last 150 years. The new shade analysis shows where specific reaches of Crooked Creek and its tributaries lack shade and where rehabilitation would likely most benefit the stream's thermal characteristics.

Table A. Water bodies and pollutants for which TMDLs were revised.

Water Body	Assessment Unit Number	Pollutant
Crooked Creek and tributaries	ID17060207SL068_02	Temperature
Crooked Creek	ID17060207SL068_03	Temperature
Crooked Creek	ID17060207SL068_04	Temperature
Crooked Creek	ID17060207SL067_05	Temperature

Table B. Summary of assessment outcomes.

Assessment Unit Name	Assessment Unit Number	Pollutant	TMDL Completed	Recommended Changes to Next Integrated Report	Justification
Crooked Creek—source to Blowout Creek and 1st- and 2nd-order tributaries	ID17060207SL068_02	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade
Crooked Creek—Blowout Creek to Big Creek	ID17060207SL068_03	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade
Crooked Creek—Lake Creek to mouth	ID17060207SL067_05	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade

Table C. Summary of assessment outcomes for unlisted assessment units.

Assessment Unit Name	Assessment Unit Number	Pollutant	TMDL Completed	Recommended Changes to Next Integrated Report	Justification
Crooked Creek—Big Creek to Lake Creek	ID17060207SL068_04	Temperature	Yes	Not impaired, remain in Category 1	Informational temperature TMDL completed

Public Participation

A formal watershed advisory group (WAG) for the subbasin does not exist. This TMDL and 5-year review was presented to the Clearwater River Basin Advisory Group on March 23, 2017. The general public was given an opportunity to review this draft document during the public comment period of May 8, 2017 through June 6, 2017.

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Introduction

This document addresses one watershed in the Middle Salmon River-Chamberlain Creek subbasin originally placed in Category 5 of Idaho's 1998 federally approved Integrated Report. This 5-year review of the total maximum daily load (TMDL) characterizes and documents current pollutant loads within the Crooked Creek watershed. 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). While the subbasin assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are up-to-date and accurate.

The subbasin assessment was used to develop a TMDL for each pollutant of concern for the Middle Salmon River-Chamberlain Creek 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. Effective shade targets were established for four assessment units (AUs) based on the concept of maximum shading under potential natural vegetation (PNV) resulting in natural background temperatures.

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. The Idaho Department of Environmental Quality (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 Section 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.

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. A TMDL is only required when a pollutant can be identified and in some way quantified.

1 Subbasin Assessment—Subbasin Characterization

The subbasin is almost entirely federal land (98%), mostly in the Nez Perce and Payette National Forests. The north side of the Salmon River is in the Nez Perce and Bitterroot National Forests and the south side in the Payette and Salmon-Challis National Forests. Forest boundaries split the northern half of the subbasin at Sabe Creek with the west side in the Nez Perce and the east side in the Bitterroot National Forest. The Payette and Salmon National Forests' common boundary occurs at the eastern edge of the Cottonwood Creek drainage near the eastern end of the subbasin.

The subbasin is considered almost entirely forested land use (DEQ 2002; Map 8-Landuse Classification). A large portion of the national forests are managed as wilderness. The Frank Church River of No Return Wilderness flanks both sides of the Salmon River from Corn Creek to the vicinity of Mackay Bar (DEQ 2002; Map 9-Landownership). At Crooked Creek, the Gospel Hump Wilderness begins on the north side of the river; the south side continues to be the Frank Church Wilderness (DEQ 2002; Map 10-Wilderness Protection Areas). Of the 2.3 million acres in the Frank Church Wilderness, 105,000 acres are in the Nez Perce National Forest, all in this subbasin. Gospel Hump Wilderness is 200,464 acres in size and mostly in this subbasin. Wilderness boundaries end where the Wind River enters the Salmon River. The remaining stretch of the Salmon River from the Wind River to the mouth of the subbasin near French Creek is primarily national forest outside of wilderness boundaries. The Warren Creek and Carey Creek drainages on the southwest end of the subbasin are primarily outside of wilderness, as is Corn Creek, Bear Basin Creek, and the top end of Horse Creek on the east end of the subbasin.

Many watersheds experienced mining in the past, with some mining activities still in existence today. In particular, larger mining areas include the Marshall Mountain area, Warren Creek, and the vicinity of Dixie. A number of small private holdings exist within the subbasin, most less than 500 acres in size. Many of these holdings have, and continue to be, used for mining

activities. The Bureau of Land Management (BLM) has an 11,000 acre area that contains the Marshall Mountain mining area. The State of Idaho also owns a section within this BLM area.

The subbasin can be divided into 18 subwatersheds or 5th-field hydrologic units (DEQ 2002; Map 2). On the north side of the Salmon River are the Wind River (includes Meadow Creek), Sheep Creek, Crooked Creek (includes Big and Lake Creeks), Big Mallard Creek, face drainages (includes Jersey, Rhett, and Little Mallard Creeks) Bargamin Creek, Sabe Creek, and Horse Creek subwatersheds. A summary of most north-side watersheds is provided in DEQ (2002, Table 5). On the south side of the river are Carey Creek (includes Fall Creek), Warren Creek, Upper Chamberlain Creek, Lower Chamberlain Creek, and Cottonwood Creek subwatersheds. Straddling both sides of the Salmon River are Bull Creek (includes California Creek), Rabbit Creek, face drainages (includes Fivemile, Lemhi, Trout, and Richardson Creeks), Dillinger Creek (includes Harrington Creek), Disappointment Creek, and Kitchen Creek (includes Corn Creek) subwatersheds.

Six north-side tributaries of the Salmon River were listed for sediment in 1998. These are Big, Crooked, Jersey, Big Mallard, Little Mallard, and Rhett Creeks. Additionally, Warren Creek, a south-side tributary to the Salmon River, was listed for habitat alteration from its headwaters to the wilderness boundary. The Salmon River was §303(d) listed from Corn Creek to Cherry Creek for unknown pollutants. The assessment outcomes from the previous approved TMDL (DEQ 2002) are as follows:

> "Available data indicate a minimally impacted subbasin and aquatic life uses are fully supported. We conclude that state water quality standards for sediment are not being exceeded in the listed water bodies in this subbasin. Therefore, Big Mallard Creek, Little Mallard Creek, Rhett Creek, Crooked Creek, Big Creek, and Jersey Creek, are to be delisted from the next 303(d) list. Warren Creek shall remain on the 303(d) list for habitat alteration. …Crooked Creek violates temperature criteria for bull trout spawning and rearing. …The IDEQ will also delist the Salmon River, from Cherry Creek to Corn Creek. There are no pollutants identified for its 303(d) listing… There is no evidence establishing that the [Salmon] river violates any state water quality standard." (DEQ 2002)

Crooked Creek

Crooked Creek is a tributary to the main Salmon River in this subbasin. Crooked Creek originates near the divide with the South Fork Red River (South Fork Clearwater River subbasin) below Elk City. The creek flows southwest for about 11 miles, bends west for several miles, and then flows southwest again for another 8 miles before entering the Salmon River. Fifty-four percent of the Crooked Creek watershed is in the Gospel Hump Wilderness (the lower half of the stream), while 2% is in private ownership. The remaining lands are in the Nez Perce National Forest. There are two large tributaries, Big Creek and Lake Creek, entering the middle reaches of Crooked Creek as well as numerous smaller tributaries throughout the upper watershed. The upper half of Crooked Creek is in mixed conifer forest communities. Below Big Creek, Crooked Creek enters an area of decreasing tree density. By the time Crooked Creek reaches the Salmon River, the landscape is predominantly grass/shrub communities with few trees.

DEQ's (2002) assessment determined that, although moderately high, sediment was not impairing aquatic life in this stream. However, it was determined that temperature measurements were high enough that salmonid spawning in upper Crooked Creek and Bull Trout spawning and rearing, if they occur in Crooked Creek, may be affected.

Temperature loggers had been placed in Crooked Creek at four locations every year from 1994 to 1999 (Figure 1) (DEQ 2002, Map 12). These four locations include (1) a headwaters site (Site 1), (2) a location below Dixie and the Forest Service's Dixie work center but above the tributaries of Big and Lake Creeks (Site 2), (3) a location directly below Lake and Big Creeks (Site 3), and (4) a fourth location near the mouth of Crooked Creek (Site 4). The monitoring data showed that the headwaters are relatively cool, but the water temperature increases rapidly through the impacted areas around Dixie. Water temperatures are cooled by entering the wilderness area and from the flows from Big and Lake Creeks. The water appeared to heat up again as it travels the remaining distance through the wilderness area to the mouth (an area extensively burned in the mid-1990s).

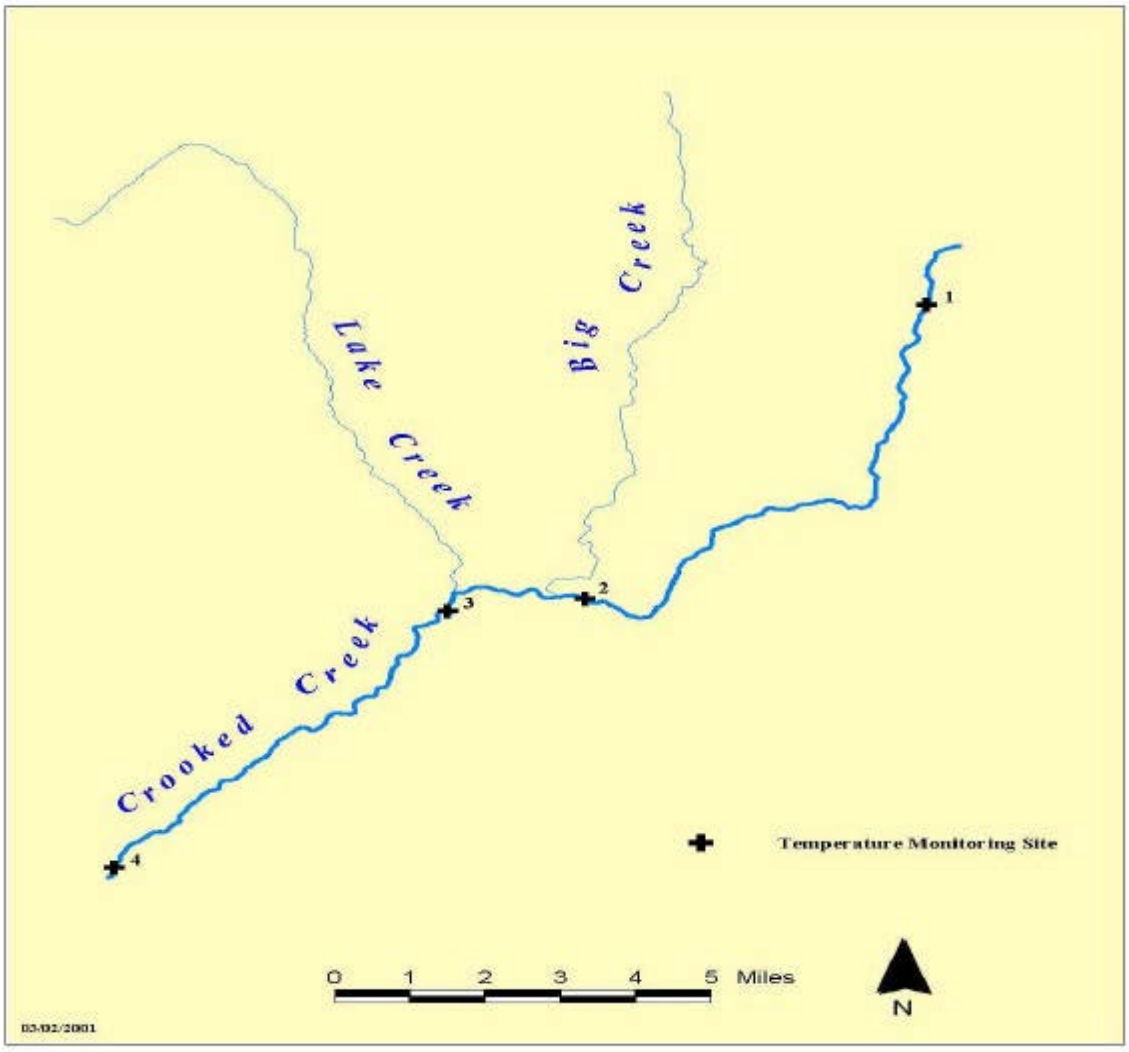


Figure 1. Temperature monitoring sites on Crooked Creek (1994–1999).

2 Subbasin Assessment—Water Quality Concerns and Status

2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

CWA §303(d) states that 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

AUs are groups of similar streams that have similar land use practices, ownership, or land management. However, 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 primarily 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 4a of the Integrated Report).

Table 1. Middle Salmon River-Chamberlain Creek subbasin §303(d)-listed assessment units.

Assessment Unit Name	Assessment Unit Number	Listed Pollutants	Listing Basis
Crooked Creek, source to mouth	ID17060207SL068_02 ID17060207SL068_03 ID17060207SL067_05	Temperature	2002 TMDL

2.2 Applicable Water Quality Standards and Beneficial Uses

Idaho water quality standards (IDAPA 58.01.02) list beneficial uses and set water quality goals for waters of the state. Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses as described briefly in the following paragraphs. The *Water Body Assessment Guidance* (DEQ 2016) provides a more detailed description of beneficial use identification for use assessment purposes.

Beneficial uses include the following:

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

For more information about beneficial uses, see Appendix A.

2.2.1 Beneficial Uses in the Subbasin

Crooked Creek is an undesignated watershed, so it was originally protected for presumed uses (cold water aquatic life and secondary contact recreation). Subsequent monitoring by DEQ and others determined that salmonids of various age classes were present throughout the watershed. Salmonid spawning and cold water aquatic life are existing uses (Table 2), and secondary contact recreation is an unassessed beneficial use (Table 3).

Table 2. Crooked Creek watershed beneficial uses of §303(d)-listed streams.

Assessment Unit Name	Assessment Unit Number	Beneficial Uses	Type of Use
Crooked Creek—source to Little Blowout Creek	ID17060207SL068_02	CW, SS	Existing
Crooked Creek—Little Blowout Creek to Big Creek	ID17060207SL068_03	CW, SS	Existing
Crooked Creek—Big Creek to Lake Creek	ID17060207SL068_04	CW, SS	Existing
Crooked Creek—Lake Creek to mouth	ID17060207SL067_05	CW, SS	Existing

Notes: Cold water (CW), salmonid spawning (SS)

Table 3. Crooked Creek watershed unassessed beneficial uses.

Assessment Unit Name	Assessment Unit Number	Beneficial Uses	Type of Use
Crooked Creek—source to Little Blowout Creek	ID17060207SL068_02	SCR	Presumed
Crooked Creek—Little Blowout Creek to Big Creek	ID17060207SL068_03	SCR	Presumed
Crooked Creek—Big Creek to Lake Creek	ID17060207SL068_04	SCR	Presumed
Crooked Creek—Lake Creek to mouth	ID17060207SL067_05	SCR	Presumed

Note: Secondary contact recreation (SCR)

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, and *narrative* criteria for pollutants such as sediment and nutrients (IDAPA 58.01.02.250–251) (Table 4). For more about temperature criteria and natural background provisions relevant to the PNV approach, see Appendix B.

Table 4. Selected numeric criteria supportive of designated beneficial uses in Idaho 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				
Temperature[a]	—	—	22 °C or less daily maximum; 19 °C or less daily average **Seasonal Cold Water**: Between summer solstice and autumn equinox: 26 °C or less daily maximum; 23 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average **Bull Trout**: Not to exceed 13 °C maximum weekly maximum temperature over warmest 7-day period, June–August; not to exceed 9 °C daily average in September and October
EPA Bull Trout Temperature Criteria: Water Quality Standards for Idaho, 40 CFR 131				
Temperature	—	—	—	7-day moving average of 10 °C or less maximum daily temperature for June–September

[a] 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.

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 2016). This guidance requires DEQ to use the most complete data available to make beneficial use support status determinations.

2.3 Summary and Analysis of Existing Water Quality Data

Previous temperature data suggested (DEQ 2002; Table 18) that Crooked Creek may have slightly elevated temperatures naturally. The mouth of Crooked Creek on average had slight exceedances of cold water aquatic life criteria, probably consistent with the Salmon River itself in this canyon. Even in the headwaters of Crooked Creek stream temperatures were slightly greater than criteria on average, creating a few days where salmonid spawning criteria were exceeded. Because salmonid spawning criteria were applied to a default time period for spring and fall spawning species, individual streams may have had warmer temperatures near the end of the spring spawning period (mid-July) or at the beginning of the fall spawning period (September 1) without seriously harming the actual spawning in the stream (i.e., fish spawn when the temperature is right and time is sufficient to do so). Additionally, because we often consider average condition, during hot years, criteria are exceeded more often, and during cold years, criteria may not be exceeded at all. The goal of the TMDL was to achieve the natural temperature regime in the stream by returning the effective shade to its natural condition. We

anticipated that the natural temperature regime is cooler than the present condition; however, the natural temperature regime may not necessarily exclude temperature criteria exceedances.

More recent temperature data collected at three locations in 2012 (Figure 2) continue to show that salmonid spawning and Bull Trout criteria are exceeded in the upper part of the watershed (Table 5 and Table 6). The conditions are improved by the input of cold water from Big Creek and Lake Creek as Crooked Creek enters the wilderness area (Table 7). Bull Trout criteria were not applied to the lowest site as it is below the elevation range (1,400 meters) for those criteria.

Table 5. Temperature criteria exceedances for Crooked Creek (ID17060207SL068_02) above Boulder Creek in Dixie (2012).

Temperature Criteria	Exceedance Days	Percentage of Days Evaluated
CWAL maximum (22 °C)	0	0
CWAL average (19 °C)	0	0
Spring SS maximum (13 °C)	10	48
Spring SS average (9 °C)	9	43
Fall SS maximum (13 °C)	7	16
Fall SS average (9 °C)	11	24
Fall Bull Trout juvenile rearing MWMT (13 °C)	68	89
Fall Bull Trout spawning average (9 °C)	11	18

Notes: Cold water aquatic life (CWAL), salmonid spawning (SS), maximum weekly maximum temperature (MWMT).

Table 6. Temperature criteria exceedances for Crooked Creek (ID17060207SL068_03) at Halfway House Campground (2012).

Temperature Criteria	Exceedance Days	Percentage of Days Evaluated
CWAL maximum (22 °C)	0	0
CWAL average (19 °C)	0	0
Spring SS maximum (13 °C)	11	52
Spring SS average (9 °C)	14	67
Fall SS maximum (13 °C)	10	22
Fall SS average (9 °C)	10	22
Fall Bull Trout juvenile rearing MWMT (13 °C)	70	92
Fall Bull Trout spawning average (9 °C)	10	17

Notes: Cold water aquatic life (CWAL), salmonid spawning (SS), maximum weekly maximum temperature (MWMT).

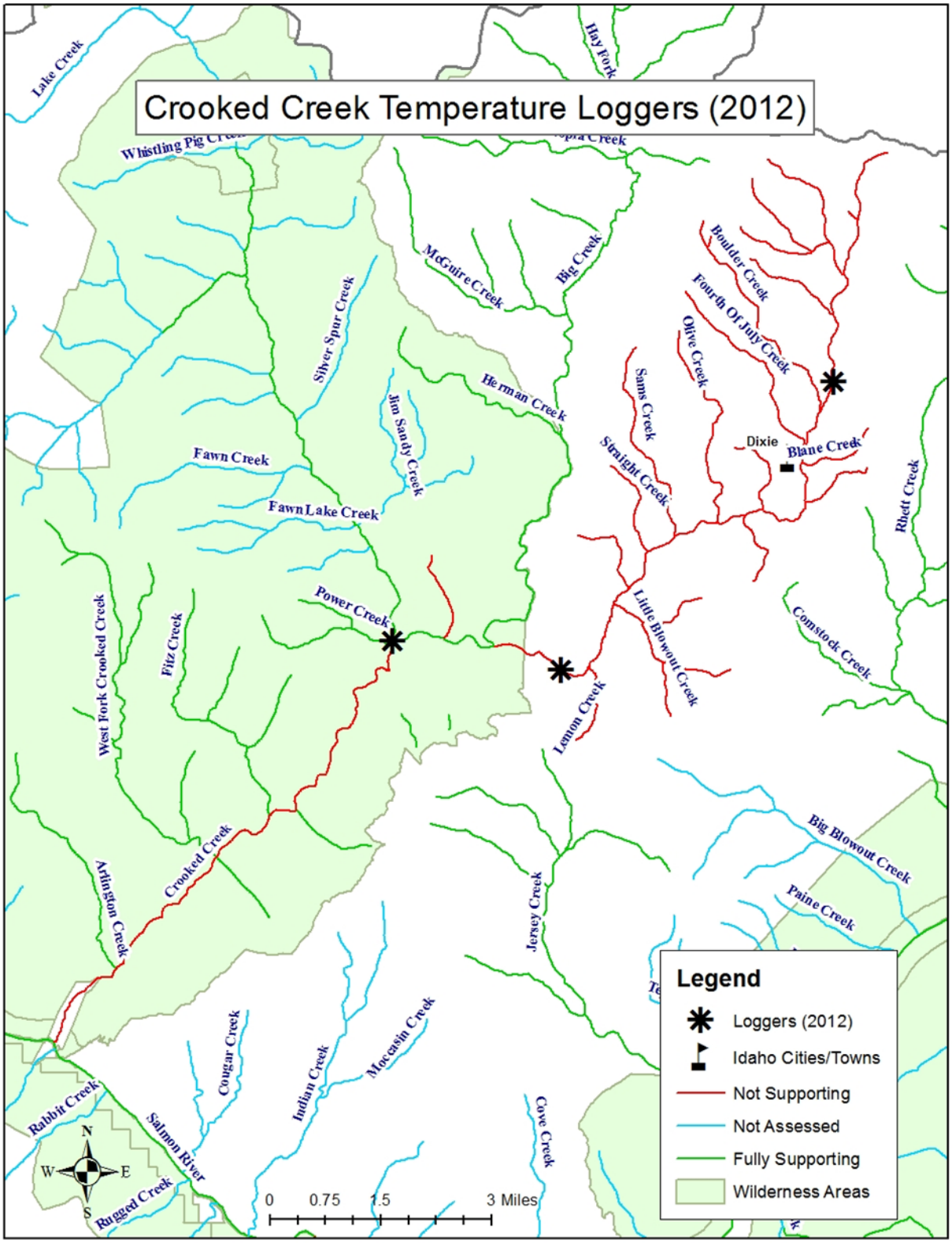


Figure 2. Locations for temperature continuous monitoring in Crooked Creek (2012).

Table 7. Temperature criteria exceedances for Crooked Creek (ID17060207SL067_05) below Lake Creek in wilderness area (2012).

Temperature Criteria	Exceedance Days	Percentage of Days Evaluated
CWAL maximum (22 °C)	0	0
CWAL average (19 °C)	0	0
Spring SS maximum (13 °C)	0	0
Spring SS average (9 °C)	4	19
Fall SS maximum (13 °C)	0	0
Fall SS average (9 °C)	12	27
Fall Bull Trout juvenile rearing MWMT (13 °C)	na	0
Fall Bull Trout spawning average (9 °C)	na	0

Notes: Cold water aquatic life (CWAL), salmonid spawning (SS), maximum weekly maximum temperature (MWMT).

2.3.1 Status of Beneficial Uses

The 2002 subbasin assessment found that Crooked Creek, although having good assessment scores generated by Beneficial Use Reconnaissance Program (BURP) data, sufficiently violated temperature criteria to warrant a temperature TMDL. DEQ has recently BURP monitored several sites in 2013 (Table 8). The data suggest the watershed may have impaired biological conditions in the lower part of the watershed, again most likely consistent with increased heat load along the creek's course.

Table 8. Beneficial Use Reconnaissance Program data for Crooked Creek.

`Assessment Unit Name	Assessment Unit Number	SMI	SFI	SHI	Average	Current Integrated Report Category
Crooked Creek and tributaries	ID17060207SL068_02	3	1	2	2	4a
Crooked Creek	ID17060207SL068_03	3	1	2	2	4a
Crooked Creek	ID17060207SL068_04	2	1	2	1.67	1
Crooked Creek	ID17060207SL067_05	1	1	2	1.33	4a

Notes: Stream macroinvertebrate index (SMI); stream fish index (SFI); stream habitat index (SHI); not assessed (NA)

2.3.2 Assessment Unit Summary

A summary of the data analysis, literature review, and field investigations and a list of conclusions for AUs included in Category 5 of the 1998 Integrated Report follows. This section includes changes that will be documented in the next Integrated Report once the TMDLs in this document have been approved by EPA.

ID17060207SL068_02, **Crooked Creek, source to Little Blowout Creek, includes 1st- and 2nd-order tributaries.**

- Listed for sediment originally in 1998.
- The original subbasin assessment (DEQ 2002) determined that, although elevated, sediment conditions were not severe enough to warrant a sediment TMDL. However, due to elevated water temperatures in the watershed, a temperature TMDL was completed and approved in 2003. The temperature TMDL was one of the first in Idaho to use the PNV approach, which set specific shade targets for riparian plant communities.
- The original temperature TMDL has been updated here because considerable change in PNV techniques based on shade has taken place since 2002.

ID17060207SL068_03, **Crooked Creek, Little Blowout Creek to Big Creek.**

- Listed for sediment originally in 1998.
- The original subbasin assessment (DEQ 2002) determined that, although elevated, sediment conditions were not severe enough to warrant a sediment TMDL. However, due to elevated water temperatures in the watershed, a temperature TMDL was completed and approved in 2003. The temperature TMDL was one of the first in Idaho to use the PNV approach, which set specific shade targets for riparian plant communities.
- The original temperature TMDL has been updated here because considerable change in PNV techniques based on shade has taken place since 2002.

ID17060207SL068_04, **Crooked Creek, Big Creek to Lake Creek.**

- Listed as fully supporting beneficial uses, although reevaluation will occur with the 2016 Integrated Report cycle.
- This AU was deemed fully supporting in the original subbasin assessment (DEQ 2002). The reach was included in the original temperature TMDL to maintain continuity of the stream in the solar load analysis.
- The AU will continue to be included in the load analysis for consistency as an informational TMDL.

ID17060207SL067_05, **Crooked Creek, Lake Creek to mouth.**

- Listed for sediment originally in 1998.
- The original subbasin assessment (DEQ 2002) determined that, although elevated, sediment conditions were not severe enough to warrant a sediment TMDL. However, due to elevated water temperatures in the watershed, a temperature TMDL was completed and approved in 2003. The temperature TMDL was one of the first in Idaho to use the PNV approach, which set specific shade targets for riparian plant communities.
- The original temperature TMDL has been updated here because considerable change in PNV techniques based on shade has taken place since 2002.

3 Subbasin Assessment—Pollutant Source Inventory

Pollution within the Crooked Creek watershed is primarily from temperature. Load allocations were established in the *Middle Salmon River-Chamberlain Creek Subbasin Assessment and Crooked Creek Total Maximum Daily Load* approved by EPA in January 2003 (DEQ 2002).

3.1 Point Sources

No permitted point sources exist in the Crooked Creek watershed. The watershed has had a long history of mining including placer, dredge, and lode mining for gold and other precious metals.

3.2 Nonpoint Sources

Dixie has the potential to produce a small, localized increase in stormwater discharge to upper Crooked Creek because of the buildings and recreational development activities. Dixie has been extensively subdivided, with 80 private residences ranging from small lots to 40-acre parcels, and several businesses. The town site is located on the 154-acre Crooked Creek Placer patented mine claim, which runs adjacent to 32 miles of Crooked Creek. This reach of the creek has been dredge mined and both the riparian and instream habitat has been moderately to severely altered. Common activities associated with the town site include channelization, bridge construction, ford crossings, riparian vegetation removal, landfills, livestock-holding corrals, and homesite development.

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. In the case of temperature, most pollutant transport is in the form of solar radiation directly to the stream as a result of exposure. In the Crooked Creek watershed, stream exposure has resulted from past mining activities within and adjacent to the channel, timber harvesting, site development, vegetation removal, roads, and livestock-grazing activities.

4 Subbasin Assessment—Summary of Past and Present Pollution Control Efforts

Since the establishment of new home sites in Dixie, riparian vegetation has been reestablishing along the creek margins increasing shade. This process is likely to continue as landscapes mature. However, because home sites need to be protected from any possible future wildfire activity, it is anticipated that streamside forests will not develop to natural conditions. The meadows area of Crooked Creek in the vicinity of the Dixie work center and airstrip continues to show progress in developing a riparian willow complex. The United States Forest Service should continue to protect this area and limit grazing in the riparian corridor.

4.1 Water Quality Monitoring

We have reexamined the original existing shade conditions on Crooked Creek. The results are presented in section 5. Existing shade was evaluated through aerial photo interpretation of 2011 National Agricultural Imagery Program (NAIP) imagery. Solar Pathfinder monitoring of existing shade has taken place at nine sites in the upper watershed to calibrate and enhance the aerial interpretation.

5 Total Maximum Daily Loads

The 2002 temperature TMDL was approved by EPA in January 2003. This TMDL was DEQ's first attempt to use a PNV or "natural shade target" approach to establish loads for a temperature TMDL. At that time, specific shade targets were developed for plant communities thought to be in the Crooked Creek area. The headwaters area was thought to be within a subalpine fir habitat followed by an extensive area of grand fir (to Lake Creek). The meadows area near the Dixie work center and airstrip was thought to be either coyote willow or tufted hairgrass meadows. The region of Crooked Creek in the canyon below Lake Creek was identified as Douglas fir forest then Ponderosa pine forest.

Since 2002, DEQ has developed extensive techniques for creating PNV-style temperature TMDLs including many new target shade curves for plant communities found in Idaho. The forest shade curves follow specific forest types developed by each of the national forests in Idaho, and we have developed many nonforest type plant community shade curves (Shumar and De Verona 2009). For Crooked Creek, in the following TMDL analysis we use new shade curves developed for the forest types found in the Nez Perce National Forest and a more appropriate willow type for the meadows region.

The results of the previous temperature TMDL (DEQ 2002) are still valid. The following analysis refines details about where shade is occurring on Crooked Creek and the appropriate target shade level.

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 be included in the TMDL. Practically, the margin of safety 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 margin of safety 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 loading in more practical and tangible ways. The rules also recognize the particular difficulty of quantifying nonpoint loads and allow "gross allotment" as a load allocation where available data or appropriate predictive techniques limit more accurate estimates. For certain pollutants whose effects are long term, such as temperature, EPA allows for seasonal or annual loads.

5.1 Instream Water Quality Targets

For the Crooked Creek temperature TMDL, we used a PNV approach. The Idaho 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. See Appendix B for further discussion of 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 Factors Controlling Water Temperature in Streams

There are several important contributors of heat to a stream, including ground water temperature, air temperature, and direct solar radiation (Poole and Berman 2001). Of these, direct solar radiation is the source of heat 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 is covered and how much is exposed to direct solar radiation.

5.1.2 Potential Natural Vegetation for Temperature TMDLs

PNV along a stream is that 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, 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 (with the exception of natural levels of disturbance and age distribution) result in the stream heating up from anthropogenically created additional solar inputs.

We can estimate PNV (and therefore 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 the average of Pendleton, Oregon, and Missoula, Montana, stations as a best approximation of conditions halfway between these two 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 the Idaho water quality standards, even if they exceed numeric criteria by more than 0.3 °C.

5.1.2.1 Existing Shade Estimates

Existing shade was estimated for the four AU from visual interpretation of aerial photos. 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 takes into consideration other physical features that block the sun from hitting the stream surface (e.g., hillsides, canyon walls, terraces, and man-made structures).

Solar Pathfinder Field Verification

The accuracy of the aerial photo interpretations was field verified with a Solar Pathfinder at ten sites. The Solar Pathfinder is a device that allows tracing 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, ten traces are taken at systematic or random intervals along the length of the stream in question.

At each sampling location, the Solar Pathfinder was placed in the middle of the stream at about the bankfull water level. Ten traces were taken following the manufacturer's instructions (i.e., orient to 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 50 to 100 meters from a bridge or fence line, and proceeded upstream or downstream taking additional traces at fixed intervals (e.g., every 50 meters, 50 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 what kinds of plant species (the large, dominant, shade-producing ones) were present. Densiometer readings can also be taken 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.

Solar Pathfinder results from ten sites monitored in 2013 show that our aerial interpretation was slightly under-predicting shade (Table 9). The average difference between the aerial photo work shade class and the Solar Pathfinder shade class was -1% ± 7.9 (average ± 95% C.I.). We underestimated shade at four sites, overestimated at two sites, and were accurate at four sites. The results of this Solar Pathfinder monitoring were used to calibrate our eye for further correction of the aerial photo interpretation. The results of that new interpretation are used below in the load analysis.

Table 9. Solar Pathfinder monitoring results for sites within the Crooked Creek (2013).

aerial class	pathfinder actual	pathfinder class	delta			
30	46.8	40	-10		site 1	Crooked Cr.
20	44.9	40	-20		site 2	Crooked Cr.
60	62.1	60	0		site 3	Crooked Cr.
50	55.7	50	0		site 4	Crooked Cr.
90	70.6	70	20		site 5	Straight Cr.
10	25.3	20	-10		site 6	Crooked Cr.
0	17.5	10	-10		site 7	Crooked Cr.
50	56.9	50	0		site 8	Crooked Cr.
70	58.5	50	20		site 9	Crooked Cr.
30	30.9	30	0		mouth	Crooked Cr.
			-1	average		
			12.87	std dev		
			7.97	95%CI		

5.1.2.2 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.

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 such that 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 3).

For each stream evaluated in the load analysis, natural bankfull width was estimated based on the drainage area of the Salmon Basin curve from Figure 3. Although estimates from other curves were examined (i.e., Upper Snake, Payette/Weiser), the Salmon Basin curve was ultimately chosen because of its proximity to the Crooked Creek watershed and similarity of climate and geology. Existing width data should also be evaluated and compared to these curve estimates if such data are available. However, for the Crooked Creek watershed, only a few BURP sites exist, and bankfull width data from those sites represent only spot data (e.g., only three measured widths in a reach just several hundred meters long) that are not always representative of the stream as a whole.

In general, we found BURP bankfull width data to generally agree with natural bankfull width estimates from the Salmon Basin curve and chose not to make Crooked Creek natural widths any larger than these existing estimates. For tributary streams and the 5th-order portion of Crooked Creek below Lake Creek, no existing bankfull width data were available, so Salmon Basin curve estimates are used for natural widths. Natural bankfull width estimates for each stream in this analysis are presented in Table 10. 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 C-2–Table C-5. Existing widths and natural widths are the same in load tables when there are no data to support making them differ.

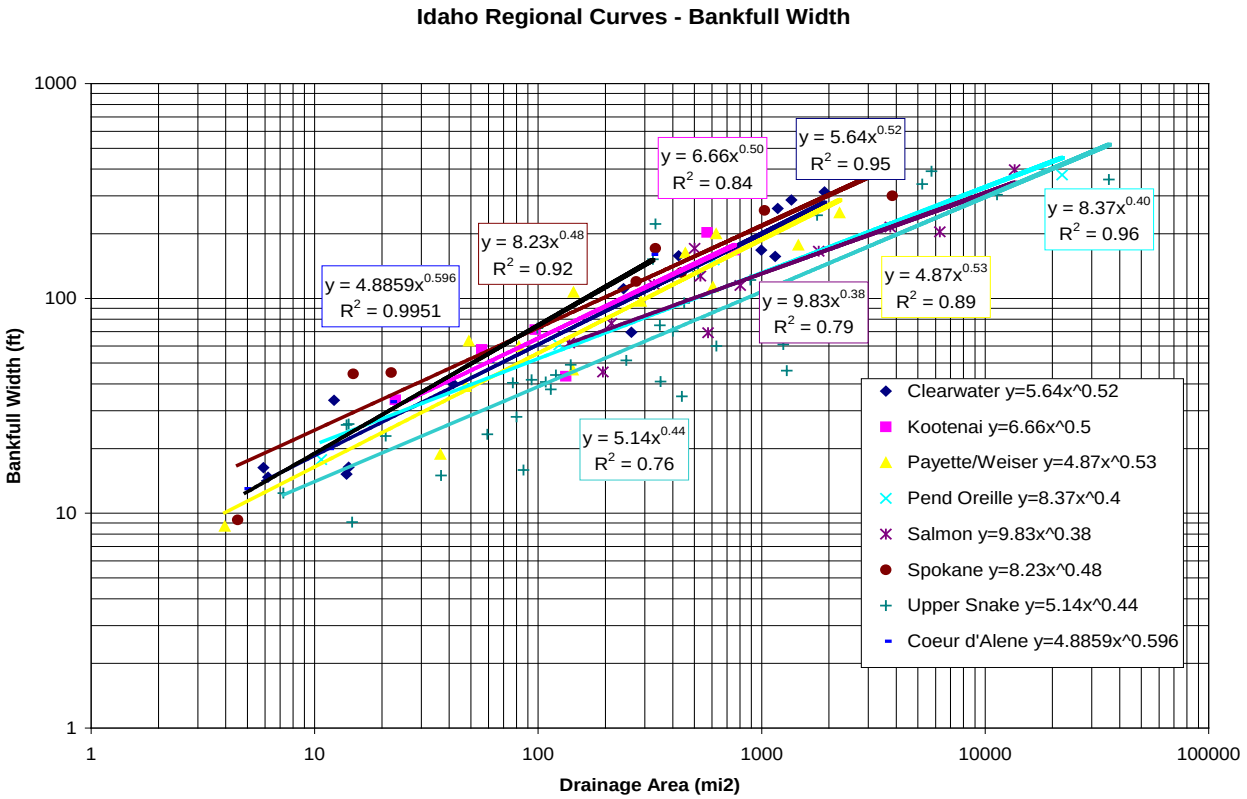


Figure 3. Bankfull width as a function of drainage area.

Table 10. Bankfull width estimates for Crooked Creek and tributaries.

Location	area (sq mi)	US (m)	Salm (m)	P/W (m)	existing (m)
Crooked Creek @ mouth	131.85	13	19	20	
Crooked Creek bl Lake Creek	102.3	12	17	17	
Crooked Creek ab Lake Creek	57.1	9	14	13	12
Crooked Creek bl Big Creek	55.37	9	14	12	11
Crooked Creek ab Big Creek	27.23	7	11	9	9.85
Crooked Creek ab Little Blowout Cr	20.6	6	9	7	8
Crooked Creek ab Olive Creek	13.82	5	8	6	6.28
Crooked Creek ab Boulder Creek	6.7	4	6	4	4
Crooked Creek ab Horse Flat Creek	1.81	2	4	2	2
Horse Flat Creek @ mouth	2.22	2	4	2	
Nuggat Gulch @ mouth	0.58	1	2	1	
Boulder Creek @ mouth	1.81	2	4	2	
4th of July Creek @ mouth	1.74	2	4	2	
Blane Creek @ mouth	0.57	1	2	1	
Hundred Dollar Gulch @ mouth	0.57	1	2	1	
Olive Creek @ mouth	2.1	2	4	2	
Sams Creek @ mouth	1.95	2	4	2	
Little Blowout Creek @ mouth	2.78	2	4	3	

Note: US = Upper Snake, Salm = Salmon, P/W = Payette/Weiser basin curves. Blank spaces under existing means no data available for that location.

Design Conditions

Upper Crooked Creek is found in the South Clearwater Forested Mountains level 4 ecoregion (McGrath et al. 2001) of the Idaho Batholith, a region known for sandy soils from its underlying granitics. The South Clearwater Forested Mountains are in a Maritime influence transition zone where Pacific coastal weather patterns only slightly influence tree species. Grand fir appears to be the only Maritime tree species here occupying the zone between subalpine fir-dominated forests and Douglas fir forests.

Lower Crooked Creek enters the Hot Dry Canyons level 4 ecoregion where deeply dissected terrain strongly influences weather. The Salmon River canyon is warm and dry, which increases with depth. Little winter snowfall occurs and Ponderosa pine, mountain sagebrush, and grasses are predominant. Douglas fir occurs but is less common then further north. South-facing slopes tend to be less wooded then north-facing slopes.

Shade Curve Selection

To determine PNV shade targets for Crooked Creek, effective shade curves from Nez Perce National Forest land-types were examined (Table 11) (Shumar and De Varona 2009). These curves were produced using vegetation community modeling of Idaho plant communities. Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis. For Crooked Creek, curves for the most similar vegetation type were selected for shade target determinations (Figure 4). Upper Crooked Creek tends to be dominated by the uplands forest type although subalpine type occurs at higher elevations of tributaries. Lower gradient portions of upper Crooked Creek tend to be dominated by alders at the stream side with forests set back several meters. We created a special shade curve for these alder sections where the nonforest alder type shade dimensions occupies the first 10 meters of stream side in the model followed by the upland forest type in the background beyond 10 meters (Appendix C, Figure C-1 shade curve).

The previous TMDL (DEQ 2002) had identified the meadows area as either coyote willow or tufted hairgrass plant communities, and we believe that information was incorrect. The stream-side vegetation in the vicinity of the meadows area near the Dixie work center and airstrip appear to be dominated by a low (2 meter) statured Lemmons willow. A shade curve was developed for Lemmons willow communities where Lemmons willow and wolfs willow codominate with shrubby cinquefoil and graminoids. The shade type's canopy cover equals 81%, and the weighted average height and overhang are 1.3 meters and 0.6 meter, respectively (Appendix C, Figure C-2 shade curve).

Below the willow meadows, Crooked Creek enters the breakland forest type for the remainder of its course to the Salmon River. This area was largely burned by wildfires in the mid-1990s although remnant patches of forest exist adjacent to the stream.

Table 11. Shade curves for the forest and nonforest vegetation types at Crooked Creek.

Forest Types	Nonforest Types
Nez Perce National Forest Subalpine	Lemmons willow
Nez Perce National Forest Upland	—
Nez Perce National Forest Breakland	—
Alder-Upland hybrid	—

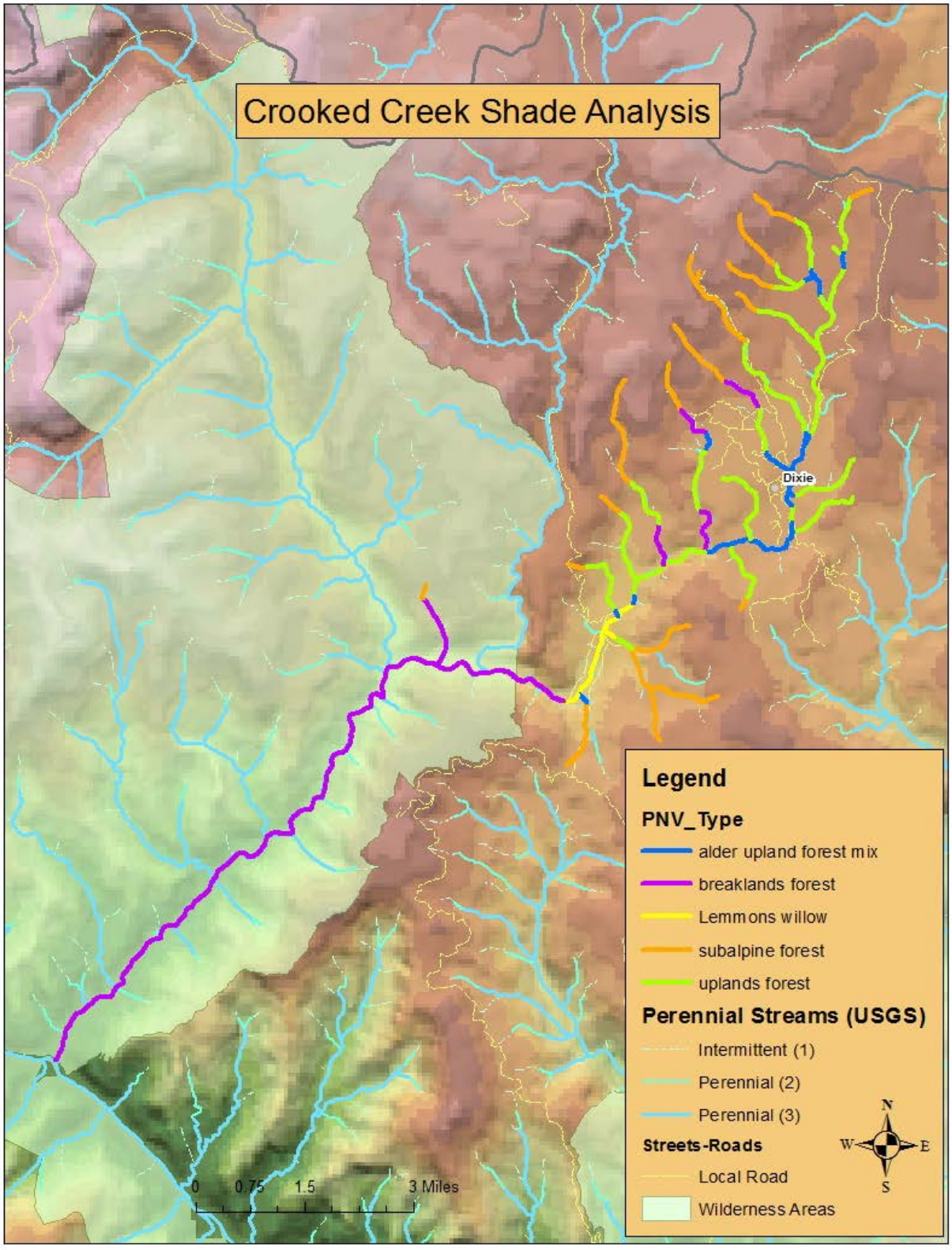


Figure 4. Vegetation types for target shade on Crooked Creek.

5.2 Load Capacity

The load capacity for a stream under PNV is essentially the solar load 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.

We obtained solar load data from flat-plate collectors at the NREL weather stations in Pendleton, Oregon, and Missoula, 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). As such, load capacity calculations are also based on this 6-month period, which coincides with the time of year when stream temperatures are increasing, deciduous vegetation is in leaf, and fall spawning is occurring. During this period, temperatures may affect beneficial uses such as spring and fall salmonid spawning and cold water aquatic life criteria may be exceeded during summer months. Late July and early August typically represent the period of highest stream temperatures. However, solar gains can begin early in the spring and affect not only the highest temperatures reached later in the summer but also salmonid spawning temperatures in spring and fall.

Table C-2–Table C-5 and Figure C-2 show the PNV shade targets. The tables also 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 segments channel width, 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 5th-order Crooked Creek (ID17060207SL067_05) with 950,000 kWh/day (Table C-5). The smallest target load was in the 4th-order Crooked Creek AU (ID 17060207SL068_04) with 94,000 kWh/day (Table C-4).

5.3 Estimates of Existing Pollutant Loads

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

Existing loads in this temperature TMDL come from estimates of existing shade as determined from aerial photo interpretations. Currently, no known permitted point sources exist 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. Existing shade data are presented in Tables C-2–Table C-5 and Figure C-3. Like load capacities (target loads), existing loads in Table C-2–Table C-5 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. Should existing load exceed target load, this difference becomes the excess load (i.e., lack of shade) to be discussed next in the load allocation section and as depicted in the shade deficit figure (Figure C-4).

The AU with the largest existing load was the 5th-order Crooked Creek (ID 17060207SL067_05) with 1.1 million kWh/day (Table C-5). The smallest existing load was in the 4th-order Crooked Creek AU (ID 17060207SL068_04) with 96,000 kWh/day (Table C-4).

5.4 Load and Wasteload Allocation

Because this TMDL is based on PNV, which is equivalent to background loading, the load allocation is essentially the desire to achieve background conditions. However, to reach that objective, load allocations are assigned to 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. Table C-2–Table C-5 show the target shade and corresponding target summer load. This target load (i.e., load capacity) is necessary to achieve background conditions. No opportunity exists to further remove shade from the stream by any activity without exceeding its load capacity. Additionally, because this TMDL is dependent upon 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 12 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. Table 12 lists the AUs in order of their excess loads, from highest to lowest. Therefore, large AUs tend to be listed first and small AUs last.

Although this TMDL analysis focuses on total solar loads, it is important to note that differences between existing and target shade, as depicted in the shade deficit figure (Figure C-4), are the key to successfully restoring these waters to achieving water quality standards. 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. Thus, 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 is listed in Table 12 and provides a general level of comparison among streams.

Table 12. Total solar loads and average lack of shade for all waters.

Water Body/ Assessment Unit Number	Total Existing Load	Total Target Load	Excess Load (%Reduction)	Average Lack of Shade (%)
	(kWh/day)			
Crooked Creek—				
ID17060207SL068_02	340,000	160,000	180,000 (53%)	-21
ID17060207SL068_03	130,000	120,000	4,000 (3%)	-3
ID17060207SL068_04	96,000	94,000	2,100 (2%)	-5
ID17060207SL067_05	1,100,000	950,000	190,000 (17%)	-9

Note: Load data are rounded to two significant figures, which may present rounding errors.

The 2nd-order AU of Crooked Creek has been impacted the most as the result of historic vegetation removal. The excess load for that AU was 53% of its total existing solar load, and the average shade deficit was -21%, much greater than the other AUs in the watershed. The 5th-order AU had the largest excess load due to extensive wildfires in the region in the past. However, that excess load was only 17% of the total existing solar load and average shade deficit was -9%. The 3rd- and 4th-order AUs are relatively unimpacted by shade removal. The 4th-order AU was previously assessed as fully supporting beneficial uses and is an unburned section within the wilderness area. The 3rd-order AU includes the lower two-thirds of the willow meadow and breakland type forests just before entering the wilderness area.

A comparison of existing shade levels developed for the 2002 TMDL to the new (2013) aerial interpretation existing shade levels suggests that shade was either previously overestimated or has been reduced somewhat in intervening years (Table 13). Existing shade in the 2nd-order AU closely matched an average shade level of 39% in 2002 compared to the current average of 41%. However, 38 different shade segments were reviewed in 2013 compared to only 9 segments in 2002. The 2002 shade levels were modeled and were not based on the aerial photo interpretation techniques used presently. The current aerial interpretation methodology provides finer resolution. Existing shade estimates in the next three AUs were consistently overestimated in 2002 with average levels for the two years differing by 8% to 14%. It is possible that shade levels have decreased between 2002 and 2013; however, we suspect that the original modeling effort simply over-estimated existing shade. Based on observations, conditions in and around the stream have not changed that much in the eleven year period.

Table 13. Average existing shade (number of segments) comparison between 2002 TMDL and 2013 5-year review.

Water Body/Assessment Unit Number	2002 Existing Shade (Number of Segments)	2013 Existing Shade (Number of Segments)
Crooked Creek—		
ID17060207SL068_02	39% (9)	41% (38)
ID17060207SL068_03	47% (3)	39% (9)
ID17060207SL068_04	53% (3)	43% (4)
ID17060207SL067_05	37% (12)	23% (15)

In the 2002 TMDL analysis, the wilderness portion (4th and 5th order AUs) of Crooked Creek showed the largest shade deficits (DEQ 2002). These deficits were likely due to applying inappropriate shade targets to this lower canyon country. Developing specific shade curves based on national forest historic range of variability information (Shumar and De Varona 2009) increased our ability to target local conditions.

The previous TMDL identified shade deficits that varied from -10% to -45% along Crooked Creek above the wilderness area. Current estimates of shade deficit (Table C-4 and Table C-5) are considerably more precise than before but are still demonstrating similar conditions with an average deficit of -21% (Table 12). The previous TMDL incorrectly identified the 5th-order AU as the area in need of the most rehabilitation, but the present analysis indicates that is clearly not true. Although the 5th- order AU has been extensively burned in wildfires, target shade is considerably lower than previously anticipated due to a better understanding of forest types and targets based on channel width, which is large at the mouth of Crooked Creek. The 5th-order AU is not the most impacted stream segment. The present analysis indicates that the 2nd-order AU in the vicinity of Dixie, where human-related activities have occurred over the last 150 years, is the most impacted area and should receive the most attention for rehabilitation.

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. The automatic difference of 6% could be attributed to the margin of safety.

5.4.1 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 reads as follows:

> 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 water quality standards indicate the following:

> The adoption of water quality standards 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 for the purpose of keeping channel water cooler for aquatic life.

5.4.2 Margin of Safety

The margin of safety in this TMDL is considered implicit in the design. Because the target is essentially background conditions, loads (shade levels) are allocated to lands adjacent to these streams at natural background levels. Because shade levels are established at natural background or system potential levels, it is unrealistic to set shade targets at higher, or more conservative, levels. 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. The automatic difference of 6% could be attributed to the margin of safety , 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.

5.4.3 Seasonal Variation

This TMDL is based on average summer loads. All loads have been calculated to be inclusive of 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. The critical time periods are April through June when spring salmonid spawning occurs, July and August when maximum temperatures may exceed cold water aquatic life criteria, and September when fall salmonid spawning 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.

5.4.4 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 (BAGs) and WAGs. The Clearwater Basin Advisory Group is the designated BAG for the Crooked Creek watershed in this subbasin.

The Idaho 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 14.

Table 14. 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

Idaho uses a voluntary approach to address agricultural nonpoint sources; however, regulatory authority is found in the water quality standards (IDAPA 58.01.02.350.01–03). IDAPA 58.01.02.055.07 refers to the Idaho Agricultural Pollution Abatement Plan (Ag Plan) (ISWCC 2015), which provides direction to the agricultural community regarding approved BMPs. A portion of the Ag Plan outlines responsible agencies or elected groups (soil conservation districts) that will take the lead if nonpoint source pollution problems need to be addressed. For

agricultural activity, the Ag Plan assigns the local soil conservation districts to assist the landowner/operator with developing and implementing BMPs to abate nonpoint source pollution associated with the land use. If a voluntary approach does not succeed in abating the pollutant problem, the state may seek injunctive relief for those situations determined to be an imminent and substantial danger to public health or the environment (IDAPA 58.01.02.350.02(a)).

The Idaho water quality standards and wastewater treatment requirements specify that if water quality monitoring indicates that water quality standards are not being met, even with the use of BMPs or knowledgeable and reasonable practices, the state may request that the designated agency evaluate and/or modify the BMPs to protect beneficial uses. If necessary, the state may seek injunctive or other judicial relief against the operator of a nonpoint source activity in accordance with the DEQ director's authority provided in Idaho Code §39-108 (IDAPA 58.01.02.350). The water quality standards list designated agencies responsible for reviewing and revising nonpoint source BMPs: the Idaho Department of Lands for timber harvest activities, oil and gas exploration and development, and mining activities; Idaho Soil and Water Conservation Commission for grazing and agricultural activities, Idaho Transportation Department for public road construction, Idaho State Department of Agriculture for aquaculture, and DEQ for all other activities (IDAPA 58.01.02.010.24).

5.4.5 Construction Stormwater and TMDL Wasteload Allocation

There are no known National Pollutant Discharge Elimination System permitted point sources in the affected watersheds and thus no wasteload allocations. Should a point source be proposed that would have thermal consequences on these waters, background provisions in Idaho 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 that is associated with municipal separate storm sewer systems, industrial stormwater covered under the Multi-Sector General Permit, and construction stormwater covered under the Construction General Permit. For more information about these permits and managing stormwater, see Appendix D.

5.4.6 Reserve for Growth

A growth reserve has not been included in this TMDL. The load capacity has been allocated to the existing sources in the watershed. Any new sources must obtain an allocation from the existing load allocation.

5.5 Implementation Strategies

Implementation strategies for TMDLs produced using PNV-based shade and solar loads should incorporate the load analysis tables presented in this TMDL (Table C-2–Table C-5). 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. Due to the inexact nature of the aerial photo interpretation technique, these tables should not be viewed as complete until verified. Implementation strategies should include Solar Pathfinder monitoring to simultaneously field verify the TMDL and mark progress toward achieving desired load reductions.

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 (addressed in section 5.4.4) for the TMDL to meet water quality standards is based on the implementation strategy. 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). It is important that existing shade for each stream segment be field verified to determine if shade differences are real and result from activities that are controllable. Information within this TMDL (maps and load analysis tables) 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.

5.5.1 Time Frame

Implementation of this 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, targets for smaller streams may be reached sooner than those for larger streams.

DEQ and the BAG will continue to reevaluate TMDLs on a 5-year cycle. During the 5-year review, implementation actions completed, in progress, and planned will be reviewed, and pollutant load allocations will be reassessed accordingly.

5.5.2 Implementation Monitoring Strategy

Effective shade monitoring can take place on any segment throughout the Crooked Creek watershed and be compared to existing shade estimates seen in Figure C-3 and described in Table C-2–Table C-5. 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. Because many existing shade estimates have not been field verified, 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.

5.5.3 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. For more information, see Appendix E.

6 Conclusions

Effective shade targets were established for the four AUs in the Crooked Creek watershed 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 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). A summary of assessment outcomes, including recommended changes to listing status in the next Integrated Report, is presented in Table 15 and Table 16.

This 5-year review of an existing, approved temperature TMDL updated existing shade levels and shade targets using the PNV approach. The 2002 TMDL indicated the 5th-order AU was the largest problem area due to solar load and temperature. This review determined that the 5th-order segment, although damaged by wildfire, is not the most impacted area. Because channel widths are naturally wide and dry forests are thin in the 5th-order region, it naturally has low shade targets. The 2nd-order section, which includes Dixie where 150 years of mining and settlement have occurred, is the primary source of excess solar load to the stream system.

Target shade levels for individual stream segments 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.

Table 15. Summary of assessment outcomes.

Assessment Unit Name	Assessment Unit Number	Pollutant	TMDL Completed	Recommended Changes to Next Integrated Report	Justification
Crooked Creek—source to Blowout Creek and 1st- and 2nd-order tributaries	ID17060207SL068_02	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade
Crooked Creek—Blowout Creek to Big Creek	ID17060207SL068_03	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade
Crooked Creek—Lake Creek to mouth	ID17060207SL067_05	Temperature	Yes	Remain in Category 4a	Excess solar load from a lack of existing shade

Table 16. Summary of assessment outcomes for unlisted assessment units.

Assessment Unit Name	Assessment Unit Number	Pollutant	TMDL(s) Completed	Recommended Changes to Next Integrated Report	Justification
Crooked Creek—Big Creek to Lake Creek	ID17060207SL068_04	Temperature	Yes	Not impaired, remain in Category 1	Informational temperature TMDL completed

This document was prepared with input from the public, as described in Appendix F. 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 G.

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GIS Coverages

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USDA – FSA Aerial Photography Field Office - 2013 National Agricultural Imagery Program (NAIP) 0.5m imagery

USDA – FSA Aerial Photography Field Office - 2015 National Agricultural Imagery Program (NAIP) 1.0m imagery

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 US Environmental Protection Agency approval.

Ambient

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

Anthropogenic

Relating to, or resulting from, the influence of human beings on nature.

Assessment Unit (AU)

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

Beneficial Use

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

Beneficial Use Reconnaissance Program (BURP)

A program for conducting systematic biological and physical habitat surveys of water bodies in Idaho. BURP protocols address lakes, reservoirs, 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 exiting beneficial uses as determined through the *Water Body Assessment Guidance* (DEQ 2016).

Load Allocation (LA)

A portion of a water body's load capacity for a given pollutant that is allocated 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 loading capacity set aside to allow for uncertainty about the relationship between the pollutant loads and the quality of the receiving water body. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The MOS is not allocated to any sources of pollution.
Natural Condition	The condition that exists with little or no anthropogenic influence.
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 of 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 a use support 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* (DEQ 2016).
Point Source	A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable "point" of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.

Pollutant	Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Pollution	A very broad concept that encompasses human-caused changes in the environment that alters the functioning of natural processes and produce undesirable environmental and health effects. These changes include human-induced alterations 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.
Riparian	Associated with aquatic (stream, river, lake) habitats. Living or located on the bank of a water body.
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 loading capacity that is allocated to one of its existing or future point sources of pollution.

	Wasteload allocations specify how much pollutant each point source may release to a water body.
Water Body	A stream, river, lake, estuary, coastline, or other water feature, or portion thereof.
Water Quality Criteria	Levels of water quality expected to render a water body suitable for its designated uses. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, or industrial processes.
Water Quality Standards	State-adopted and US 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

Existing Uses

Existing uses under the Clean Water Act 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 salmonid spawning to a water that supported salmonid spawning 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 Clean Water Act 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 water aquatic life or salmonid spawning. Designated uses are described in the Idaho 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 non-designated waters. Sections 101.02 and 101.03 specifically address non-designated 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 water aquatic life and either primary or secondary contact 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., salmonid spawning) exists, then the additional numeric criteria for salmonid spawning 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 aquatic life) 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

Water Quality Standards Applicable to Salmonid Spawning Temperature

Water quality standards for temperature are specific numeric values not to be exceeded during the salmonid spawning 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 2016). 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 potential natural vegetation temperature TMDLs, it is assumed that natural temperatures may exceed these criteria during certain time periods. If potential natural vegetation 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 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)

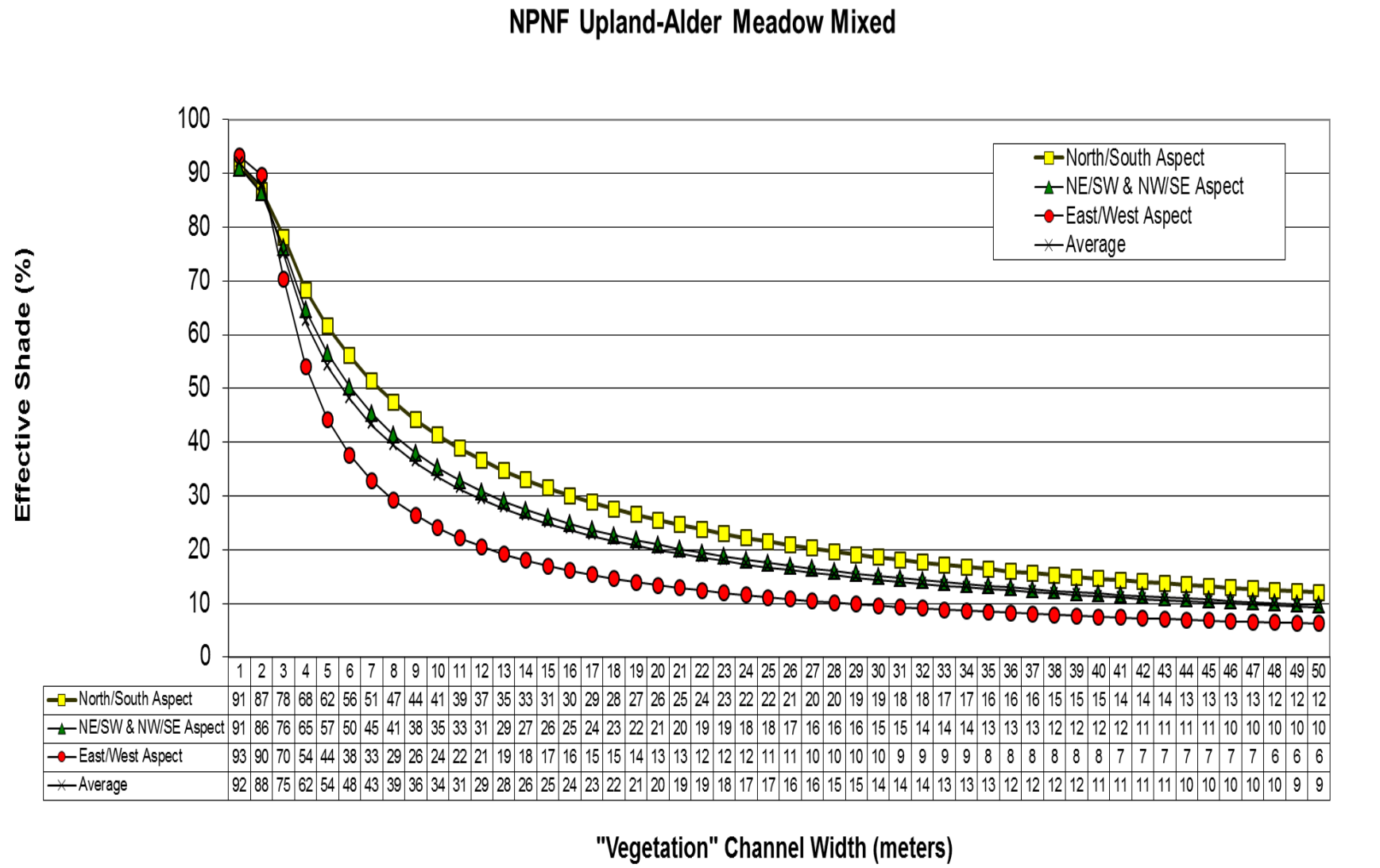
Section 401 relates to point source wastewater treatment requirements. In this case, if temperature criteria for any aquatic life use are exceeded due to natural conditions, then a point source discharge cannot raise the water temperature by more than 0.3 °C (IDAPA 58.01.02.401.01.c).

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Appendix C. Data Sources and Target Shade Curve Data

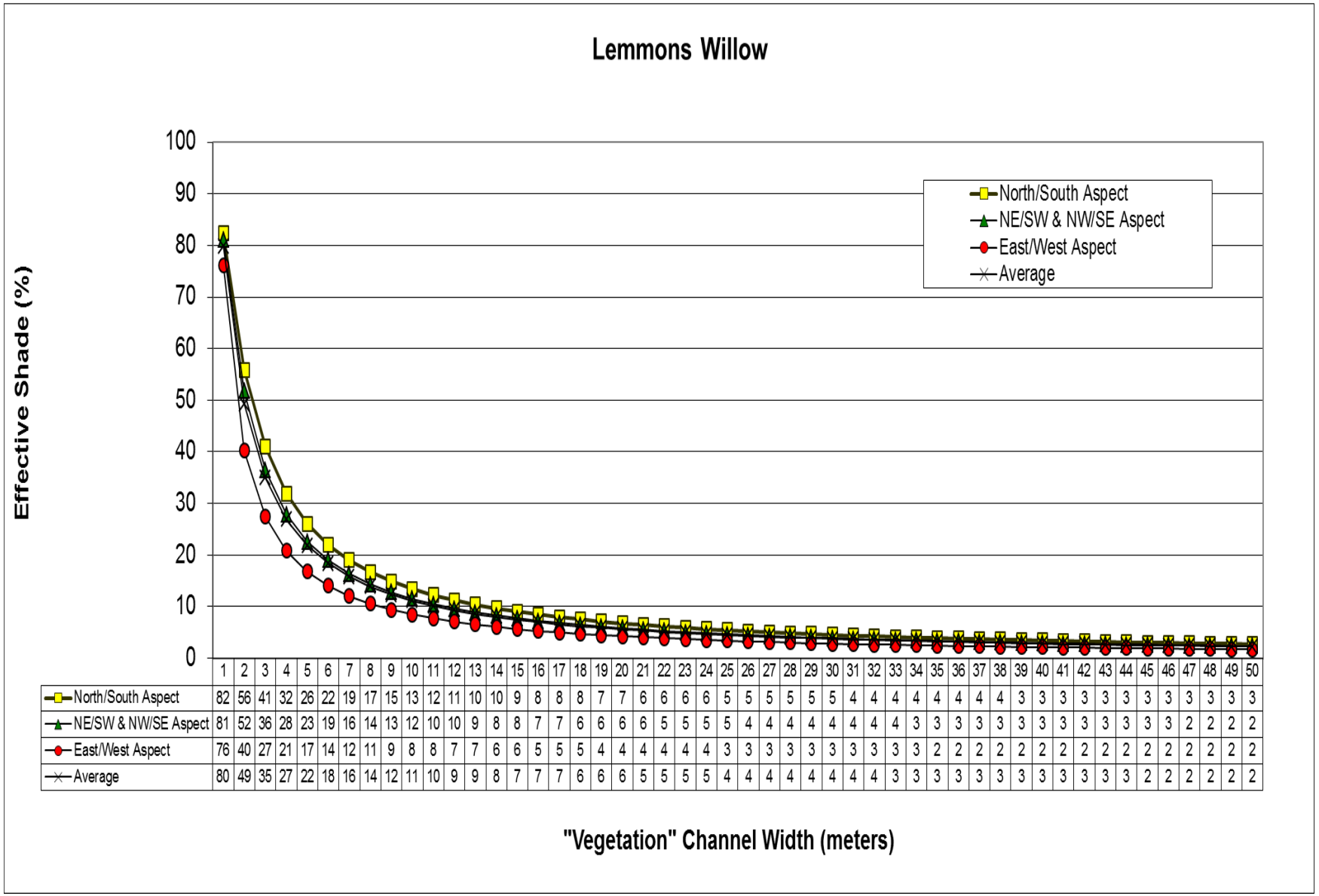
Table C-1. Data sources for Crooked Creek subbasin assessment.

Water Body	Data Source	Type of Data	Collection Date
Crooked Creek	DEQ Lewiston Regional Office	Solar Pathfinder effective shade and stream width	Summer 2013
Crooked Creek	DEQ State Technical Services Office	Aerial photo interpretation of existing shade and stream width estimation	Summer 2013
Crooked Creek	DEQ IDASA Database	Temperature	June–Sept 2012



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	91	87	78	68	62	56	51	47	44	41	39	37	35	33	31	30	29	28	27	26	25	24	23	22	22	21	20	20	19	19	18	18	17	17	16	16	16	15	15	15	14	14	14	13	13	13	13	12	12	12
NE/SW & NW/SE Aspect	91	86	76	65	57	50	45	41	38	35	33	31	29	27	26	25	24	23	22	21	20	19	19	18	18	17	16	16	16	15	15	14	14	14	13	13	13	12	12	12	12	11	11	11	11	10	10	10	10	10
East/West Aspect	93	90	70	54	44	38	33	29	26	24	22	21	19	18	17	16	15	15	14	13	13	12	12	12	11	11	10	10	10	10	9	9	9	9	8	8	8	8	8	8	7	7	7	7	7	7	7	6	6	6
Average	92	88	75	62	54	48	43	39	36	34	31	29	28	26	25	24	23	22	21	20	19	19	18	17	17	16	16	15	15	14	14	14	13	13	13	12	12	12	12	11	11	11	11	10	10	10	10	10	9	9

Figure C-1. Target shade curve for the alder-upland forest hybrid community used in the Crooked Creek temperature TMDL.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	82	56	41	32	26	22	19	17	15	13	12	11	10	10	9	8	8	8	7	7	6	6	6	6	5	5	5	5	5	5	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3
NE/SW & NW/SE Aspect	81	52	36	28	23	19	16	14	13	12	10	10	9	8	8	7	7	6	6	6	6	5	5	5	5	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2
East/West Aspect	76	40	27	21	17	14	12	11	9	8	8	7	7	6	6	5	5	5	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
Average	80	49	35	27	22	18	16	14	12	11	10	9	9	8	7	7	7	6	6	6	5	5	5	5	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2

Figure C-2. Target shade curve for the Lemmons willow plant community used in the Crooked Creek temperature TMDL.

Table C-2. Existing and target solar loads for 2nd-order Crooked Creek and its tributaries.

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
068_02	Crooked Creek	1	490	subalpine	98%	0.12	1	500	60	90%	0.58	1	500	300	200	-8%
068_02	Crooked Creek	2	820	uplands	98%	0.12	1	800	90	90%	0.58	1	800	500	400	-8%
068_02	Crooked Creek	3	520	uplands	98%	0.12	1	500	60	80%	1.16	1	500	600	500	-18%
068_02	Crooked Creek	4	48	alder upland	88%	0.69	2	100	70	20%	4.63	2	100	500	400	-68%
068_02	Crooked Creek	5	260	alder upland	88%	0.69	2	500	300	50%	2.90	2	500	1,000	700	-38%
068_02	Crooked Creek	6	790	uplands	98%	0.12	2	2,000	200	80%	1.16	2	2,000	2,000	2,000	-18%
068_02	Crooked Creek	7	230	uplands	98%	0.12	2	500	60	60%	2.32	2	500	1,000	900	-38%
068_02	Crooked Creek	8	170	uplands	98%	0.12	2	300	30	20%	4.63	2	300	1,000	1,000	-78%
068_02	Crooked Creek	9	140	uplands	98%	0.12	2	300	30	50%	2.90	2	300	900	900	-48%
068_02	Crooked Creek	10	150	uplands	98%	0.12	2	300	30	40%	3.47	2	300	1,000	1,000	-58%
068_02	Crooked Creek	11	140	uplands	97%	0.17	3	400	70	30%	4.05	3	400	2,000	2,000	-67%
068_02	Crooked Creek	12	790	uplands	97%	0.17	3	2,000	300	40%	3.47	3	2,000	7,000	7,000	-57%
068_02	Crooked Creek	13	600	uplands	97%	0.17	3	2,000	300	50%	2.90	3	2,000	6,000	6,000	-47%
068_02	Crooked Creek	14	160	uplands	97%	0.17	3	500	90	30%	4.05	3	500	2,000	2,000	-67%
068_02	Crooked Creek	15	400	uplands	95%	0.29	4	2,000	600	60%	2.32	4	2,000	5,000	4,000	-35%
068_02	Crooked Creek	16	130	uplands	95%	0.29	4	500	100	20%	4.63	4	500	2,000	2,000	-75%
068_02	Crooked Creek	17	88	uplands	95%	0.29	4	400	100	40%	3.47	4	400	1,000	900	-55%
068_02	Crooked Creek	18	190	uplands	95%	0.29	4	800	200	60%	2.32	4	800	2,000	2,000	-35%
068_02	Crooked Creek	19	250	uplands	95%	0.29	4	1,000	300	40%	3.47	4	1,000	3,000	3,000	-55%
068_02	Crooked Creek	20	180	alder upland	62%	2.20	4	700	2,000	30%	4.05	4	700	3,000	1,000	-32%
068_02	Crooked Creek	21	460	alder upland	62%	2.20	4	2,000	4,000	20%	4.63	4	2,000	9,000	5,000	-42%
068_02	Crooked Creek	22	840	alder upland	54%	2.66	5	4,000	10,000	20%	4.63	5	4,000	20,000	10,000	-34%
068_02	Crooked Creek	23	73	alder upland	54%	2.66	5	400	1,000	40%	3.47	5	400	1,000	0	-14%
068_02	Crooked Creek	24	210	alder upland	54%	2.66	5	1,000	3,000	20%	4.63	5	1,000	5,000	2,000	-34%
068_02	Crooked Creek	25	380	uplands	93%	0.41	5	2,000	800	40%	3.47	5	2,000	7,000	6,000	-53%
068_02	Crooked Creek	26	500	alder upland	54%	2.66	5	3,000	8,000	20%	4.63	5	3,000	10,000	2,000	-34%
068_02	Crooked Creek	27	110	alder upland	48%	3.01	6	700	2,000	40%	3.47	6	700	2,000	0	-8%
068_02	Crooked Creek	28	93	alder upland	48%	3.01	6	600	2,000	20%	4.63	6	600	3,000	1,000	-28%
068_02	Crooked Creek	29	1300	alder upland	48%	3.01	6	8,000	20,000	40%	3.47	6	8,000	30,000	10,000	-8%
068_02	Crooked Creek	30	540	alder upland	48%	3.01	6	3,000	9,000	50%	2.90	6	3,000	9,000	0	0%
068_02	Crooked Creek	31	120	alder upland	43%	3.30	7	800	3,000	40%	3.47	7	800	3,000	0	-3%
068_02	Crooked Creek	32	460	uplands	88%	0.69	7	3,000	2,000	60%	2.32	7	3,000	7,000	5,000	-28%
068_02	Crooked Creek	33	1300	uplands	88%	0.69	7	9,000	6,000	50%	2.90	7	9,000	30,000	20,000	-38%
068_02	Crooked Creek	34	380	uplands	88%	0.69	8	3,000	2,000	50%	2.90	8	3,000	9,000	7,000	-38%
068_02	Crooked Creek	35	180	alder upland	39%	3.53	8	1,000	4,000	40%	3.47	8	1,000	3,000	(1,000)	0%
068_02	Crooked Creek	36	460	lemmons willow	14%	4.98	8	4,000	20,000	10%	5.21	8	4,000	20,000	0	-4%
068_02	Crooked Creek	37	410	lemmons willow	14%	4.98	8	3,000	10,000	20%	4.63	8	3,000	10,000	0	0%
068_02	Crooked Creek	38	82	lemmons willow	14%	4.98	8	700	3,000	10%	5.21	8	700	4,000	1,000	-4%

Note: All assessment unit (AU) numbers start with ID17060207SL in all load tables (Tables C-2 –C-5). Significant figures are controlled by the lowest level in the calculation, typically that of the channel width. Some rounding errors may result.

Table C-2 (continued). Existing and target solar loads for 2nd-order Crooked Creek and its tributaries.

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
068_02	1st to Crooked	1	280	uplands	98%	0.12	1	300	30	80%	1.16	1	300	300	300	-18%
068_02	Horse Flat Creek	1	410	subalpine	98%	0.12	1	400	50	90%	0.58	1	400	200	200	-8%
068_02	Horse Flat Creek	2	190	subalpine	98%	0.12	1	200	20	80%	1.16	1	200	200	200	-18%
068_02	Horse Flat Creek	3	160	subalpine	98%	0.12	1	200	20	70%	1.74	1	200	300	300	-28%
068_02	Horse Flat Creek	4	240	subalpine	97%	0.17	2	500	90	90%	0.58	2	500	300	200	-7%
068_02	Horse Flat Creek	5	170	subalpine	97%	0.17	2	300	50	80%	1.16	2	300	300	300	-17%
068_02	Horse Flat Creek	6	610	uplands	98%	0.12	2	1,000	100	90%	0.58	2	1,000	600	500	-8%
068_02	Horse Flat Creek	7	150	uplands	97%	0.17	3	500	90	90%	0.58	3	500	300	200	-7%
068_02	Horse Flat Creek	8	310	alder upland	75%	1.45	3	900	1,000	50%	2.90	3	900	3,000	2,000	-25%
068_02	Horse Flat Creek	9	250	alder upland	62%	2.20	4	1,000	2,000	20%	4.63	4	1,000	5,000	3,000	-42%
068_02	Horse Flat Creek	10	220	alder upland	62%	2.20	4	900	2,000	30%	4.05	4	900	4,000	2,000	-32%
068_02	Horse Flat Creek	11	140	uplands	95%	0.29	4	600	200	90%	0.58	4	600	300	100	-5%
068_02	Horse Flat Creek	12	86	uplands	95%	0.29	4	300	90	70%	1.74	4	300	500	400	-25%
068_02	Horse Flat Creek	13	110	uplands	95%	0.29	4	400	100	40%	3.47	4	400	1,000	900	-55%
068_02	1st to Horse Flat	1	1300	subalpine	98%	0.12	1	1,000	100	90%	0.58	1	1,000	600	500	-8%
068_02	1st to Horse Flat	2	190	subalpine	97%	0.17	2	400	70	80%	1.16	2	400	500	400	-17%
068_02	1st to Horse Flat	3	680	uplands	98%	0.12	2	1,000	100	90%	0.58	2	1,000	600	500	-8%
068_02	2nd to Horse Flat	1	770	subalpine	98%	0.12	1	800	90	90%	0.58	1	800	500	400	-8%
068_02	2nd to Horse Flat	2	320	subalpine	98%	0.12	1	300	30	80%	1.16	1	300	300	300	-18%
068_02	2nd to Horse Flat	3	1300	uplands	98%	0.12	2	3,000	300	90%	0.58	2	3,000	2,000	2,000	-8%
068_02	2nd to Horse Flat	4	210	alder upland	75%	1.45	3	600	900	40%	3.47	3	600	2,000	1,000	-35%
068_02	Nugget Gulch	1	230	subalpine	98%	0.12	1	200	20	90%	0.58	1	200	100	80	-8%
068_02	Nugget Gulch	2	230	subalpine	98%	0.12	1	200	20	50%	2.90	1	200	600	600	-48%
068_02	Nugget Gulch	3	190	subalpine	98%	0.12	1	200	20	60%	2.32	1	200	500	500	-38%
068_02	Nugget Gulch	4	540	uplands	98%	0.12	1	500	60	90%	0.58	1	500	300	200	-8%
068_02	Nugget Gulch	5	220	uplands	98%	0.12	2	400	50	80%	1.16	2	400	500	500	-18%
068_02	Nugget Gulch	6	940	uplands	98%	0.12	2	2,000	200	70%	1.74	2	2,000	3,000	3,000	-28%
068_02	Boulder Creek	1	310	subalpine	98%	0.12	1	300	30	90%	0.58	1	300	200	200	-8%
068_02	Boulder Creek	2	320	subalpine	98%	0.12	1	300	30	70%	1.74	1	300	500	500	-28%
068_02	Boulder Creek	3	230	subalpine	98%	0.12	1	200	20	80%	1.16	1	200	200	200	-18%
068_02	Boulder Creek	4	1600	subalpine	97%	0.17	2	3,000	500	90%	0.58	2	3,000	2,000	2,000	-7%
068_02	Boulder Creek	5	1700	uplands	97%	0.17	3	5,000	900	90%	0.58	3	5,000	3,000	2,000	-7%
068_02	Boulder Creek	6	770	uplands	95%	0.29	4	3,000	900	80%	1.16	4	3,000	3,000	2,000	-15%
068_02	Boulder Creek	7	200	uplands	95%	0.29	4	800	200	70%	1.74	4	800	1,000	800	-25%
068_02	Boulder Creek	8	240	alder upland	62%	2.20	4	1,000	2,000	40%	3.47	4	1,000	3,000	1,000	-22%
068_02	1st to Boulder	1	260	subalpine	98%	0.12	1	300	30	90%	0.58	1	300	200	200	-8%
068_02	Fourth Of July Creek	1	1700	subalpine	98%	0.12	1	2,000	200	90%	0.58	1	2,000	1,000	800	-8%
068_02	Fourth Of July Creek	2	970	breaklands	94%	0.35	2	2,000	700	90%	0.58	2	2,000	1,000	300	-4%
068_02	Fourth Of July Creek	3	540	uplands	97%	0.17	3	2,000	300	80%	1.16	3	2,000	2,000	2,000	-17%
068_02	Fourth Of July Creek	4	560	uplands	97%	0.17	3	2,000	300	90%	0.58	3	2,000	1,000	700	-7%
068_02	Fourth Of July Creek	5	640	alder upland	62%	2.20	4	3,000	7,000	70%	1.74	4	3,000	5,000	(2,000)	8%
068_02	Fourth Of July Creek	6	420	alder upland	62%	2.20	4	2,000	4,000	40%	3.47	4	2,000	7,000	3,000	-22%
068_02	Blane Creek	1	840	uplands	98%	0.12	1	800	90	90%	0.58	1	800	500	400	-8%
068_02	Blane Creek	2	200	uplands	98%	0.12	1	200	20	70%	1.74	1	200	300	300	-28%
068_02	Blane Creek	3	710	uplands	98%	0.12	2	1,000	100	90%	0.58	2	1,000	600	500	-8%
068_02	Blane Creek	4	130	alder upland	88%	0.69	2	300	200	60%	2.32	2	300	700	500	-28%

Table C-2 (continued). Existing and target solar loads for 2nd-order Crooked Creek and its tributaries.

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
068_02	2nd to Crooked	1	380	uplands	98%	0.12	1	400	50	90%	0.58	1	400	200	200	-8%
068_02	2nd to Crooked	2	320	uplands	98%	0.12	1	300	30	70%	1.74	1	300	500	500	-28%
068_02	2nd to Crooked	3	1000	uplands	98%	0.12	2	2,000	200	90%	0.58	2	2,000	1,000	800	-8%
068_02	2nd to Crooked	4	44	alder upland	88%	0.69	2	90	60	40%	3.47	2	90	300	200	-48%
068_02	Hundred Dollar Gulch	1	470	uplands	98%	0.12	1	500	60	90%	0.58	1	500	300	200	-8%
068_02	Hundred Dollar Gulch	2	1600	uplands	98%	0.12	2	3,000	300	80%	1.16	2	3,000	3,000	3,000	-18%
068_02	3rd to Crooked	1	230	subalpine	98%	0.12	1	200	20	90%	0.58	1	200	100	80	-8%
068_02	3rd to Crooked	2	1600	uplands	98%	0.12	2	3,000	300	90%	0.58	2	3,000	2,000	2,000	-8%
068_02	Olive Creek	1	1100	subalpine	98%	0.12	1	1,000	100	90%	0.58	1	1,000	600	500	-8%
068_02	Olive Creek	2	830	breaklands	94%	0.35	2	2,000	700	90%	0.58	2	2,000	1,000	300	-4%
068_02	Olive Creek	3	430	alder upland	88%	0.69	2	900	600	70%	1.74	2	900	2,000	1,000	-18%
068_02	Olive Creek	4	1500	uplands	97%	0.17	3	5,000	900	80%	1.16	3	5,000	6,000	5,000	-17%
068_02	Olive Creek	5	980	breaklands	81%	1.10	4	4,000	4,000	80%	1.16	4	4,000	5,000	1,000	-1%
068_02	Olive Creek	6	210	breaklands	81%	1.10	4	800	900	70%	1.74	4	800	1,000	100	-11%
068_02	Sams Creek	1	950	subalpine	98%	0.12	1	1,000	100	90%	0.58	1	1,000	600	500	-8%
068_02	Sams Creek	2	410	subalpine	98%	0.12	1	400	50	70%	1.74	1	400	700	700	-28%
068_02	Sams Creek	3	990	subalpine	97%	0.17	2	2,000	300	90%	0.58	2	2,000	1,000	700	-7%
068_02	Sams Creek	4	240	subalpine	97%	0.17	2	500	90	70%	1.74	2	500	900	800	-27%
068_02	Sams Creek	5	870	uplands	97%	0.17	3	3,000	500	90%	0.58	3	3,000	2,000	2,000	-7%
068_02	Sams Creek	6	360	uplands	97%	0.17	3	1,000	200	80%	1.16	3	1,000	1,000	800	-17%
068_02	Sams Creek	7	750	breaklands	81%	1.10	4	3,000	3,000	90%	0.58	4	3,000	2,000	(1,000)	0%
068_02	Sams Creek	8	250	breaklands	81%	1.10	4	1,000	1,000	80%	1.16	4	1,000	1,000	0	-1%
068_02	Straight Creek	1	270	subalpine	98%	0.12	1	300	30	70%	1.74	1	300	500	500	-28%
068_02	Straight Creek	2	270	subalpine	98%	0.12	1	300	30	90%	0.58	1	300	200	200	-8%
068_02	Straight Creek	3	1200	uplands	98%	0.12	2	2,000	200	90%	0.58	2	2,000	1,000	800	-8%
068_02	Straight Creek	4	570	uplands	98%	0.12	2	1,000	100	70%	1.74	2	1,000	2,000	2,000	-28%
068_02	4th to Crooked	1	320	subalpine	98%	0.12	1	300	30	50%	2.90	1	300	900	900	-48%
068_02	4th to Crooked	2	120	subalpine	98%	0.12	1	100	10	70%	1.74	1	100	200	200	-28%
068_02	4th to Crooked	3	460	uplands	98%	0.12	1	500	60	90%	0.58	1	500	300	200	-8%
068_02	4th to Crooked	4	700	uplands	98%	0.12	2	1,000	100	80%	1.16	2	1,000	1,000	900	-18%
068_02	4th to Crooked	5	360	uplands	98%	0.12	2	700	80	90%	0.58	2	700	400	300	-8%
068_02	4th to Crooked	6	150	alder upland	88%	0.69	2	300	200	70%	1.74	2	300	500	300	-18%
068_02	Little Blowout Creek	1	1200	subalpine	98%	0.12	1	1,000	100	90%	0.58	1	1,000	600	500	-8%
068_02	Little Blowout Creek	2	1000	subalpine	97%	0.17	2	2,000	300	90%	0.58	2	2,000	1,000	700	-7%
068_02	Little Blowout Creek	3	210	uplands	95%	0.29	4	800	200	90%	0.58	4	800	500	300	-5%
068_02	Little Blowout Creek	4	290	uplands	95%	0.29	4	1,000	300	70%	1.74	4	1,000	2,000	2,000	-25%
068_02	Little Blowout Creek	5	250	lemmons willow	27%	4.23	4	1,000	4,000	30%	4.05	4	1,000	4,000	0	0%
068_02	1st to Little Blowout	1	1600	subalpine	98%	0.12	1	2,000	200	90%	0.58	1	2,000	1,000	800	-8%
068_02	2nd to Little Blowout	1	1600	subalpine	98%	0.12	1	2,000	200	90%	0.58	1	2,000	1,000	800	-8%
068_02	Lemon Creek	1	860	subalpine	98%	0.12	1	900	100	80%	1.16	1	900	1,000	900	-18%
068_02	Lemon Creek	2	740	subalpine	97%	0.17	2	1,000	200	90%	0.58	2	1,000	600	400	-7%
068_02	Lemon Creek	3	270	alder upland	88%	0.69	2	500	300	60%	2.32	2	500	1,000	700	-28%
068_02	5th to Crooked	1	360	subalpine	98%	0.12	1	400	50	90%	0.58	1	400	200	200	-8%
068_02	5th to Crooked	2	1300	breaklands	95%	0.29	1	1,000	300	90%	0.58	1	1,000	600	300	-5%
068_02	5th to Crooked	3	360	breaklands	94%	0.35	2	700	200	80%	1.16	2	700	800	600	-14%
							Totals		160,000					340,000	180,000	

Table C-3. Existing and target solar loads for the 3rd-order Crooked 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
068_03	Crooked Creek	1	1300	lemmons willow	14%	4.98	8	10,000	50,000	10%	5.21	8	10,000	50,000	0	-4%
068_03	Crooked Creek	2	350	lemmons willow	14%	4.98	8	3,000	10,000	0%	5.79	8	3,000	20,000	10,000	-14%
068_03	Crooked Creek	2	190	lemmons willow	14%	4.98	8	2,000	10,000	20%	4.63	8	2,000	9,000	(1,000)	0%
068_03	Crooked Creek	3	210	lemmons willow	14%	4.98	8	2,000	10,000	10%	5.21	8	2,000	10,000	0	-4%
068_03	Crooked Creek	4	430	breaklands	58%	2.43	8	3,000	7,000	60%	2.32	8	3,000	7,000	0	0%
068_03	Crooked Creek	6	460	breaklands	58%	2.43	8	4,000	10,000	70%	1.74	8	4,000	7,000	(3,000)	0%
068_03	Crooked Creek	7	74	breaklands	53%	2.72	9	700	2,000	60%	2.32	9	700	2,000	0	0%
068_03	Crooked Creek	8	210	breaklands	53%	2.72	9	2,000	5,000	70%	1.74	9	2,000	3,000	(2,000)	0%
068_03	Crooked Creek	9	820	breaklands	53%	2.72	9	7,000	20,000	50%	2.90	9	7,000	20,000	0	-3%
							Totals		120,000					130,000	4,000	

Table C-4. Existing and target solar loads for the 4th-order Crooked 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
068_04	Crooked Creek	1	270	breaklands	46%	3.13	11	3,000	9,400	50%	2.90	11	3,000	8,700	(700)	0%
068_04	Crooked Creek	2	190	breaklands	44%	3.24	12	2,300	7,500	30%	4.05	12	2,300	9,300	1,800	-14%
068_04	Crooked Creek	3	840	breaklands	44%	3.24	12	10,000	32,000	50%	2.90	12	10,000	29,000	(3,000)	0%
068_04	Crooked Creek	5	1200	breaklands	44%	3.24	12	14,000	45,000	40%	3.47	12	14,000	49,000	4,000	-4%
							Totals		94,000					96,000	2,100	

Table C-5. Existing and target solar loads for the 5th-order Crooked 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
067_05	Crooked Creek	1	690	breaklands	34%	3.82	17	12,000	46,000	40%	3.47	17	12,000	42,000	(4,000)	0%
067_05	Crooked Creek	2	1100	breaklands	34%	3.82	17	19,000	73,000	30%	4.05	17	19,000	77,000	4,000	-4%
067_05	Crooked Creek	3	1500	breaklands	34%	3.82	17	26,000	99,000	10%	5.21	17	26,000	140,000	41,000	-24%
067_05	Crooked Creek	4	720	breaklands	34%	3.82	17	12,000	46,000	30%	4.05	17	12,000	49,000	3,000	-4%
067_05	Crooked Creek	5	2700	breaklands	32%	3.94	18	49,000	190,000	10%	5.21	18	49,000	260,000	70,000	-22%
067_05	Crooked Creek	6	320	breaklands	32%	3.94	18	5,800	23,000	30%	4.05	18	5,800	24,000	1,000	-2%
067_05	Crooked Creek	7	1200	breaklands	32%	3.94	18	22,000	87,000	20%	4.63	18	22,000	100,000	13,000	-12%
067_05	Crooked Creek	8	1300	breaklands	31%	4.00	19	25,000	100,000	10%	5.21	19	25,000	130,000	30,000	-21%
067_05	Crooked Creek	9	1300	breaklands	31%	4.00	19	25,000	100,000	20%	4.63	19	25,000	120,000	20,000	-11%
067_05	Crooked Creek	10	170	breaklands	31%	4.00	19	3,200	13,000	30%	4.05	19	3,200	13,000	0	-1%
067_05	Crooked Creek	11	210	breaklands	31%	4.00	19	4,000	16,000	40%	3.47	19	4,000	14,000	(2,000)	9%
067_05	Crooked Creek	12	440	breaklands	31%	4.00	19	8,400	34,000	30%	4.05	19	8,400	34,000	0	-1%
067_05	Crooked Creek	13	180	breaklands	31%	4.00	19	3,400	14,000	10%	5.21	19	3,400	18,000	4,000	-21%
067_05	Crooked Creek	14	870	breaklands	31%	4.00	19	17,000	68,000	30%	4.05	19	17,000	69,000	1,000	-1%
067_05	Crooked Creek	15	580	breaklands	31%	4.00	19	11,000	44,000	10%	5.21	19	11,000	57,000	13,000	-21%
							Totals		950,000					1,100,000	190,000	

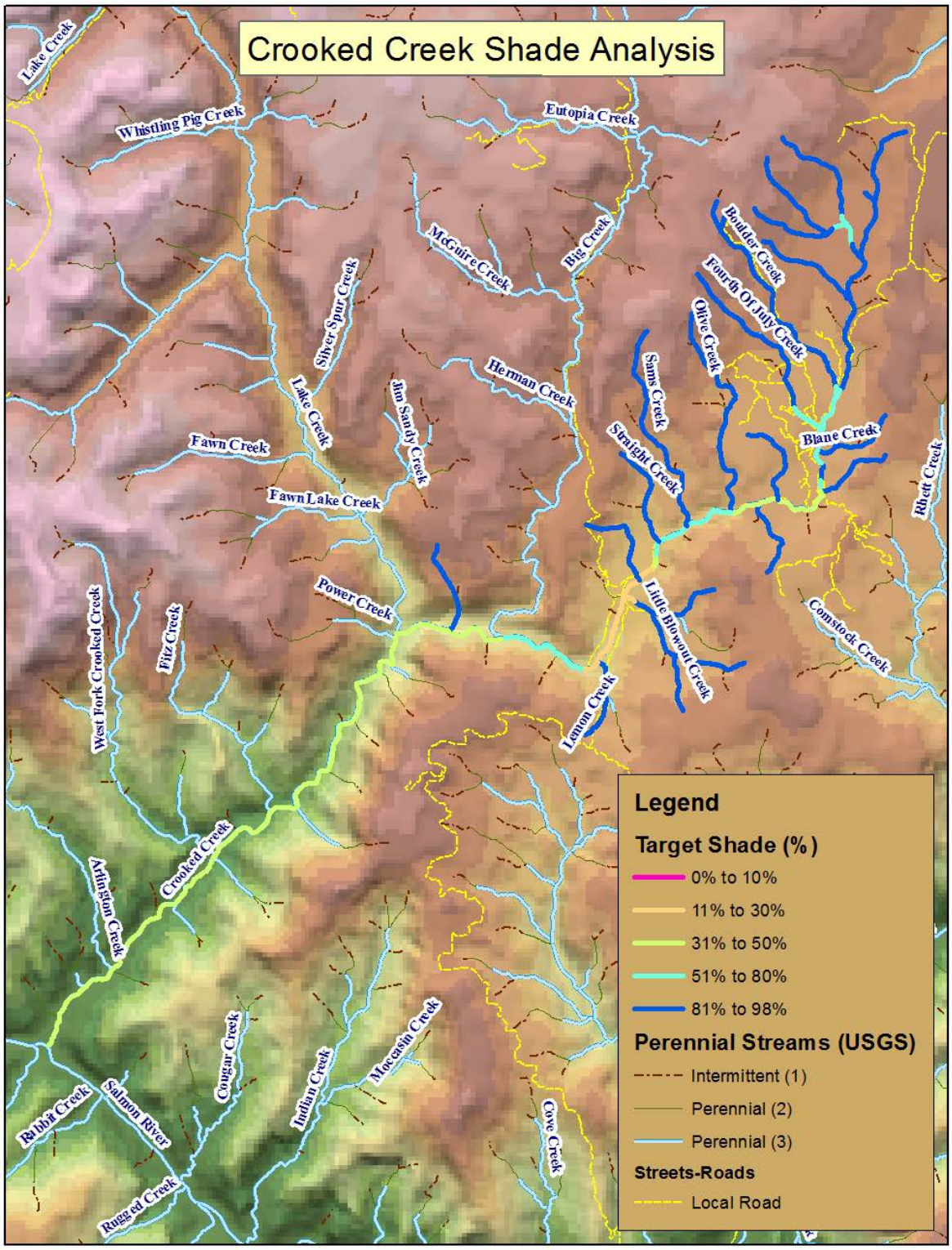


Figure C-2. Target shade for Crooked Creek.

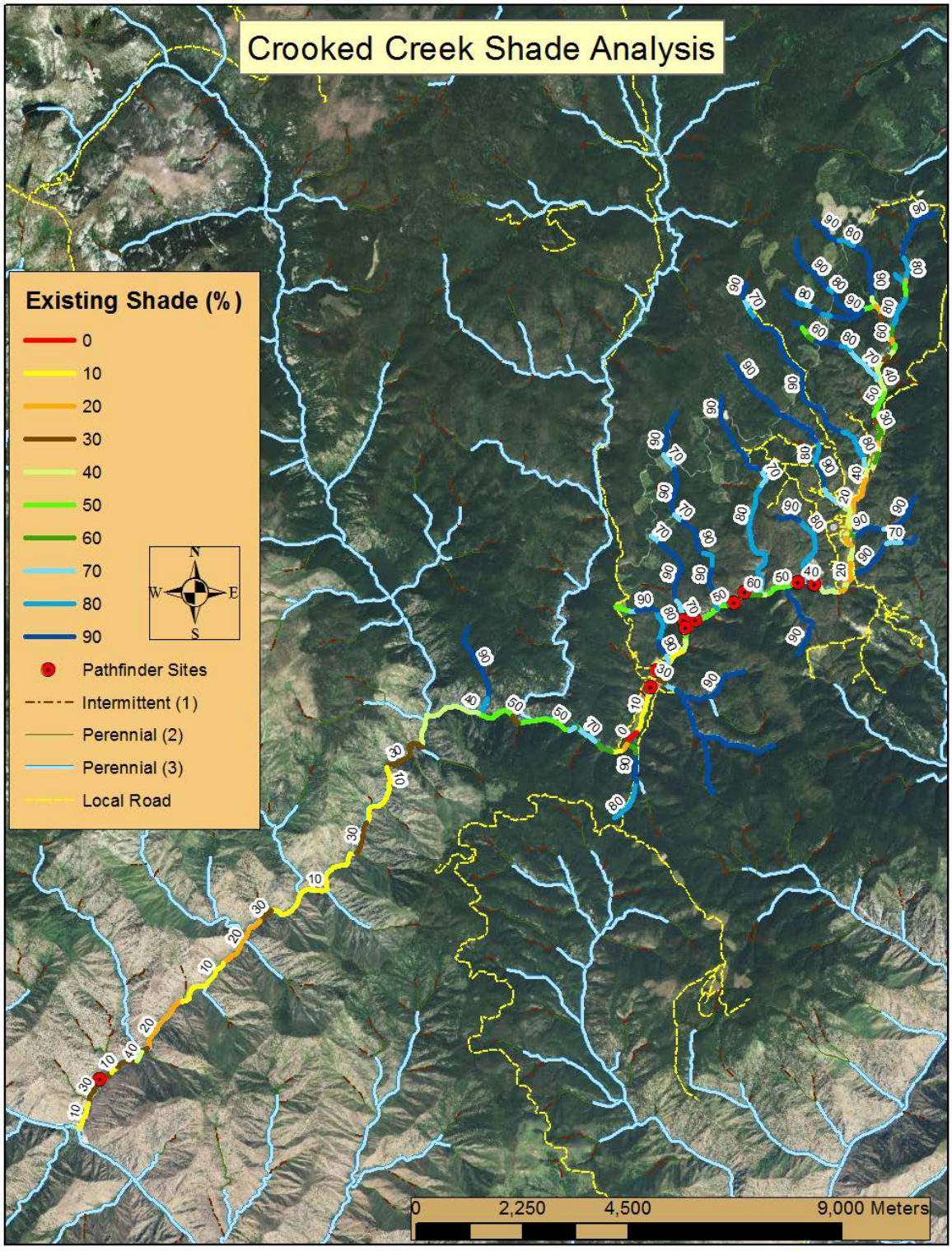


Figure C-3. Existing shade estimated for Crooked Creek by aerial photo interpretation.

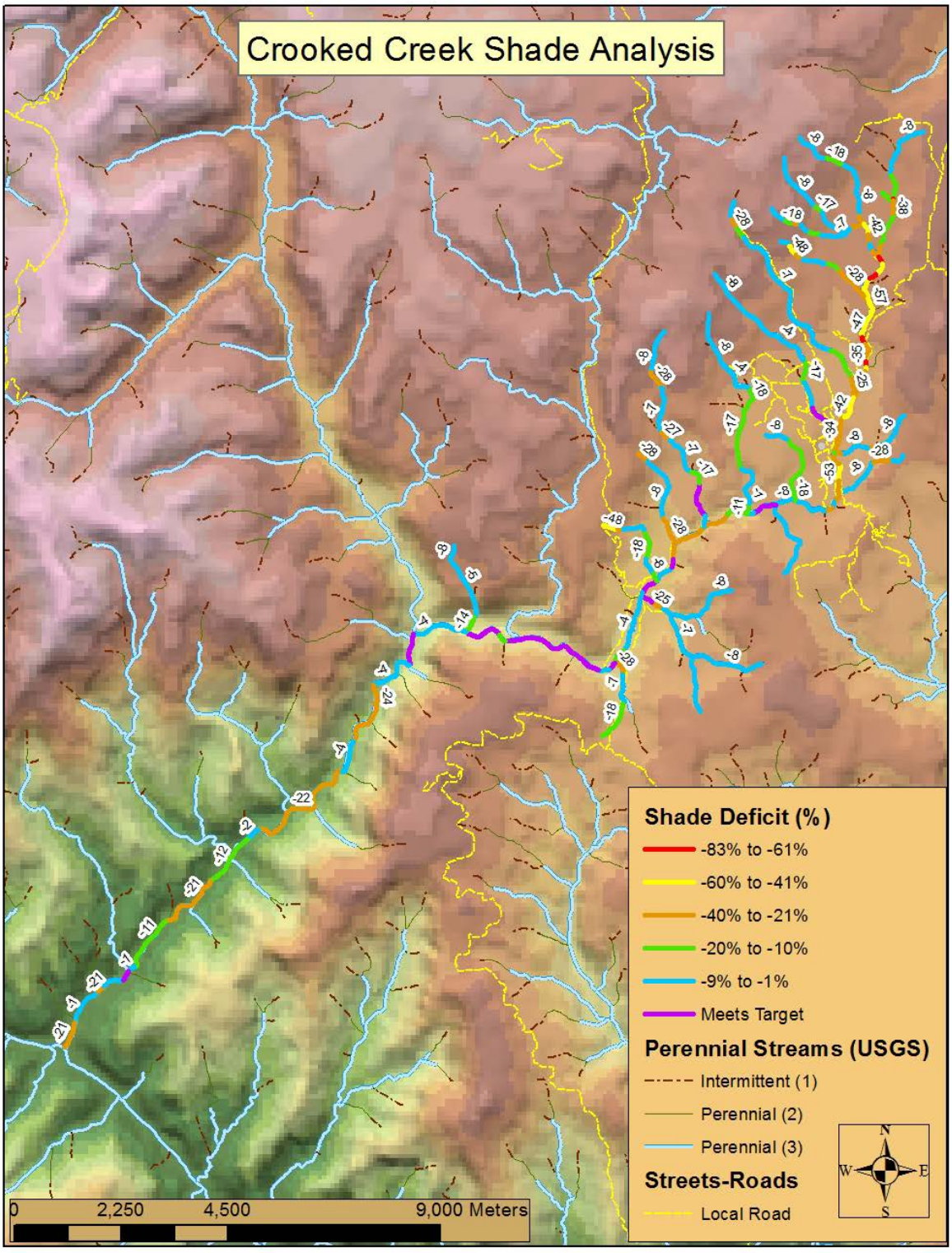


Figure C-4. Shade deficit (difference between existing and target) for Crooked Creek.

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Appendix D. 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 U.S.
- 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 an National Pollutant Discharge Elimination System (NPDES) permit from the United States 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 U.S., 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. EPA anticipates issuing a new MSGP in December 2013. DEQ anticipates including specific requirements for impaired waters as a condition of the §401 certification. The new 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 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 Construction General Permit (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 2005) should be used to select the proper suite of BMPs for the specific site, soils, climate, and project phasing 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.

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Appendix E. 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 total maximum daily load (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 Idaho's water quality standards at IDAPA 58.01.02.055.06. The Idaho Department of Environmental Quality (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 Trading Guidance* sets forth the procedures to be followed for pollutant trading (DEQ 2016).

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 National Pollutant Discharge Elimination System (NPDES) effluent limits set initially by the wasteload allocation.
- Nonpoint sources create credits by implementing approved best management practices (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 watershed advisory group, 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 2016).

Appendix F. Public Participation and Public Comments

This TMDL addendum was developed with participation from the Clearwater Basin Advisory Group (March 23, 2017) and a 30-day public comment period (May 8, 2017 through June 6, 2017).

30-day Public Comment period (May 8, 2017 to June 6, 2017) provided comments from Susan Hagle, Double Aught Ranch on May 27, 2017 and the Idaho Conservation League (ICL) on June 6, 2017 (attached letter).

Response to Public Comments

Susan Hagle Comments: I am pleased to see your efforts to assess and address water conditions in Crooked Creek. I hope you can proceed with re-vegetating the stream banks soon. The spawning habitat is particularly important to our family and we look forward to the improvements on Crooked Creek.

DEQ Response: Thank you for your comments. We look forward to an improved Crooked Creek as well.

ICL Comments: Margin of Safety – concern with a lack of explicit margin of safety for TMDLs based on shade.

DEQ Response: DEQ worked with EPA on the creation of the PNV TMDL process and in fact many of our forest shade targets were created by their scientists. An implicit margin of safety was incorporated in the shade target process by utilizing the 90^{th} percentile of possible shade level outcomes for any one forest type. In other words, the shade target is not an average but at the higher end of closed canopy system. We set this level knowing full well that there are many open forest types that could not meet those shade levels. The idea being that this added level of shade would compensate for any lack of accuracy in determining shade on streams.

Additionally, DEQ uses the lowest value of a 10% shade class for identifying existing shade. For example, a shade class identified as 30% represents possible existing shade levels of 30% to 39.9%. Actual shade on a stream may be 39% but we only credit it with 30% shade. This difference ends up being another portion of the implicit margin of safety. These features led us and EPA to conclude that the PNV TMDL process had sufficient implicit margin of safety and explicit margins were not necessary.

ICL Comments: Field verification of natural bankfull width – concern with a lack of field measurements.

DEQ Response: A lack of field data is a constant issue with the development of any TMDL. Although we may desire to have plenty of data, the lack of time, resources and access to the stream often prevent us from obtaining an abundance of data. For bankfull width we often rely upon BURP sites in the area where bankfull width has been measured at three different locations at each site. Also, whenever we filed verify shade at a solar pathfinder site, we will measure bankfull width in several locations on the stream. But some streams do not have BURP or pathfinder sites. In those cases we often rely upon our ability to measure the bankfull width on an aerial photograph. It is not ideal, but is often what we can do within limitations.

ICL Comments: Field verification of PNV – concern with a lack of field measurements.

DEQ Response: As indicated above we often lack the resources or accessibility to do more measurements, including solar pathfinder shade measurements. The process of field verification of shade is not necessarily to measure shade on all portions of the stream, but to take opportunistic samples and compare them to aerial interpretation estimates of shade. If the 10 samples we take show that we have done a poor job of estimating shade, then we repeat the aerial interpretation armed with the knowledge of how we erred. It is the most expedient method to accomplish shade estimation in a timely manner. We anticipate and hope that others involved in TMDL implementation or other kinds of stream restoration work will also measure shade in additional locations. We would welcome volunteers to measure shade with a solar pathfinder to facilitate that data gathering process. Often we cannot get permission to enter private property to take measurements on streams, whereas others may experience less access restrictions.

ICL Comments: Natural background provision – concern with interpretation.

DEQ Response: DEQ disagrees with the assumption that shade targets do not represent natural background conditions. Because shade targets are modeled from measured or estimated plant community data, we believe they represent the best possible interpretation of natural shade, often at a near maximum closed canopy extent as explained earlier. Regarding instream flow, DEQ believes we have an obligation to provide natural shade levels to stream channels regardless of how much water is in those channels at any given time. We do not have control over how much water is in the channel, regardless of what controls flow (climate, weather, geology, use). The use of shade targets implies that there should be sufficient water to maintain a natural riparian plant community to provide those shade levels.

ICL Comments: Water Diversion – concern with not analyzing impacts.

DEQ Response: DEQ does not analyze the impacts of water diversion. In many watersheds across the state water rights potential consumption often meets or exceeds all the available flow in watersheds. Such an analysis of water rights impacts would be fruitless. We see that in any given water body, the use of those rights is highly variable from year to year and even from day to day. An analysis of impacts in such a highly variable environment would be enormously resource intensive, and, in our opinion, would provide little value given the laws that govern water rights. We instead focus on the need for a healthy riparian plant community to provide adequate shade on streams and hope that the use of water rights within the watershed will be conducted in such a manner to sustain those plant communities.

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Mark Shumar
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Boise, ID 83706

Submitted via email to: mark.shumar@deq.idaho.gov

June 6, 2017

RE: 2017 Crooked Creek Temperature TMDL and 5-year Review

Dear Mr. Shumar:

Thank you for the opportunity to comment on the 2017 Crooked Creek Draft TMDL and 5-year Review (Draft TMDL). Since 1973, the Idaho Conservation League has been Idaho's leading voice for clean water, clean air and wilderness—values that are the foundation for Idaho's extraordinary quality of life. The Idaho Conservation League works to protect these values through public education, outreach, advocacy and policy development. As Idaho's largest state-based conservation organization, we represent over 25,000 supporters, many of whom have a deep personal interest in protecting Idaho's human health and environment.

Attached, please find my comments on behalf of the Idaho Conservation League regarding the Draft TMDL.

Thank you for your time and consideration. Please do not hesitate to contact me at (208) 265-9565 or mnykiel@idahoconservation.org if you have any questions regarding our comments or if we can provide you with any additional information on this matter.

Sincerely,

Matthew Nykiel
Conservation Associate

ICL Comments

Margin of Safety

The Idaho Department of Environmental Quality (DEQ) must incorporate a margin of safety into total maximum daily loads (TMDL) and should have done so in the Draft TMDL. When developing TMDLs, the Water Quality and Planning Management federal regulations require a margin of safety be included, which takes into account any lack of knowledge concerning the development of thermal water quality criteria for protection and propagation of a balanced, indigenous population of shellfish, fish and wildlife in the identified waters or parts thereof. 40 CFR 130.7(c)(2).

Section 5.4.2 of the Draft TMDL indicates that a margin of safety was not included in the Draft TMDL because the margin of safety is implicit in the design of the Draft TMDL. In DEQ's view, because target shade levels are established at natural background levels, it would be unrealistic to set higher shade targets. Although natural background levels of shade may, in theory, be a logical baseline condition for evaluating load capacity and setting waste and waste load allocations, DEQ fails to acknowledge that its Potential Natural Vegetation (PNV) targets are based on models and approximations, not on a 100% verified account of natural background levels. Because DEQ lacks knowledge concerning the actual natural background levels of shade, DEQ is required, under 40 CFR 130.7(c)(2), to incorporate a margin of safety in the development of this TMDL.

The Draft TMDL is clear throughout that many of the essential figures, such as PNV and solar loads, are based on models and approximations rather than field verification. Section 5.1.2 of the Draft TMDL explains that DEQ estimates PNV (and therefore target shade) from models of plant community structure (shade curves for specific riparian plant communities). DEQ also estimates solar loads based on the average of weather data collected from weather stations in Pendleton, Oregon and Missoula, Montana. These weather stations are roughly 161 miles and 115 miles away, respectively, from the Crooked Creek watershed. These are just a few examples of how dependent this TMDL is on models and approximations. Despite all this, DEQ assumes its determination of PNV shade and associated solar loads reflect the natural condition of the Crooked Creek watershed. *See* Draft TMDL at 16. However, DEQ cannot make this assumption and also consider that a margin of safety is implicit in the design of the Draft TMDL.

A margin of safety is required by federal regulation to account for any lack of knowledge concerning the development of thermal water quality criteria. The federal regulations require TMDLs to incorporate a margin of safety because in many cases, the data on which agencies develop water quality criteria is imperfect. If any of DEQ's modeling or estimations of PNV are wrong, a margin of safety would ensure that achieving the Draft TMDL's target shade levels will still result in restoring the water quality of the Crooked Creek watershed.

Accordingly, DEQ must incorporate a margin of safety into the revised Draft TMDL to account for the assumptions implicit in DEQ's analysis of PNV. We suggest that DEQ calculate the margin of error for its estimates of PNV. DEQ can then increase target shade levels by that

amount to incorporate an adequate margin of safety. There may be other methods of incorporating a margin of safety into the revised Draft TMDL that we would support. The bottom line is that a margin of safety is legally required and would ensure that stream temperature is effectively reduced below the applicable water quality standards. If DEQ declines to include a margin of safety, we request DEQ explain the basis for its decision.

Field Verification of Natural Bankfull Width

Target shade levels are inherently dependent on the width of a stream, as the width directly affects the amount of shade a stream receives. The PNV method utilizes the bankfull stage of a stream to measure stream width because it best approximates the width between the points on either side of a stream where riparian vegetation starts. However, as noted in the Draft TMDL, bankfull width estimates may not always reflect natural conditions, as impacts to streams and riparian zones generally create wider streams. Given this likelihood, it is imperative that PNV estimates based on approximated bankfull widths be verified with field measurements and corrected if necessary.

In its current form, the Draft TMDL appears to have no field verification of bankfull width estimates. If particular streams are in fact wider than the approximated bankfull width, then the target shade levels will not be accurate and the predicted reductions in temperature will be erroneous. In order to provide maximum assurance that background temperatures will be achieved, DEQ should perform field validation at a minimum of ten stream sites.

Field Verification of PNV

The Draft TMDL indicates that shade was verified at ten sites using Solar Pathfinder analysis. Draft TMDL at 16. We would prefer DEQ utilize more than ten Solar Pathfinder sites to ensure an accurate analysis of PNV. In lieu of more sites, we request that DEQ diversify the location of the current Solar Pathfinder sites. As shown in Figure C-3 of the Draft TMDL, the ten Pathfinder sites are clustered along the middle portion of Crooked Creek. While these Pathfinder sites help verify aerial shade analyses, large segments of Crooked Creek have not been verified for existing shade.

It is critical that DEQ diversify its Pathfinder sites, otherwise DEQ will be unable to accurately determine and monitor shade levels throughout the watershed. Indeed, the placement of current Pathfinder sites fails to capture the variability of shade downstream, due to differences in terrain and ecology, and the variability of shade upstream, due to residential development and other land uses. We request DEQ install additional Pathfinder sites or diversify the locations of current Pathfinder sites to further verify shade levels both upstream and downstream from the current Pathfinder sites. If DEQ declines this request, we further request DEQ explain its decision.

Natural Background Provision

In Appendix B of the Draft TMDL, DEQ incorrectly interprets and explains Idaho's provision for Natural Background Conditions as Criteria (IDAPA 58.01.02.200.09). DEQ asserts that if PNV targets are achieved but stream temperature remains warmer than water quality standards require, the temperature of the stream under these conditions is assumed natural and constitutes the maximum temperature criteria for the stream segment. This is incorrect because DEQ's PNV targets do not represent a verified or complete account of natural background conditions.

To apply the natural background provision, DEQ must know the natural background condition of the particular stream segment at issue. As explained above, DEQ has not completely verified the shade levels that constitute the natural background condition of the stream segments in this watershed. Rather, DEQ bases PNV on models and develops target shade levels based on these estimations. DEQ assumes these figures are the natural background condition, but no language in the regulatory code permits DEQ to apply this provision based on such an assumption.

Furthermore, DEQ's interpretation of the natural background provision is incorrect because DEQ bases its understanding of natural background conditions solely on PNV. The natural background conditions affecting water temperature include more factors than simply shade levels. With respect to water temperature, the natural background conditions should reflect, at least, shade levels *and* instream flow. More or less instream flow, or the quantity of water flowing in a particular stream segment, affects the amount of water exposed to a given level of solar radiation, which can impact water temperature. Because of this the natural background temperature of a stream can only be identified if the stream is both shaded at natural background levels and contains an amount of water at the natural background level.

Given the impact of instream flow on stream temperatures, DEQ must, at a minimum, redraft its explanation of the natural background provision. However, in the context of water temperature, the Idaho code would not permit the application of this provision without an accurate account of all natural conditions – in this case, at least the natural shade levels and natural instream flow. Since DEQ lacks an accurate accounting of these natural background conditions, DEQ must remove its explanation and application of the natural background provision from the Draft TMDL entirely. If DEQ does not remove references to the natural background provision in the revised Draft TMDL, we request DEQ provide the basis for its decision.

Water Diversions

DEQ should quantify the impact, if any, that water diversions have on stream temperature in this watershed. DEQ's rationale for not quantifying or analyzing this impact is that state statute allows water diversions and that nothing in the Draft TMDL supersedes water appropriation in the affected watershed. Draft TMDL at 26. Although all this is true, it is not clear why it precludes DEQ from conducting an analysis of the impact of water diversions. TMDLs often analyze the impacts of things like land use practices, even though the TMDL does not include

obligations that supersede the rights or prerogatives related to certain land use practices. However, it is critically important that a TMDL include these analyses because it fulfills the main purpose of a TMDL, which is to provide a comprehensive assessment of what actions are necessary to achieve water quality standards.

Analyzing the impact of water diversions will not obligate local water right holders to do anything, but a complete understanding of how to achieve water quality standards in this watershed is impossible without such an analysis. Moreover, if DEQ wants to effectively encourage local landowners and water right holders to voluntarily improve instream flow, DEQ must and should provide an analysis that shows how better management of water diversions may improve water quality. For example, this type of analysis could provide dates and times of when high instream flow is most critical to maintaining cold water temperature. The analysis could also identify what stream segments are most vulnerable to unnaturally low flows.

It may be the case that there are relatively few water diversions in this watershed due to low agricultural use and the high percentage of national forest in this area. However reasonable it may be to presume few water diversions because of these circumstances, TMDLs must be comprehensive in analysis and should not ignore potential impacts to water quality based on presumptions. What water diversions exist in this area should be accounted for and analyzed for their impact on water quality. We request that DEQ incorporate an analysis of the impact of water diversions on stream temperature in the revised Draft TMDL. If DEQ declines this request, we further request an explanation of DEQ's decision.

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Appendix G. Distribution List

Clearwater Basin Advisory Group

Idaho Department of Environmental Quality: DEQ State Office and Lewiston Regional Office

United States Environmental Protection Agency, Idaho Operations Office

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