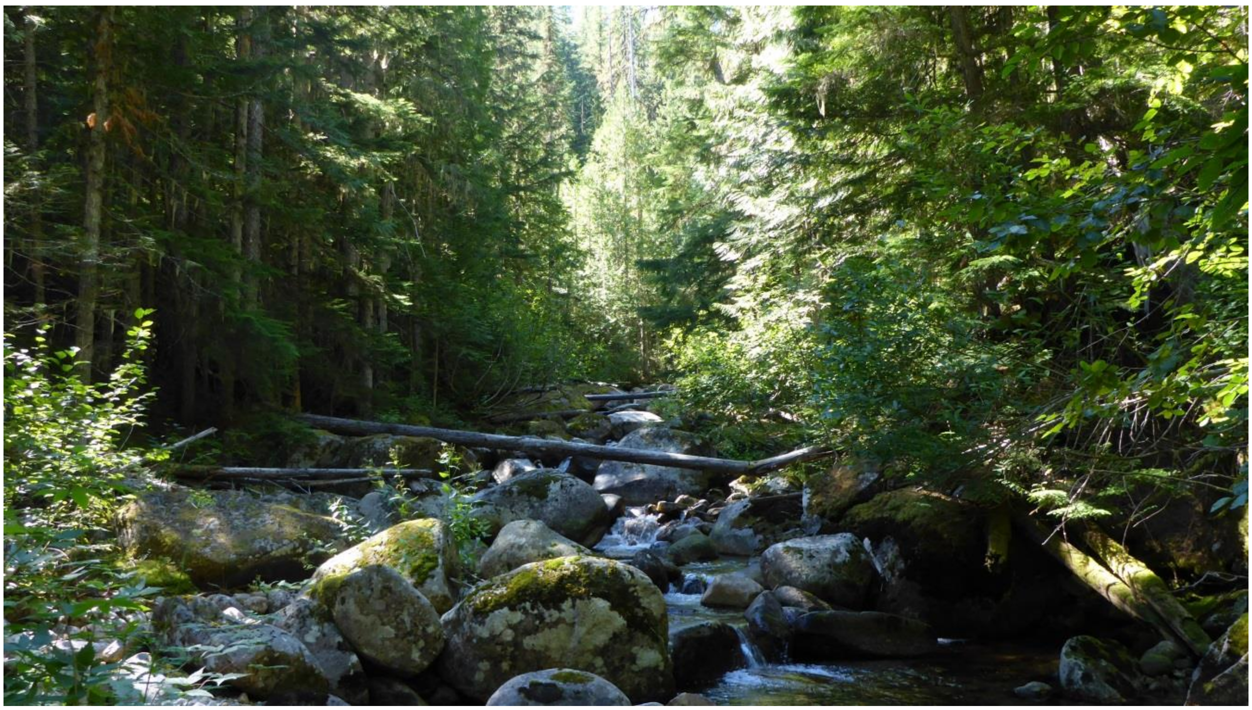
Assessment of Water Quality in Kootenai River and Moyie River Subbasins

2019 Temperature TMDL

Hydrologic Unit Code 17010104



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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

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

m^2 square meter

MOS margin of safety

MS4 municipal separate storm sewer system

MSGP Multi-Sector General Permit

NB natural background

NPDES National Pollutant Discharge Elimination System

NREL National Renewable Energy Laboratory

PNV potential natural vegetation

SWPPP Stormwater Pollution Prevention Plan

TMDL total maximum daily load

US United States

USC United States Code

WAG watershed advisory group

WLA wasteload allocation

Executive Summary

The federal Clean Water Act requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the Clean Water Act, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the Clean Water Act establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards).

States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters in Category 5 Idaho's Integrated Report. Currently, this list is published every 2 years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants. The TMDL analysis establishes water quality targets and load capacities, estimates existing pollutant loads, and allocates responsibility for load reductions needed to return listed waters to a condition meeting water quality standards. It also identifies implementation strategies—including reasonable time frames, approach, responsible parties, and monitoring strategies—necessary to achieve load reductions and meet water quality standards. Once a TMDL is completed, it is placed in Category 4a of Idaho's Integrated Report.

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. For temperature impaired waters, the Idaho Department of Environmental Quality (DEQ) establishes TMDL targets at instream conditions under the natural level of shade and channel width (or potential natural vegetation) using methodology defined in *Potential Natural Vegetation (PNV) Temperature Total Maximum Daily Load (TMDL) Procedures Manual* (Shumar and De Varona 2009). These natural conditions are considered consistent with the water quality standards, even if it exceeds numeric temperature criteria.

This document addresses two water bodies, Deep and Boundary Creeks, representing seven assessment units [AUs]) in the Kootenai River subbasin (hydrologic unit code 17010104) located in northern Idaho (Figure A). These AUs were placed in Category 4a of Idaho's most recent federally approved Integrated Report (DEQ 2014b) for reasons associated with temperature criteria exceedances. This document revises the original temperature TMDLs found in *Assessment of Water Quality in Kootenai River and Moyie River Subbasins (TMDL)* (DEQ 2006). The revisions were necessary to establish more accurate shade targets using updated shade curve methodology as defined in Shumar and De Varona (2009). Additionally, the 2006 subbasin assessment and TMDL analyzed only the main stem sections of Deep and Boundary Creeks. In accordance to the new methodology, this TMDL establishes heat loads for all tributary streams within the Deep and Boundary Creek AUs as well as the main stem sections. This TMDL does not address the sediment TMDLs in DEQ (2006). The updated methodology in Shumar and De Varona (2009) was used for new temperature-impaired waters in the lower Kootenai and Moyie River Subbasins in an addendum to the 2006 TMDL (DEQ 2014a); however, shade targets for Deep and Boundary Creeks were not updated in the 2014 TMDL. Therefore, shade targets for Deep and Boundary Creeks are updated in this TMDL.

This TMDL describes key physical and biological characteristics of the subbasin; water quality concerns and status; pollutant sources; and recent pollution control actions in the Kootenai River subbasin. Detailed information about the subbasin and previous TMDLs is provided in DEQ (2006) and DEQ (2014a).

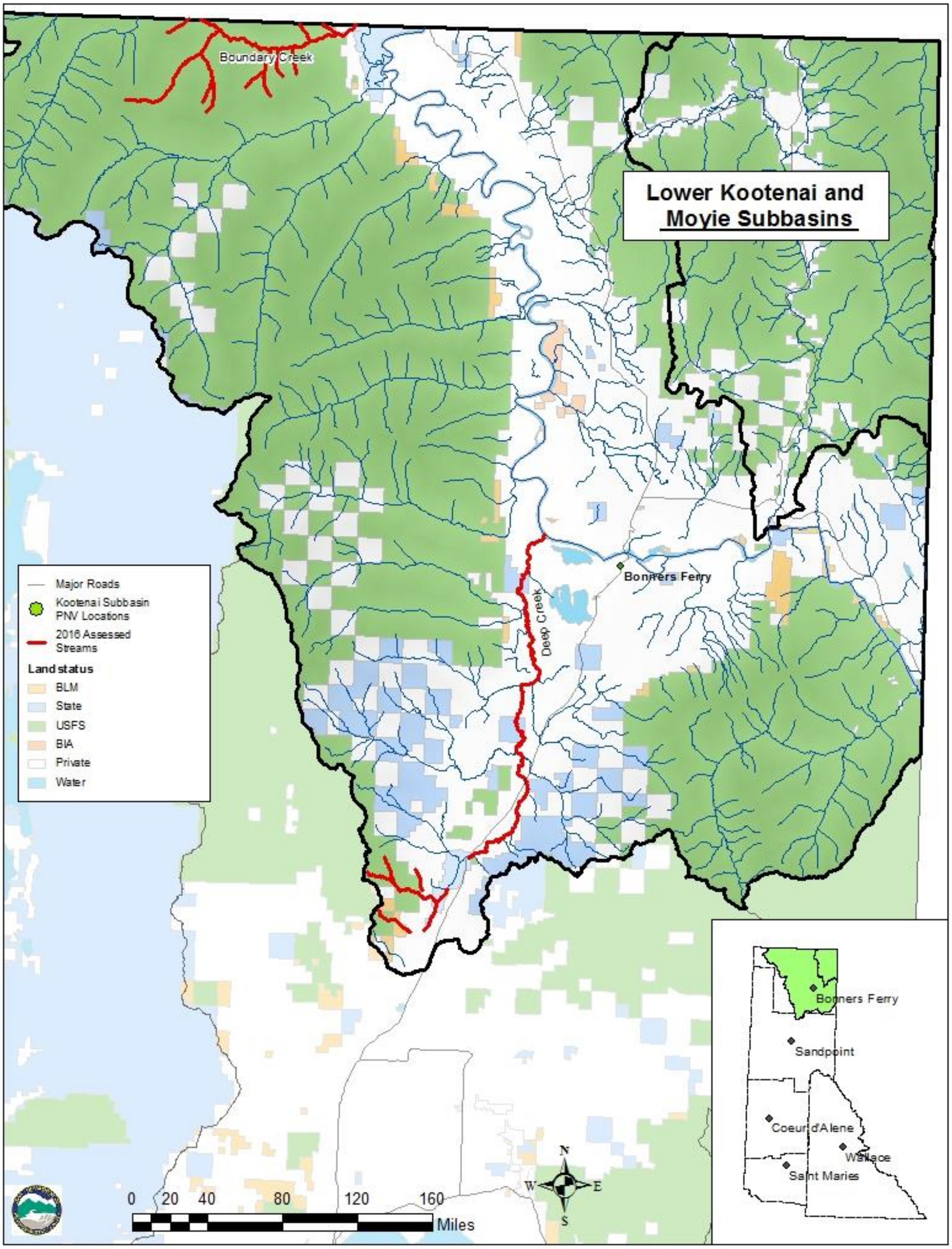

Figure A. Lower Kootenai River and Moyie River subbasins.

Key Findings

Boundary and Deep Creeks were placed on the 1998 §303(d) list of impaired waters, or subsequent lists, for temperature criteria violations. Biological and temperature data were originally used to determine temperature impairment of beneficial uses. DEQ developed temperature TMDLs for these waters in DEQ (2006) (Table A). New temperature impairments in waterbodies in the Kootenai and Moyie subbasins were addressed in an addendum to the 2006 TMDL (DEQ 2014a); however, Deep Creek and Boundary Creeks were not included in the addendum.

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

Water Body	Water Body Description	Assessment Unit	Pollutant
Boundary Creek - Headwaters	1st & 2nd Order to Fan Creek	ID17010104PN002_02	Temperature
Boundary Creek - 3rd Order	Fan Creek to U.S./Canada Border	ID17010104PN002_03	Temperature
Deep Creek - Headwaters	1st & 2nd Order to McArthur Lake	ID17010104PN025_02	Temperature
Deep Creek - 3rd Order	McArthur Lake to Trail Creek	ID17010104PN022_03	Temperature
Deep Creek - 4th Order	Trail Creek to Brown Creek	ID17010104PN019_04	Temperature
Deep Creek - 4th Order	Brown Creek to Snow Creek	ID17010104PN018_04	Temperature
Deep Creek - 4th Order	Snow Creek to Kootenai River	ID17010104PN015_04	Temperature

To update the 2006 TMDLs for Deep and Boundary Creeks, effective target shade levels for seven AUs in Deep and Boundary Creeks based on the concept of maximum shading under potential natural vegetation 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). A summary of assessment outcomes, including recommended changes to listing status in the next Integrated Report, is presented in Table B.

Since 2006, no known TMDL implementation projects have been done in the Deep Creek watershed. Boundary Creek is largely inaccessible, and the US Forest Services has no planned activities in Boundary Creek; therefore, natural recovery of the watershed is happening.

Table B. Summary of assessment outcomes for §303(d)-listed AUs.

Water Body	Assessment Unit	Pollutant	TMDL(s) Completed	Recommeded Changes to Next Integrated Report
Boundary Creek - Headwaters	ID17010104PN002_02	Temperature	Yes	Remain in Category 4a
Boundary Creek - 3rd Order	ID17010104PN002_03	Temperature	Yes	Remain in Category 4a
Deep Creek - Headwaters	ID17010104PN025_02	Temperature	Yes	Remain in Category 4a
Deep Creek - 3rd Order	ID17010104PN022_03	Temperature	Yes	Remain in Category 4a
Deep Creek - 4th Order	ID17010104PN019_04	Temperature	Yes	Remain in Category 4a
Deep Creek - 4th Order	ID17010104PN018_04	Temperature	Yes	Remain in Category 4a
Deep Creek - 4th Order	ID17010104PN015_04	Temperature	Yes	Remain in Category 4a

Public Participation

The general public was provided the opportunity to comment on this document during a public comment period. No comments were received.

Introduction

This document addresses temperature impairments in Deep and Boundary Creeks in the Kootenai River subbasin. These water bodies have been placed in Category 4a of Idaho's most recent federally approved Integrated Report due to temperature criteria exceedances (DEQ 2014b). This total maximum daily load (TMDL) revises the original temperature TMDLs found in the *Assessment of Water Quality in Kootenai River and Moyie River Subbasins* (TMDL) (DEQ 2006) with a new approach based on updated shade curve methodology as described in the *Potential Natural Vegetation (PNV) Temperature Total Maximum Daily Load (TMDL) Procedures Manual* (Shumar and De Varona 2009).

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, the Idaho Department of Environmental Quality (DEQ) performs the assessment to ensure impairment listings are up-to-date and accurate.

The subbasin assessment is used to develop the temperature TMDLs for Deep and Boundary Creeks. The TMDL (section 5) is a plan to improve water quality by limiting the thermal load to Deep and Boundary Creeks. Specifically, the TMDL is an estimation of the maximum thermal load that can be present in a water body and still allow that water body to meet water quality standards (40 CFR 130). 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. For temperature-impaired waters, DEQ establishes TMDL targets at instream conditions under the natural level of shade and channel width (or potential natural vegetation [PNV]) using methodology defined in Shumar and De Varona (2009). These natural conditions are considered consistent with the water quality standards, even if it exceeds numeric temperature criteria. Effective shade targets were established for seven AUs in Deep and Boundary Creeks based on the concept of maximum shading under PNV resulting in natural background temperatures.

Regulatory Requirements

This document was prepared in compliance with federal and state regulatory requirements. Congress passed the Federal Water Pollution Control Act, or more commonly called the Clean Water Act (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). DEQ implements the CWA in Idaho, while EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

States and tribes, pursuant to CWA §303, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. 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 Characterization

The Kootenai River subbasin (hydrologic unit code 17010104) is located in the northern Idaho panhandle, bordering both Canada and Montana with small portions in each. The Kootenai River flows west-northwest into Idaho from Libby, Montana, turns north after Bonners Ferry, and flows into Canada. The physical and biological characteristics of the Kootenai River subbasin are explained in the *Assessment of Water Quality in Kootenai River and Moyie River Subbasins (TMDL)* (DEQ 2006) and its addendum (DEQ 2014a). The subbasin and streams assessed in this TMDL are included in Figure 1.

The majority of land in the Kootenai River subbasin is owned by the federal government and managed by the United States Forest Service (USFS). Most of the privately owned land is in the form of dryland agriculture within the Kootenai Valley. Some of the privately owned land is forested. The Idaho Department of Lands, United States Bureau of Land Management, United States Fish and Wildlife Service, and Idaho Department of Fish and Game manage the remaining public lands. For a map of distribution of the different land ownership refer to Figure 1.

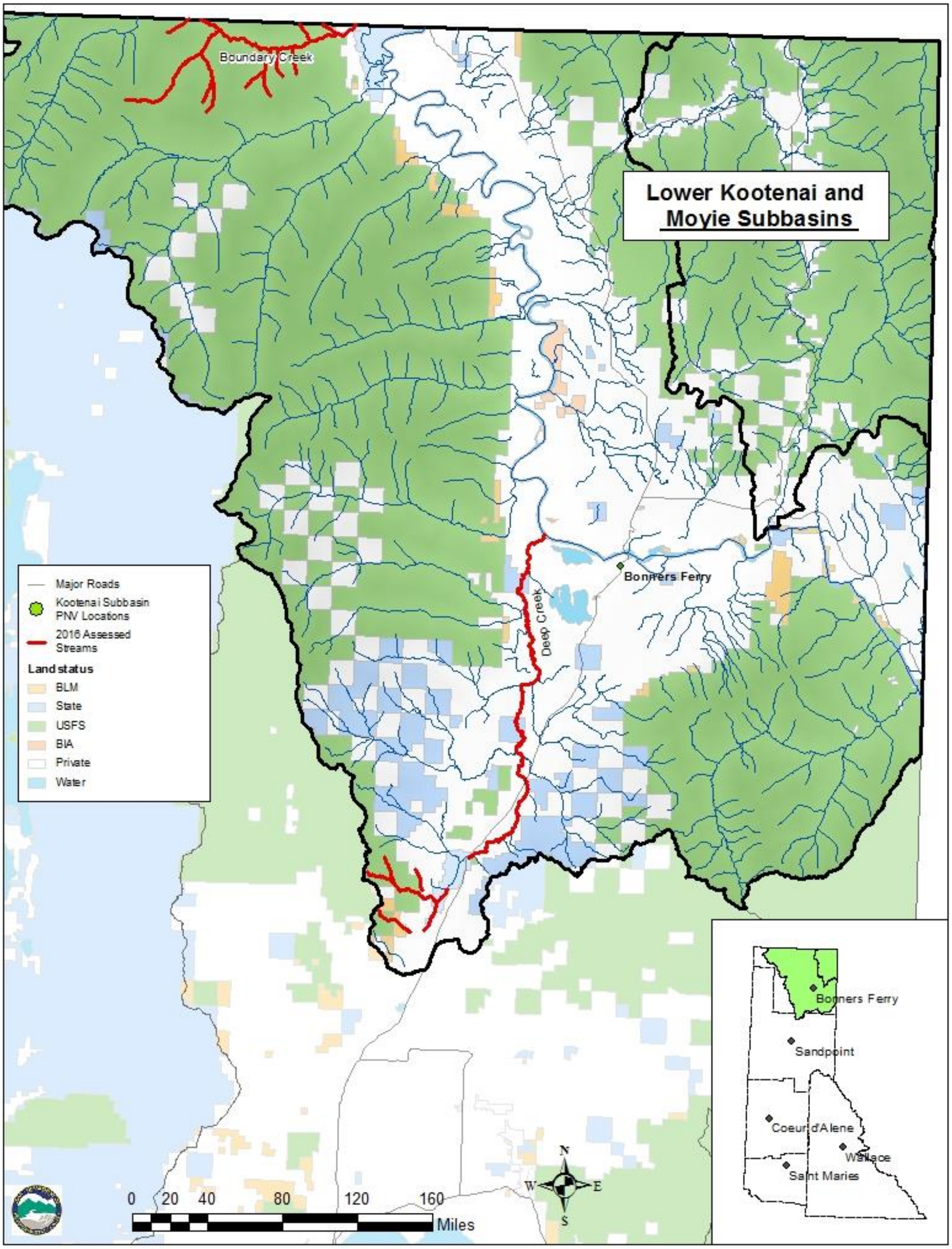

Figure 1. Lower Kootenai River and Moyie River subbasins.

2 Water Quality Concerns and Status

2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

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

2.1.1 Assessment Units

Assessment units (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 identified by 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 AUs with temperature TMDLs in the subbasin (i.e., AUs in Category 4a of the Integrated Report).

Table 1. Lower Kootenai River subbasin §303(d)-listed AUs in the subbasin.

Water Body	Water Body Description	Assessment Unit	Pollutant
Boundary Creek - Headwaters	1st & 2nd Order to Fan Creek	ID17010104PN002_02	Temperature
Boundary Creek - 3rd Order	Fan Creek to U.S./Canada Border	ID17010104PN002_03	Temperature
Deep Creek - Headwaters	1st & 2nd Order to McArthur Lake	ID17010104PN025_02	Temperature
Deep Creek - 3rd Order	McArthur Lake to Trail Creek	ID17010104PN022_03	Temperature
Deep Creek - 4th Order	Trail Creek to Brown Creek	ID17010104PN019_04	Temperature
Deep Creek - 4th Order	Brown Creek to Snow Creek	ID17010104PN018_04	Temperature
Deep Creek - 4th Order	Snow Creek to Kootenai River	ID17010104PN015_04	Temperature

Boundary Creek is a 3rd-order tributary located in northern Idaho that flows parallel to the United States/Canadian international border. Boundary Creek flows into the Kootenai River approximately 100 meters north of the international border. Major tributaries to Boundary Creek include Blue Joe, Grass, and Saddle Creeks. For this TMDL, the portions of Boundary Creek referenced are from the Idaho/Canadian border, west to east. Land within the US portion of the watershed is publicly owned and managed by the USFS.

Boundary Creek is orientated in a west-east direction with a dendritic stream feeder pattern to the Kootenai River. Elevation in the watershed ranges from 3,400 feet above sea level where the creek enters Idaho from Canada to 1,760 feet above sea level where the creek enters back into Canada.

The Boundary Creek drainage is predominantly underlain by weakly weathered granitic formation of the Kaniksu Batholith. The area is characterized by warm, dry summers and cold, wet winters. The majority of the precipitation occurs as winter snowfall and spring rain. High-volume runoff occurs during spring snowmelt and major rain-on-snow events. Vegetation varies with elevation and aspect. Most of the watershed is vegetated by coniferous species.

Deep Creek is an 116,760-acre watershed in the southwest corner of the lower Kootenai River subbasin. Deep Creek joins the Kootenai River approximately 3 miles downstream from Bonners Ferry. Major tributaries within the Deep Creek drainage include Brown, Twentymile, Trail, Dodge, Fall, Ruby, Caribou, and Snow Creeks. The drainage in oriented in a northerly direction with side tributaries entering mostly from the west and east. Average precipitation across the Deep Creek watershed is 36 inches per year. Mean annual discharge from the creek is 336 cubic feet per second. High-volume runoff occurs during spring snowmelt and major rain-on-snow events.

The Deep Creek drainage is predominantly underlain by glacial till, coarse textured alluvium, highly and weakly weathered Belt Supergroup metasediments, and highly weathered and weakly weathered granitic formation of the Kanisku Batholith. These highly and weakly weathered rocks are typically divided, with the highly weathered material occurring along the lower elevations and the weakly weathered material occupies the uplands and ridgelines.

Much of the low-lying floodplain is dominated by grasslands and mixed conifer/broadleaf vegetation types. Forested riparian areas along floodplains typically support mixed grasses, forbes, and broadleaf and needleleaf hydrophilic species. South-to-west facing slopes at lower elevations support stands of Ponderosa Pine, Lodgepole Pine, and Douglas Fir vegetation types. As side slope elevation increases forest stands generally become denser with a greater number of coniferous species. The presence of Douglas Fir, Grand Fir, Western Hemlock, Western Redcedar, Western Larch, Western White Pine, and Subalpine Fir increases with increasing elevation and effective precipitation.

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. For a description of these uses, see the 2006 TMDL (DEQ 2006). 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

2.2.1 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 has 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.

2.2.2 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).

2.2.3 Presumed Uses

- 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. These undesignated waters ultimately need to be designated for appropriate uses. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and primary or secondary contact recreation beneficial uses.

2.2.4 Beneficial Uses in the Subbasin

Beneficial uses for §303(d)-listed water bodies in the Kootenai River subbasin are listed in Table 2 and described in DEQ (2006). Beneficial uses within the AUs assessed in this TMDL are *designated* beneficial uses.

Table 2. Lower Kootenai River subbasin beneficial uses of §303(d)-listed streams.

Water Body	Assessment Unit	Beneficial Uses	Type of Use
Boundary Creek - Headwaters	ID17010104PN002_02	COLD, SS, PCR	Designated
Boundary Creek - 3rd Order	ID17010104PN002_03	COLD, SS, PCR	Designated
Deep Creek - Headwaters	ID17010104PN025_02	COLD, SS, PCR, DWS	Designated
Deep Creek - 3rd Order	ID17010104PN022_03	COLD, SS, PCR	Designated
Deep Creek - 4th Order	ID17010104PN019_04	COLD, SS, PCR, DWS	Designated
Deep Creek - 4th Order	ID17010104PN018_04	COLD, SS, PCR, DWS	Designated
Deep Creek - 4th Order	ID17010104PN015_04	COLD, SS, PCR, DWS	Designated[a]

Notes: Cold water aquatic life (CWAL), salmonid spawning (SS), primary contact recreation (PCR), domestic water supply (DWS)

2.2.5 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 3).

Table 3. 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				
Bacteria				
Geometric mean	<126 *E. coli*/100 mL[b]	<126 *E. coli*/100 mL	—	—
pH	—	—	Between 6.5 and 9.0	Between 6.5 and 9.5
Dissolved oxygen (DO)	—	—	DO exceeds 6.0 milligrams/liter (mg/L)	**Water Column DO**: DO exceeds 6.0 mg/L in water column or 90% saturation, whichever is greater **Intergravel DO**: DO exceeds 5.0 mg/L for a 1-day minimum and exceeds 6.0 mg/L for a 7-day average
Temperature[c]	—	—	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
Turbidity	—	—	Turbidity shall not exceed background by more than 50 nephelometric turbidity units (NTU) instantaneously or more than 25 NTU for more than 10 consecutive days.	—
Ammonia	—	—	Ammonia not to exceed calculated concentration based on pH and temperature.	—
EPA Bull Trout Temperature Criteria: Water Quality Standards for Idaho, 40 CFR Part 131				
Temperature				—

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

2.2.5.1 Water Quality Standards for 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 spawning periods:

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

For the purposes of a temperature total maximum daily load (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 Idaho's numeric temperature criteria.

Idaho 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. The DEQ Coeur d'Alene Regional Office set the general spawning and incubation windows with assistance from the Idaho Department of Fish and Game to better reflect and protect salmonid spawning and incubation in northern Idaho (Table 4). Six native salmonid species inhabit the lower Kootenai River subbasin: Bull Trout (*Salvelinus confluentus*), Westslope Cutthroat Trout (*Oncorhynchus clarki lewisi*), Redband Rainbow Trout (*Oncorhynchus mykiss ssp*.), Kokanee Salmon (*Oncorhynchus nerka*), Pygmy Whitefish (*Prosopium coulteri*), and Mountain Whitefish (*Prosopium williamsoni*). In addition to the endangered White Sturgeon (*Acipenser transmontanus*), the Kootenai River also contains Idaho's only population of native Burbot (*Lota lota*), a species of special concern. The salmonids and burbot species are discussed in more detail in DEQ (2006).

Bull Trout is listed as a threatened species by the United States Fish and Wildlife Service. To protect the species in Idaho, a recovery plan was developed by the state in which water temperature criteria were set to protect the threatened species (IDAPA 58.01.02.250.02.g). EPA also promulgated Bull Trout water quality temperature criteria (40 CFR 131.33).

Table 4. Time periods for applying Idaho salmonid spawning temperature criteria in the Idaho Panhandle.

Species	Timing
Westslope Cutthroat Trout	Elevation ≥ 400 feet (1,219 meters) = June 1–July 31 Elevation 3,000–4,000 feet (914–1,219 meters) = May 15–July 15 Elevation < 3,000 feet (< 914 meters) = May 1–July 1
Rainbow Trout	May 1–July 1
Fall spawning salmonids	August 15–November 15

The cold water aquatic life criteria are not discussed in this section because where cold water aquatic life beneficial use criteria apply, the SS criteria also apply and are more protective (i.e., require a lower temperature) than the cold water aquatic life criteria, except for McArthur Lake. When temperature data exceed the more protective salmonid spawning criteria, the water body is identified as impaired by temperature regardless of whether it fails the cold water aquatic life criteria.

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

DEQ allows for minor exceedances of water quality temperature criteria when the exceedance occurs less than 10% of the critical time period and no other evidence of thermal inputs exists (DEQ 2016). Exceptions are also made for water temperature exceedances that occur during periods when air temperatures exceed the 90th percentile of air temperatures recorded in the area (DEQ 2016).

2.2.6 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)

IDAPA 58.01.02.401.01.c 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.

2.3 Summary and Analysis of Existing Water Quality Data

No new data have been collected for these streams since the 2006 TMDL (DEQ 2006) other than the data necessary for this TMDL. Data collection was necessary for updated shade curves based on Idaho plant communities as defined in the PNV manual (Shumar and De Varona 2009). Data sources are provided in Appendix A.

The 2006 TMDL analysis examined main-stem sections of streams listed for temperature pollution. This TMDL analysis included all tributary streams within the headwater segments of the Deep Creek and Boundary Creek AUs — specifically, 2nd-order streams (those AUs with an _02 AU designation). Higher order AUs were generally similar between the 2006 and 2014 with the only differences occurring in the bankfull width, which does have some impact on calculations of solar loads. Stream width must be known to calculate target solar loads since the width of a stream affects the amount of shade the stream receives. Bankfull width is used to calculate target shade because it best approximates the width between the points on either side of the stream where riparian vegetation starts. Estimation of bankfull width and calculating target solar loads is further explained in section 5.1.2.2. Table 5 compares the 2006 and 2014 existing and target solar loads and the percentage of load reduction required to meet target.

Table 5. Comparative existing and target solar loads (2006 and 2014).

Water Body Segment	Assessment Unit	2006				2016			
		Total Existing Load	Total Target Load	Excess Load	Load Reduction	Total Existing Load	Total Target Load	Excess Load	Load Reduction
		(kWh/day)			(%)	(kWh/day)			(%)
Boundary Creek	ID17010104PN002_02 ID17010104PN002_03	631,096	602,595	28,500	5%	600,000	620,000	0	0%
Deep Creek	ID17010104PN025_02 ID17010104PN022_03 ID17010104PN019_04 ID17010104PN018_04 ID17010104PN015_04	1,846,455	1,133,354	713,101	39%	2,400,000	2,300,000	95,000	4%

Observations relating to the data presented in Table 5 align with the conditions presented in the previous paragraph. For example, within Deep Creek some of the difference between the analysis years can be attributed to the bankfull width examined. The 2006 analysis used a bankfull width of 10 meters for the entire length analyzed. The 2016 analysis used estimated bankfull widths of 2 meters near the headwater segments up to 28 meters at the mouth. Total stream area examined for solar load in 2006 was 453,850 square meters (m^2). The 2016 analysis considered 598,200 m^2 of stream area. In addition, the 2016 analysis examined over 46 kilometers (km) of stream, which is just over 1km more stream analyzed than in 2006. In summary, the updated shade curve application resulted in an increase in solar load to Deep Creek. Despite the increase in solar load in Deep Creek calculated in 2016, existing solar loads are much closer to target levels when compared to 2006.

2.3.1 Status of Beneficial Uses

Elevated stream temperatures can be harmful to fish at all life stages, especially if they occur in combination with other habitat limitations such as low dissolved oxygen or poor food supply. Acceptable temperature ranges vary for different species of fish, with cold water species being the least tolerant of high water temperatures. Elevated stream temperatures can also harm aquatic invertebrates, amphibians, and mollusks, although less is known about these effects.

3 Pollutant Source Inventory

Pollution within the Kootenai River subbasin is primarily from temperature and sediment/siltation. Sediment impairments in the Kootenai River subbasin are not addressed in this document. Waterbodies with sediment impairments in the 2006 TMDL are Blue Joe Creek, Boulder Creek, Caribou Creek, Cow Creek, Deep Creek, and the Moyie River.

3.1 Point Sources

The AUs being evaluated for PNV in this document are not affected by the discharge of any identified point sources.

3.2 Nonpoint Sources

All pollutant sources in the Kootenai River subbasin are nonpoint.

4 Summary of Past and Present Pollution Control Efforts

A detailed summary of past pollution control efforts for the Kootenai River subbasin are found in the 2006 TMDL (DEQ 2006) and the *Draft Kootenai River Total Maximum Daily Load Implementation Plan* (KTOI et al. 2005). Current efforts toward natural recovery of the Boundary Creek watershed has allowed for plant growth and more shade in the riparian area. Since 2006, no known pollution control efforts have occurred in the Deep Creek watershed.

5 Total Maximum Daily Loads

A TMDL prescribes an upper limit (i.e., load capacity) on discharge of a pollutant from all sources to ensure water quality standards are met. It further allocates this load capacity among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation, and nonpoint sources, each of which receives a load allocation. Natural background contributions, when present, are considered part of the load allocation but are often treated separately because they represent a part of the load not subject to control. Because of uncertainties about quantifying loads and the relation of specific loads to attaining water quality standards, the rules regarding TMDLs (40 CFR 130) require a margin of safety 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; target solar load (kWh/day).
MOS = margin of safety; implicit in the PNV method, no separate allowance identified.
NB = natural background; existing solar load (kWh/day).
LA = load allocation; stream segment dependent based on existing and target solar loads (kWh/day).
WLA = wasteload allocation; no point sources present in subbasin, no separate allowance identified (kWh/day). .

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

Sections 5.2 through 5.4 thoroughly describe how the components of the TMDL equation are calculated and how they are applied to determine a TMDL in terms of the PNV analysis completed.

5.1 Instream Water Quality Targets

For the 7 AUs in the Lower Kootenai River subbasin, DEQ used a PNV approach to develop these temperature TMDLs. 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.

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 PNV 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 Spokane, Washington, station. 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.

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.

5.1.2.1 Existing Shade Estimates

Existing shade was estimated for seven AUs 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 seven sites in the Lower Kootenai River subbasin. The Solar Pathfinder is a device that allows one to trace the outline of shade-producing objects on monthly solar path charts. The percentage of the sun's path covered by these objects is the effective shade on the stream at the 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. One can also take densiometer readings at the same location as Solar Pathfinder traces. These readings provide the potential to develop relationships between canopy cover and effective shade for a given stream. A summary of aerial stream shade classification and pathfinder measurements is presented in Table 6.

Table 6. Solar Pathfinder field verification results for the lower Kootenai River subbasin.

Site	Latitude	Longitude	Aerial Classification	Pathfinder Measurement	Pathfinder Classification	Classification Difference[1]
Boundary Cr_01	48.9950	-116.6852	60	54	50	1
Deep Cr_01	48.6851	-116.3993	10	23	20	-1
Deep Cr_02	48.6779	-116.4027	20	18	10	1
Deep Cr_03	48.4942	-116.4659	40	35	30	1
Deep Cr_05	48.5961	-116.4025	20	21	20	0
Deep Cr_06	48.5935	-116.4015	30	34	30	0
Saddle Cr_01	48.9932	-116.6856	90	85	80	1

[1]Mean = 0.43, Standard Deviation = 0.79, Confidence Level (95%) = 0.73

All aerial interpretations of stream shade cover were within one shade class of the Solar Pathfinder measurements that were taken. Verifying aerial interpretations allows for a check on accuracy and further refinement of the assessment techniques involved. Solar Pathfinder data were used to correct the stream segments with the largest over and under estimations. Adjacent stream segments that showed similar characteristics were also corrected. Allowing for this correction gives a more accurate estimate of solar load for the water body segment.

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 2). For each stream evaluated in the load analysis, natural bankfull width was estimated based on the drainage area of the Kootenai River curve from Figure 2. Although estimates from other curves were examined (i.e., Pend Oreille and Spokane Rivers), the Kootenai River curve was ultimately chosen because of its proximity to the watersheds examined and primarily due to the fact that the streams examined are tributaries to the Kootenai River. Existing width data should also be evaluated and compared to these curve estimates if such data are available. However, for the Boundary and Deep Creek watersheds, only a few Beneficial Use Reconnaissance Program (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 disagree with natural bankfull width estimates from the Kootenai River basin curve and chose not to make natural widths any smaller than these Boundary and Deep Creek basin estimates. Natural bankfull width estimates for each stream in this analysis are presented in Appendix A. 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 Tables A2 and A3. Existing widths and natural widths are the same in load tables when there are no data to support making them differ.

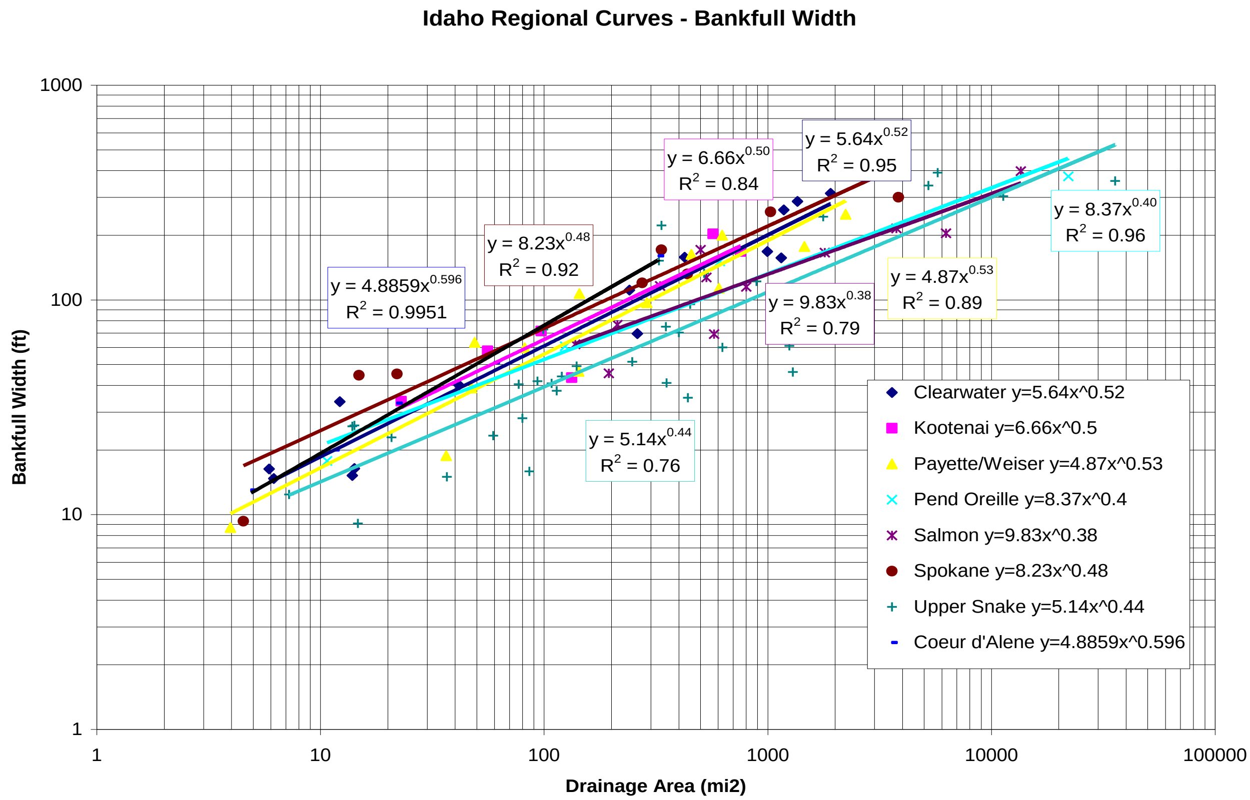

Figure 2. Bankfull width as a function of drainage area.

5.1.3 Design Conditions

The Kootenai River subbasin is within the Northern Rockies ecoregion (McGrath et al. 2001), which is mountainous and rugged. The climate within this ecoregion is maritime influenced with Pacific species of trees such as Western Redcedar, Western Hemlock, Mountain Hemlock and Grand Fir present. Forested areas may also contain stands of Douglas Fir, Subalpine Fir, Englemann Spruce, Western Larch, Ponderosa Pine, and Lodgepole Pine. The majority of the Kootenai River subbasin is typified by the Selkirk Mountains, with the Kootenai River and the mouth of Deep Creek found within the Kootenai Valley. The headwaters of tributary streams to Boundary Creek may be found within portions of the High Northern Rockies.

The Selkirk Mountains are described as rugged, partly glaciated land that is covered in mixed coniferous forests containing mantled soils with components of volcanic ash that increase forest productivity (McGrath et al. 2001). Like the Northern Rockies ecoregion a mix of Pacific and Rocky Mountain tree species are found here. Given the strong maritime influence in climate and the high relief landscape, low and mid-elevation locations have higher summer precipitation, fog, and relative humidity than elsewhere in northern Idaho. Boreal influences are stronger here and some north-facing valleys have extensive peatland formations.

The Kootenai Valley is a broad, glacial scoured valley that is drier than the Inland Maritime Foothills and Valleys to the south (McGrath et al. 2001). The drier climate is attributable to the effects from the nearby Selkirk Mountain range. The Kootenai River within the valley has a broad floodplain that has been reclaimed with levees and is intensively farmed.

5.1.4 Shade Curve Selection

To determine PNV shade targets for the Kootenai River subbasin, effective shade curves from the Idaho Panhandle National Forest were examined (Table 7) (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 the Kootenai River subbasin, curves for the most similar vegetation type were selected for shade target determinations. The predominant shade curves utilized for shade target determinations were the Moist (Group B) forest type and Group 1 Hardwoods in nonforested sections of valley bottoms. The Moist (Group B) forest is typified by low to mid-elevations with favorable soil moisture and temperature regimes that favor abundant plant growth. The Group 1 Hardwood nonforest type is found in valley bottoms of streams that are designated as 5th order or less, and a stream gradient of less than 3%. This grouping includes a mix of coniferous and deciduous tree and shrub species. Figure 3 shows gradients of streams analyzed as part of this analysis, and Figure 4 shows the relative composition of tree and shrub species found within the Group 1 Hardwoods.

Table 7. Shade curve types for developing shade targets in the lower Kootenai River subbasin.

Idaho Panhandle National Forest	Idaho Non-Forest Types
Warm/Dry (Group A)	Graminoid
Moist (Group B)	Group 1 Hardwoods
Subalpine (Groups C and D)	

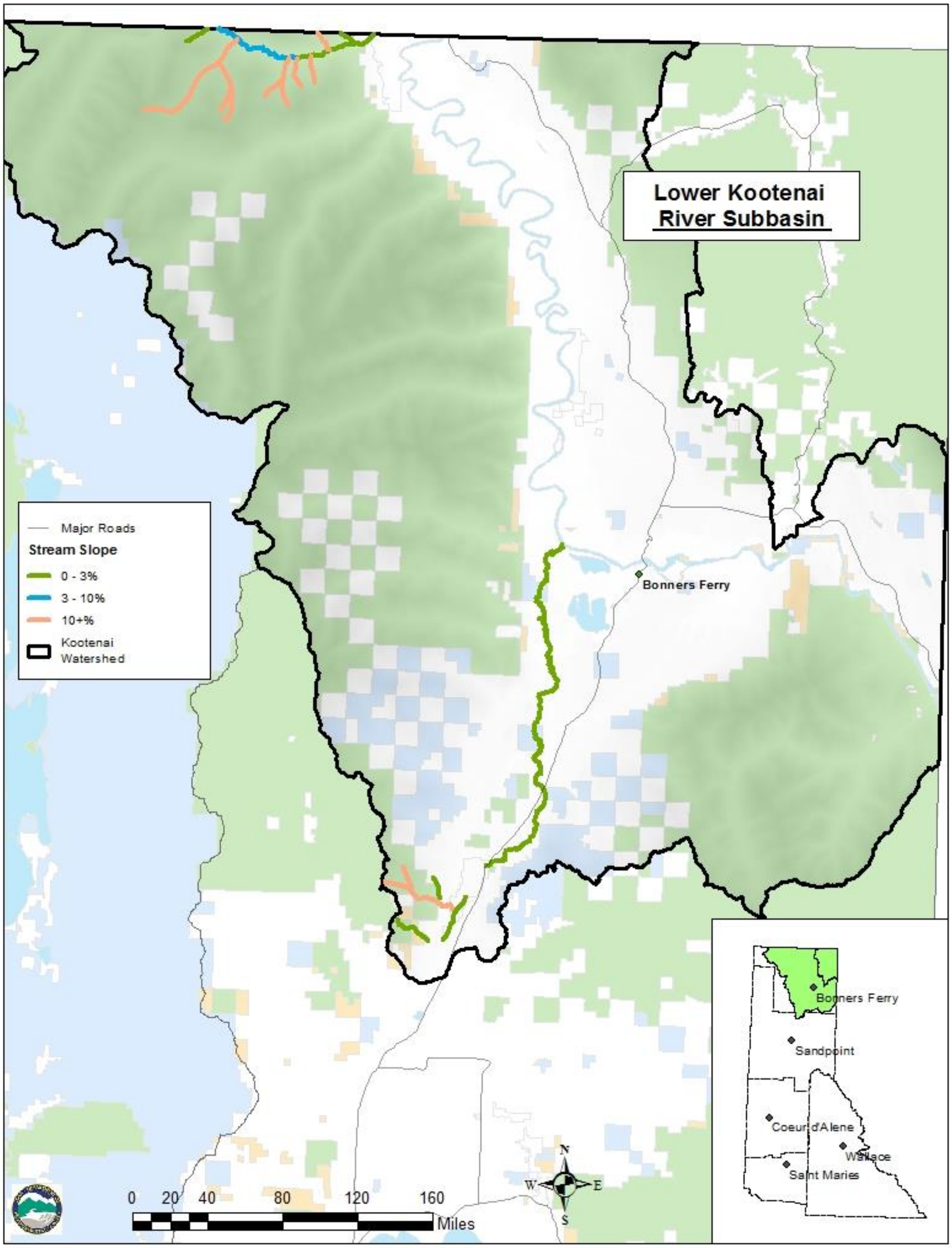

Figure 3. Stream gradients (slopes) for the lower Kootenai River subbasin.

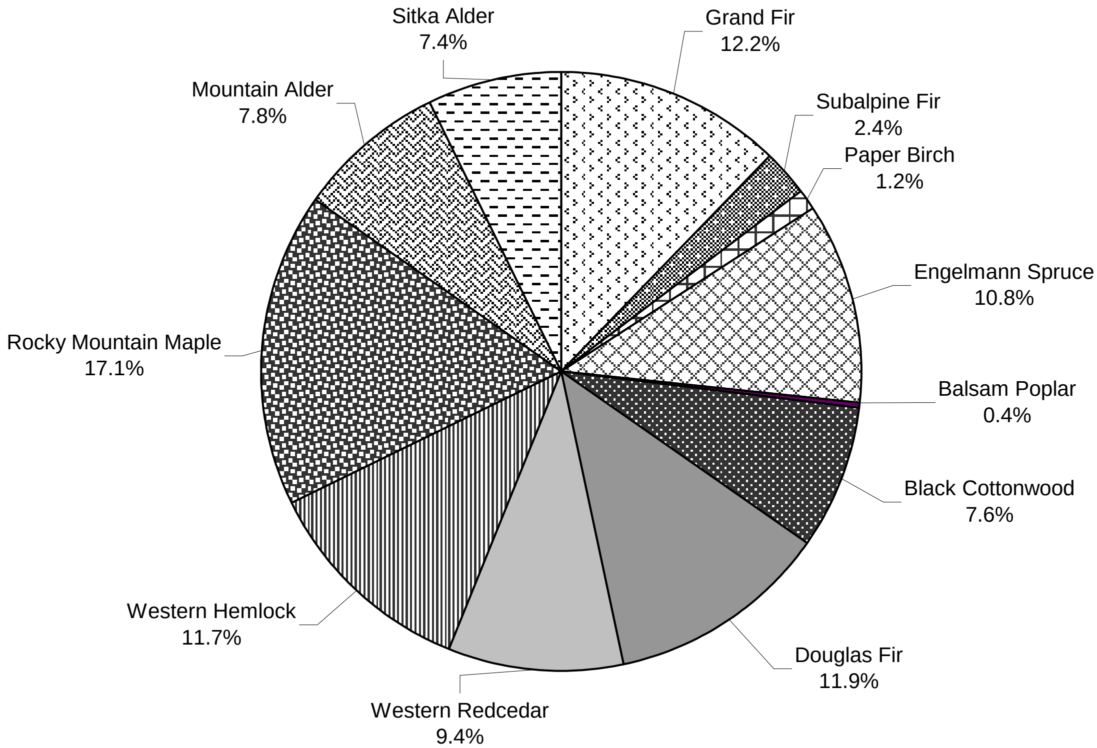

Figure 4. Relative species composition of Group 1 Hardwoods (DEQ 2013).

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), then the solar load hitting the stream under that target is 40% of the load hitting the flat-plate collector under full sun.

We obtained solar load data from flat-plate collectors at the NREL weather station in Spokane, Washington. 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 SS and CWAL 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 SS temperatures in spring and fall.

Tables A4–A10 and Figures A1 and A4 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 segment's 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 Deep Creek (ID17010104PN015_04) with 800,000 kWh/day (Table A9). The smallest target load capacity was in the Boundary Creek AU (ID17010104PN002_02) with 22,000 kWh/day (Table A3).

5.3 Estimates of Existing Pollutant Loads

Regulations allow that loads "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading" (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. There are currently no permitted point sources in the affected AUs. Like target shade, existing shade was converted to a solar load by multiplying the fraction of open stream by the solar radiation measured on a flat-plate collector at the NREL weather station. Existing shade data are presented in Tables A4–A10. Like load capacities (target loads), existing loads in Tables A4–A10 are presented on an area basis (kWh/m^2/day) and as a total load (kWh/day). Existing load estimates from aerial interpretation are shown in Figures A2 and A5. Existing loads in kWh/day are also summed for the entire stream or portion of stream examined in a single load analysis table. The difference between target and existing load is also summed for the entire table. If existing load exceeds target load, this difference becomes the excess load (i.e., lack of shade), which is discussed in section 5.4 and depicted in Figures A3 and A6.

The AU with the largest existing load was Deep Creek (ID17101014PN015_04) with 900,000 kWh/day (Table A9). The smallest existing load was in the Boundary Creek AU (ID17010104PN002_02) with 62,000 kWh/day (Table A3).

5.4 Load and Wasteload Allocation

Because this TMDL is based on PNV, which is equivalent to background load, 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 depend on the target load for a given segment. Tables A4–A10 (Appendix A) show the target shade and corresponding target summer load. This target load (i.e., load capacity) is necessary to achieve background conditions. There is no opportunity to further remove shade from the stream by any activity without exceeding its load capacity. Additionally, because this TMDL depends on background conditions for achieving water quality standards, all tributaries to the waters examined here must be in natural conditions to prevent excess heat loads to the system.

Table 8 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 8 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 figures (Figures A3 and A6), 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 8 and provides a general level of comparison among streams.

Table 8. Total solar loads and average lack of shade for all waters.

Water Body	Assessment Unit	Total Existing Load (kWh/day)	Total Target Load (kWh/day)	Excess Load (% Reduction)	Average Lack of Shade (%)
Boundary Creek - Headwaters	ID17010104PN002_02	62,000	22,000	41,000 66%	-11%
Boundary Creek - 3rd Order	ID17010104PN002_03	600,000	620,000	0 0%	0%
Deep Creek - Headwaters	ID17010104PN025_02	82,000	67,000	15,000 18%	-16%
Deep Creek - 3rd Order	ID17010104PN022_03	280,000	290,000	0 0%	0%
Deep Creek - 4th Order	ID17010104PN019_04	530,000	550,000	0 0%	0%
Deep Creek - 4th Order	ID17010104PN018_04	600,000	590,000	10,000 2%	-8%
Deep Creek - 4th Order	ID17010104PN015_04	900,000	800,000	100,000 11%	-7%

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

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

Most differences in target and existing shade are relatively small with excess shade ranging from 0–18%. The notable exception to this is the tributary streams of the Boundary Creek system. This AU has small tributary streams, and the excess load is present primarily as the difference between the target level and shade class. Excess loads are difficult to evaluate and compare because they vary with stream width and overall length of the AU. Shade deficit figures presented in this TMDL that show shade deficits (lack of shade) are useful for interpreting where problems in a stream may be occurring. The lack of shade shown in Figures A3 and A6 could be attributed to margin of safety, variation inherent within the method, and the natural variation of vegetative density within a vegetation community type. Differences between existing and target shade greater than 20% should be considered as outside of normal reference conditions for this watershed. A reference watershed, Long Canyon Creek, was identified in the 2014 TMDL addendum for the Lower Kootenai and Moyie River subbasins. This reference watershed has very little to no human disturbance.

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 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. Additionally, existing shade levels are reduced to the next lower 10% shade class, which likely underestimates actual shade in the load analysis. Although the load analysis used in this TMDL involves gross estimations that are likely to have large variances, load allocations are applied to the stream and its riparian vegetation rather than specific nonpoint source activities and can be adjusted as more information is gathered from the stream environment.

5.4.3 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 and watershed advisory groups (WAGs). The Kootenai Valley Resource Initiative served as the WAG for the lower Kootenai River and Moyie River subbasins.

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 9.

Table 9. 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 IDAPA 58.01.02.350.01–03. IDAPA 58.01.02.055.07 refers to the Idaho Agricultural Pollution Abatement Plan (Ag Plan) (SCC and DEQ 2003), 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 (NPDES) 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.

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 Clean Water Act purposes, including stormwater that is associated with municipal separate storm sewer systems (MS4s), industrial stormwater covered under the Multi-Sector General Permit (MSGP), and construction stormwater covered under the Construction General Permit (CGP) (Appendix C).

5.4.6 Reserve for Growth

No reserves for other pollutant additions have been made in this TMDL. Allocations in this TMDL are based on achieving background shade levels through the BMP application. If it is determined that beneficial use support is achieved and water quality standards are being met at shade levels lower than those outlined in this TMDL, then the TMDL may be revised accordingly.

5.5 Implementation Strategies

Implementation strategies for TMDLs produced using PNV-based shade and solar loads should incorporate the load analysis tables (Tables A4–A10). 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 (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 10–40 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 designated WAG 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 Approach and Responsible Parties

Development of the implementation plan for the Kootenai River subbasin TMDL will proceed under the existing practice established for Idaho. DEQ, the Kootenai Valley Resource Initiative, federal land management agencies, affected private landowners, and other watershed stakeholders with input through the established public process will cooperatively develop and implement the plan. Other individuals may be identified to assist in developing site specific implementation plans if their areas of expertise are identified as beneficial to the process.

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

5.5.3 Implementation Monitoring Strategy

Effective shade monitoring can take place on any segment throughout the Kootenai River subbasin and be compared to existing shade estimates seen in Figures A2 and A5 and described in Tables A4–A10. 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. Since 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.

5.5.4 Pollutant Trading

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

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

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

Pollutant trading is recognized in Idaho's water quality standards at IDAPA 58.01.02.055.06. DEQ allows for pollutant trading as a means to meet TMDLs, thus restoring water quality limited water bodies to compliance with water quality standards. DEQ's *Water Quality Pollutant Trading Guidance* sets forth the procedures to be followed for pollutant trading (DEQ 2010). For more information on pollutant trading and TMDL refer to Appendix D.

6 Conclusions

Effective shade targets were established for water bodies and AUs in the Kootenai River subbasin 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 IDAPA 58.01.02. Many stream reaches analyzed as part of this TMDL meet normal reference condition for this watershed (i.e., have shade deficits less than 20%). A reference watershed, Long Canyon Creek, was identified in the 2014 TMDL addendum for the Lower Kootenai and Moyie River subbasins. This reference watershed has very little to no human disturbance. A summary of assessment outcomes, including recommended changes the next Integrated Report, is presented in Table 10.

Table 10. Summary of assessment outcomes.

Water Body	Assessment Unit	Pollutant	TMDL(s) Completed	Recommeded Changes to Next Integrated Report
Boundary Creek - Headwaters	ID17010104PN002_02	Temperature	Yes	Remain in Category 4a
Boundary Creek - 3rd Order	ID17010104PN002_03	Temperature	Yes	Remain in Category 4a
Deep Creek - Headwaters	ID17010104PN025_02	Temperature	Yes	Remain in Category 4a
Deep Creek - 3rd Order	ID17010104PN022_03	Temperature	Yes	Remain in Category 4a
Deep Creek - 4th Order	ID17010104PN019_04	Temperature	Yes	Remain in Category 4a
Deep Creek - 4th Order	ID17010104PN018_04	Temperature	Yes	Remain in Category 4a
Deep Creek - 4th Order	ID17010104PN015_04	Temperature	Yes	Remain in Category 4a

This analysis revisits a shade analysis completed for the 2006 TMDL. The 2006 TMDL used surrogate shade curve values to estimate solar loads on listed streams. The 2016 analysis updates those methods and incorporates shade curves developed from riparian communities found within the state of Idaho. The 2016 shade analysis was completed for the entire sections of the AUs listed, and represents an expansion of the shade analysis completed in 2006. The 2006 analysis considered only main stem sections of streams in listed AUs.

A comparison of solar loads calculated in 2006 and 2016 show reasonable differences between the years when considering the parameters of the analysis. The analysis for Boundary Creek – 3rd Order (ID17010104PN002_03) was very similar and, based on 2016 data, shows no excess solar load to the stream. Some differences in stream width were noticed in the analysis for Deep Creek, which resulted in a larger overall stream area when compared to the 2006 analysis. Despite an increase in existing solar load the stream is closer to target solar loads when compared against 2006 values.

The 1st- and 2nd-order segments of tributary streams to Boundary and Deep Creeks currently show the largest differences between existing and target solar loads. Much of this difference is found within the calculation of each load type and is not unexpected. In some instances the difference between target load and the existing shade classification load can vary between 2%–8%, which can have a relatively large combined effect within an AU.

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.

This document was prepared with input from the public, as described in Appendix B. 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 E.

References Cited

Armantrout, N.B., compiler. 1998. *Glossary of Aquatic Habitat Inventory Terminology*. Bethesda, MD: American Fisheries Society.

CFR (Code of Federal Regulation). 1977. "Guidelines Establishing Test Procedures for the Analysis of Pollutants." 40 CFR 136.

CFR (Code of Federal Regulation). 1983. "EPA Administered Permit Programs: The National Pollutant Discharge Elimination System." 40 CFR 122.

CFR (Code of Federal Regulation). 1983. "Water Quality Standards." 40 CFR 131.

CFR (Code of Federal Regulation). 1995. "Water Quality Planning and Management." 40 CFR 130.

DEQ (Idaho Department of Environmental Quality). 2005. *Catalog of Stormwater Best Management Practices for Idaho Cities and Counties*. Boise, ID: DEQ. *http://www.deq.idaho.gov/water-quality/wastewater/stormwater.aspx*.

DEQ (Idaho Department of Environmental Quality). 2006. *Assessment of Water Quality in Kootenai River and Moyie River Subbasins (TMDL)*. Coeur d'Alene, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2010. *Water Quality Pollutant Trading Guidance*. Boise, ID: DEQ. *http://www.deq.idaho.gov/water-quality/surface-water/pollutant-trading.aspx*.

DEQ (Idaho Department of Environmental Quality). 2013. *Upper (North Fork) Coeur d'Alene River Subbasin Temperature Total Maximum Daily Loads*. Coeur d'Alene, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2014a. *Assessment of Water Quality in Kootenai River and Moyie River Subbasins (TMDL) 2014 Temperature Addendum*. Coeur d'Alene, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2014b. *Idaho's 2012 Integrated Report*. Boise, ID: DEQ. *http://www.deq.idaho.gov/water-quality/surface-water/monitoring-assessment/integrated-report.aspx*.

DEQ (Idaho Department of Environmental Quality). 2016 *Water Body Assessment Guidance*. 3rd ed. Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality. 2015. *Idaho Nonpoint Source Management Plan*. Boise, ID: DEQ.

EPA (US Environmental Protection Agency). 1996. *Biological Criteria: Technical Guidance for Streams and Small Rivers*. Washington DC: EPA, Office of Water. EPA 822-B-96-001.

IDAPA. 2017. "Idaho Water Quality Standards." Idaho Administrative Code. IDAPA 58.01.02.

IDL (Idaho Department of Lands). 2000. *Forest Practices Cumulative Watershed Effects Process for Idaho*. Boise, ID: IDL.

ISWCC (Idaho Soil and Water Conservation Commission) 2003. *Idaho Agricultural Pollution Abatement Plan.* Boise, ID: ISWCC.

KTOI et al. (Kootenai Tribe of Idaho, Idaho Department of Environmental Quality, and US Environmental Protection Agency). 2005. *Draft Kootenai River Total Maximum Daily Load Implementation Plan*. Bonners Ferry, ID: KTOI.

Küchler, A.U. 1964. “Potential Natural Vegetation of the Conterminous United States.” American Geographical Society Special Publication 36.

McGrath, C.L., A.J. Woods, J.M. Omernik, S.A. Bryce, M. Edmondson, J.A. Nesser, J. Shelden, R.C. Crawford, J.A. Comstock, and M.D. Plocher. 2001. “Ecoregions of Idaho.” Reston, VA: US Geological Survey.

OWEB (Oregon Watershed Enhancement Board). 2001. “Stream Shade and Canopy Cover Monitoring Methods.” In *Water Quality Monitoring Technical Guide Book*, chap. 14. Salem, OR: OWEB.

Poole, G.C. and C.H. Berman. 2001. “An Ecological Perspective on In-Stream Temperature: Natural Heat Dynamics and Mechanisms of Human-Caused Thermal Degradation.” *Environmental Management* 27(6):787–802.

Shumar, M.L. and J. De Varona. 2009. *The Potential Natural Vegetation (PNV) Temperature Total Maximum Daily Load (TMDL) Procedures Manual*. Boise, ID: Idaho Department of Environmental Quality.

Strahler, A.N. 1957. “Quantitative Analysis of Watershed Geomorphology.” *Transactions American Geophysical Union* 38:913–920.

US Congress. 1972. Clean Water Act (Federal Water Pollution Control Act). 33 USC §1251–1387.

GIS Coverages

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Glossary

§303(d)

Refers to section 303 subsection "d" of the Clean Water Act. Section 303(d) requires states to develop a list of water bodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to 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 load 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 alter 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 load capacity that is allocated to one of its existing or future point sources of pollution. Wasteload allocations specify how much pollutant each point source may release to a water body.

Water Body

A stream, river, lake, estuary, coastline, or other water feature, or portion thereof.

Water Quality Criteria

Levels of water quality expected to render a 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. Data Sources

Table A1. Bankfull width estimates in Boundary Creek tributaries and main-stem segments (ID17010104PN002_02 and ID17010104PN002_03) for streams in load analysis.

Location	Area (sq mi)	Spokane (m)	Kootenai (m)	PendOreille (m)	Clearwater (m)	BURP (m)
Boundary Creek_Trib_01	0.8	2	2	2	2	
Saddle Creek	10.3	8	7	6	6	7.2
Shorty Creek	3.1	4	4	4	3	
Shorty Creek_Trib	0.7	2	2	2	1	
Fan Creek	3.2	4	4	4	3	
Fan Creek_Trib	1.0	3	2	3	2	
Italian Creek	0.4	2	1	2	1	
Boundary Creek_Trib_02	1.0	3	2	3	2	
Dodge Creek	4.6	5	4	5	4	
Boundary Creek_Trib_03	0.2	1	1	1	1	
Boundary Creek	93	22	20	16	18	14.9

Table A2. Bankfull width estimates in Deep Creek for streams in load analysis.

Location	Stream Segment (AU)	Area (sq mi)	Spokane (m)	Kootenai (m)	PendOreille (m)	Clearwater (m)	BURP (m)
Deep Creek	Source to McArthur Lake (025_02)	11.5	8	7	7	6	
Deep Creek Trib 1	Source to McArthur Lake (025_02)	0.5	2	1	2	1	
Deep Creek Trib 2	Source to McArthur Lake (025_02)	0.9	2	2	2	2	
Deep Creek Trib 3	Source to McArthur Lake (025_02)	7.1	6	5	6	5	
Deep Creek	McArthur Lake to Trail Creek (022_03)	41.9	15	13	11	12	10.3
Deep Creek	Trail Creek to Brown Creek (019_04)	103.8	23	21	16	19	
Deep Creek	Ruby Creek to Snow Creek (018_04)	137.3	27	24	18	22	13.6
Deep Creek	Snow Creek to Kootenai River (015_04)	190.9	31	28	21	26	

Table A3. Existing and target solar loads for Boundary Creek—1st- and 2nd-order 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
002_02	Boundary Creek_Trib_01	1	1675	Moist	98%	0.11	2	3,000	300	80%	1.14	2	3,000	3,000	3,000	-18%
002_02	Boundary Creek_Trib_02	1	1742	Moist	98%	0.11	2	3,000	300	90%	0.57	2	3,000	2,000	2,000	-8%
002_02	Boundary Creek_Trib_03	1	1155	Moist	98%	0.11	1	1,000	100	90%	0.57	1	1,000	600	500	-8%
002_02	Dodge Creek	1	1452	Moist	96%	0.23	4	6,000	1,000	80%	1.14	4	6,000	7,000	6,000	-16%
002_02	Fan Creek	1	1593	Moist	98%	0.11	2	3,000	300	80%	1.14	2	3,000	3,000	3,000	-18%
002_02	Fan Creek	2	634	Moist	97%	0.17	3	2,000	300	90%	0.57	3	2,000	1,000	700	-7%
002_02	Fan Creek	3	980	Moist	96%	0.23	4	4,000	900	80%	1.14	4	4,000	5,000	4,000	-16%
002_02	Fan Creek_Trib	1	1709	Moist	98%	0.11	2	3,000	300	90%	0.57	2	3,000	2,000	2,000	-8%
002_02	Italian Creek	1	1939	Moist	98%	0.11	1	2,000	200	90%	0.57	1	2,000	1,000	800	-8%
002_02	Saddle Creek	1	608	Subalpine	96%	0.23	2	1,000	200	80%	1.14	2	1,000	1,000	800	-16%
002_02	Saddle Creek	2	145	Subalpine	96%	0.23	3	400	90	70%	1.71	3	400	700	600	-26%
002_02	Saddle Creek	3	1095	Subalpine	94%	0.34	4	4,000	1,000	80%	1.14	4	4,000	5,000	4,000	-14%
002_02	Saddle Creek	4	4794	Moist	94%	0.34	5	20,000	7,000	90%	0.57	5	20,000	10,000	3,000	-4%
002_02	Saddle Creek	5	974	Moist	92%	0.46	6	6,000	3,000	90%	0.57	6	6,000	3,000	0	-2%
002_02	Saddle Creek	6	1018	Moist	90%	0.57	7	7,000	4,000	80%	1.14	7	7,000	8,000	4,000	-10%
002_02	Shorty Creek	1	605	Subalpine	98%	0.11	1	600	70	90%	0.57	1	600	300	200	-8%
002_02	Shorty Creek	2	395	Subalpine	97%	0.17	2	800	100	80%	1.14	2	800	900	800	-17%
002_02	Shorty Creek	3	1277	Moist	97%	0.17	3	4,000	700	90%	0.57	3	4,000	2,000	1,000	-7%
002_02	Shorty Creek	4	1898	Moist	96%	0.23	4	8,000	2,000	90%	0.57	4	8,000	5,000	3,000	-6%
002_02	Shorty Creek_Trib	1	650	Subalpine	98%	0.11	1	700	80	90%	0.57	1	700	400	300	-8%
002_02	Shorty Creek_Trib	2	994	Moist	98%	0.11	2	2,000	200	90%	0.57	2	2,000	1,000	800	-8%
							Totals		22,000					62,000	41,000	

Note: All assessment unit (AU) numbers start with ID17010104PN. Significant figures are controlled by the lowest level in the calculation, typically that of the channel width. Some rounding errors may result.

Table A4. Existing and target solar loads for Boundary Creek—3rd order.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
002_03	Boundary Creek	1	1566	Moist	57%	2.45	16	30,000	70,000	50%	2.85	16	30,000	90,000	20,000	-7%
002_03	Boundary Creek	2	4248	Moist	54%	2.62	17	70,000	200,000	60%	2.28	17	70,000	200,000	0	6%
002_03	Boundary Creek	3	606	Moist	52%	2.74	18	10,000	30,000	60%	2.28	18	10,000	20,000	(10,000)	8%
002_03	Boundary Creek	4	981	Moist	52%	2.74	18	20,000	50,000	60%	2.28	18	20,000	50,000	0	8%
002_03	Boundary Creek	5	1405	Moist	52%	2.74	18	30,000	80,000	60%	2.28	18	30,000	70,000	(10,000)	8%
002_03	Boundary Creek	6	1843	Moist	50%	2.85	19	40,000	100,000	60%	2.28	19	40,000	90,000	(10,000)	10%
002_03	Boundary Creek	7	1009	Moist	48%	2.96	20	20,000	60,000	60%	2.28	20	20,000	50,000	(10,000)	12%
002_03	Boundary Creek	8	537	Moist	48%	2.96	20	10,000	30,000	50%	2.85	20	10,000	30,000	0	2%
							Totals		620,000					600,000	-20,000	

Note: All assessment unit (AU) numbers start with ID17010104PN. Significant figures are controlled by the lowest level in the calculation, typically that of the channel width. Some rounding errors may result.

Table A5. Existing and target solar loads for Deep Creek—Headwaters 1st and 2nd order.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
025_02	Deep Creek	1	1908	Moist	98%	0.11	2	4,000	500	90%	0.57	2	4,000	2,000	2,000	-8%
025_02	Deep Creek	2	2365	Moist	96%	0.23	4	9,000	2,000	90%	0.57	4	9,000	5,000	3,000	-6%
025_02	Deep Creek	3	226	Graminoid	13%	4.96	5	1,000	5,000	40%	3.42	5	1,000	3,000	(2,000)	27%
025_02	Deep Creek	4	1010	Group1 Hardwoods	65%	2.00	6	6,000	10,000	60%	2.28	6	6,000	10,000	0	-5%
025_02	Deep Creek	5	1110	Graminoid	9%	5.19	7	8,000	40,000	30%	3.99	7	8,000	30,000	(10,000)	21%
025_02	Deep Creek_Trib_01	1	2083	Moist	98%	0.11	1	2,000	200	90%	0.57	1	2,000	1,000	800	-8%
025_02	Deep Creek_Trib_02	1	1466	Moist	98%	0.11	2	3,000	300	80%	1.14	2	3,000	3,000	3,000	-18%
025_02	Deep Creek_Trib_03	1	1768	Moist	98%	0.11	1	2,000	200	90%	0.57	1	2,000	1,000	800	-8%
025_02	Deep Creek_Trib_03	2	316	Warm/Dry	93%	0.40	2	600	200	80%	1.14	2	600	700	500	-13%
025_02	Deep Creek_Trib_03	3	706	Warm/Dry	93%	0.40	2	1,000	400	70%	1.71	2	1,000	2,000	2,000	-23%
025_02	Deep Creek_Trib_03	4	319	Group1 Hardwoods	86%	0.80	3	1,000	800	80%	1.14	3	1,000	1,000	200	-6%
025_02	Deep Creek_Trib_03	5	520	Group1 Hardwoods	86%	0.80	3	2,000	2,000	50%	2.85	3	2,000	6,000	4,000	-36%
025_02	Deep Creek_Trib_03	6	266	Group1 Hardwoods	78%	1.25	4	1,000	1,000	40%	3.42	4	1,000	3,000	2,000	-38%
025_02	Deep Creek_Trib_03	7	138	Group1 Hardwoods	78%	1.25	4	600	800	20%	4.56	4	600	3,000	2,000	-58%
025_02	Deep Creek_Trib_03	8	276	Group1 Hardwoods	78%	1.25	4	1,000	1,000	40%	3.42	4	1,000	3,000	2,000	-38%
025_02	Deep Creek_Trib_03	9	448	Group1 Hardwoods	71%	1.65	5	2,000	3,000	30%	3.99	5	2,000	8,000	5,000	-41%
							Totals		67,000					82,000	15,000	

Note: All assessment unit (AU) numbers start with ID17010104PN. Significant figures are controlled by the lowest level in the calculation, typically that of the channel width. Some rounding errors may result.

Table A6. Existing and target solar loads for Deep Creek—3rd order (McArthur Lake to Trail Creek).

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
022_03	Deep Creek	6	2348	Group1 Hardwoods	55%	2.57	8	20,000	50,000	60%	2.28	8	20,000	50,000	0	5%
022_03	Deep Creek	7	1621	Group1 Hardwoods	51%	2.79	9	10,000	30,000	50%	2.85	9	10,000	30,000	0	-1%
022_03	Deep Creek	8	3010	Group1 Hardwoods	48%	2.96	10	30,000	90,000	60%	2.28	10	30,000	70,000	(20,000)	12%
022_03	Deep Creek	9	1702	Group1 Hardwoods	45%	3.14	11	20,000	60,000	50%	2.85	11	20,000	60,000	0	5%
022_03	Deep Creek	10	877	Group1 Hardwoods	41%	3.36	12	10,000	30,000	20%	4.56	12	10,000	50,000	20,000	-21%
022_03	Deep Creek	11	1052	Group1 Hardwoods	39%	3.48	13	10,000	30,000	70%	1.71	13	10,000	20,000	(10,000)	31%
							Totals		290,000					280,000	-10,000	

Note: All assessment unit (AU) numbers start with ID17010104PN. Significant figures are controlled by the lowest level in the calculation, typically that of the channel width. Some rounding errors may result.

Table A7. Existing and target solar loads for Deep Creek—4th order (Trail Creek to Brown Creek).

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
019_04	Deep Creek	12	520	Group1 Hardwoods	35%	3.71	15	8,000	30,000	50%	2.85	15	8,000	20,000	(10,000)	15%
019_04	Deep Creek	13	370	Group1 Hardwoods	33%	3.82	16	6,000	20,000	40%	3.42	16	6,000	20,000	0	7%
019_04	Deep Creek	14	824	Group1 Hardwoods	32%	3.88	17	10,000	40,000	20%	4.56	17	10,000	50,000	10,000	-12%
019_04	Deep Creek	15	1690	Group1 Hardwoods	30%	3.99	18	30,000	100,000	30%	3.99	18	30,000	100,000	0	0%
019_04	Deep Creek	16	2027	Group1 Hardwoods	29%	4.05	19	40,000	200,000	20%	4.56	19	40,000	200,000	0	-9%
019_04	Deep Creek	17	861	Group1 Hardwoods	28%	4.10	20	20,000	80,000	50%	2.85	20	20,000	60,000	(20,000)	22%
019_04	Deep Creek	18	1157	Group1 Hardwoods	27%	4.16	21	20,000	80,000	30%	3.99	21	20,000	80,000	0	3%
							Totals		550,000					530,000	-20,000	

Note: All assessment unit (AU) numbers start with ID17010104PN. Significant figures are controlled by the lowest level in the calculation, typically that of the channel width. Some rounding errors may result.

Table A8. Existing and target solar loads for Deep Creek—4th order (Brown Creek to Snow Creek).

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
018_04	Deep Creek	19	3234	Group1 Hardwoods	26%	4.22	22	70,000	300,000	20%	4.56	22	70,000	300,000	0	-6%
018_04	Deep Creek	20	946	Group1 Hardwoods	25%	4.28	23	20,000	90,000	10%	5.13	23	20,000	100,000	10,000	-15%
018_04	Deep Creek	21	2236	Group1 Hardwoods	24%	4.33	24	50,000	200,000	20%	4.56	24	50,000	200,000	0	-4%
							Totals		590,000					600,000	10,000	

Note: All assessment unit (AU) numbers start with ID17010104PN. Significant figures are controlled by the lowest level in the calculation, typically that of the channel width. Some rounding errors may result.

Table A9. Existing and target solar loads for Deep Creek—4th order (Snow Creek to Kootenai River).

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
015_04	Deep Creek	22	3613	Group1 Hardwoods	23%	4.39	26	90,000	400,000	10%	5.13	26	90,000	500,000	100,000	-13%
015_04	Deep Creek	23	3326	Group1 Hardwoods	21%	4.50	28	90,000	400,000	20%	4.56	28	90,000	400,000	0	-1%
							Totals		800,000					900,000	100,000	

Note: All assessment unit (AU) numbers start with ID17010104PN. Significant figures are controlled by the lowest level in the calculation, typically that of the channel width. Some rounding errors may result.

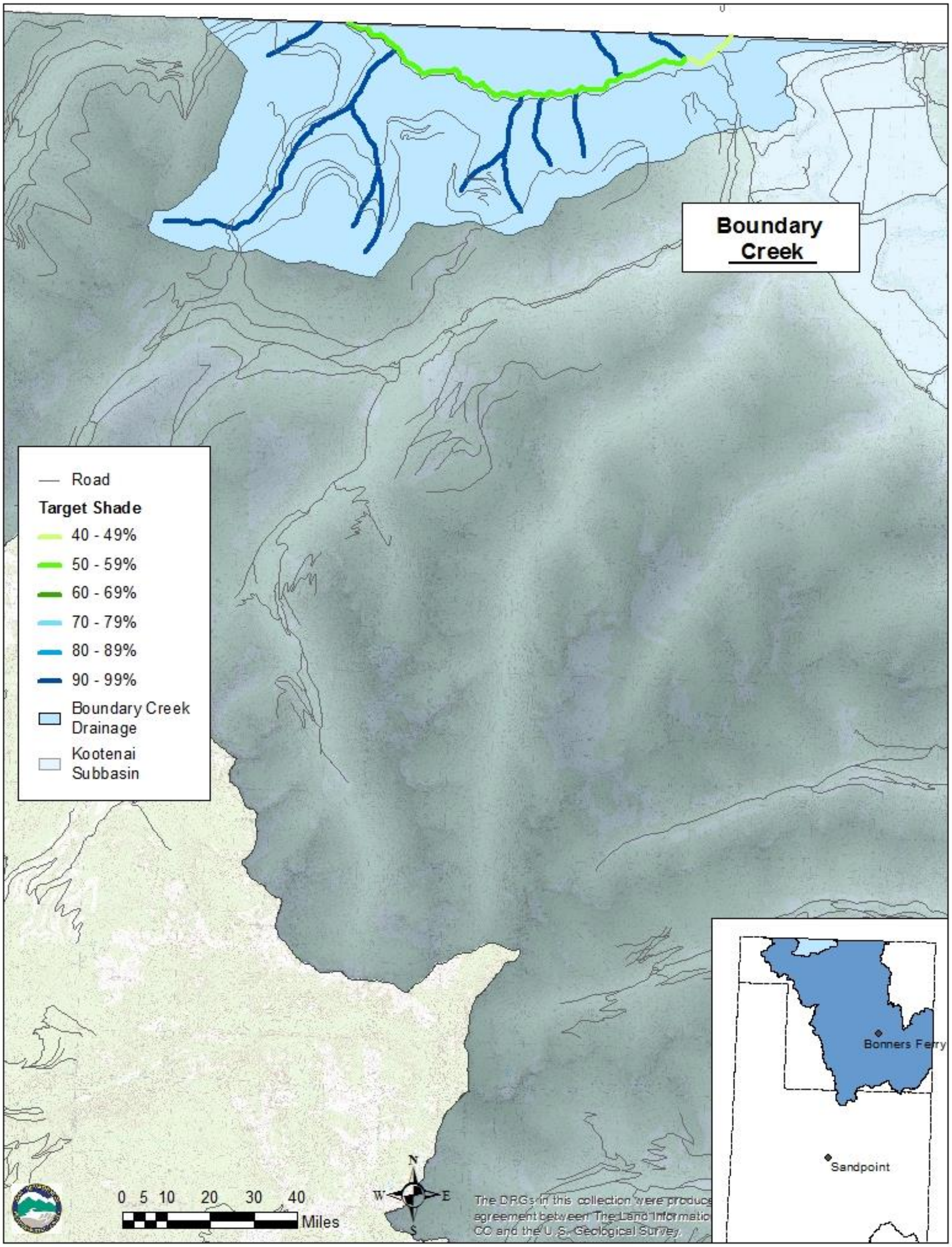

Figure A1. Boundary Creek—1st-, 2nd-, and 3rd-order stream segments (ID17010104PN002_02 and ID17010104PN002_03) target shade levels.

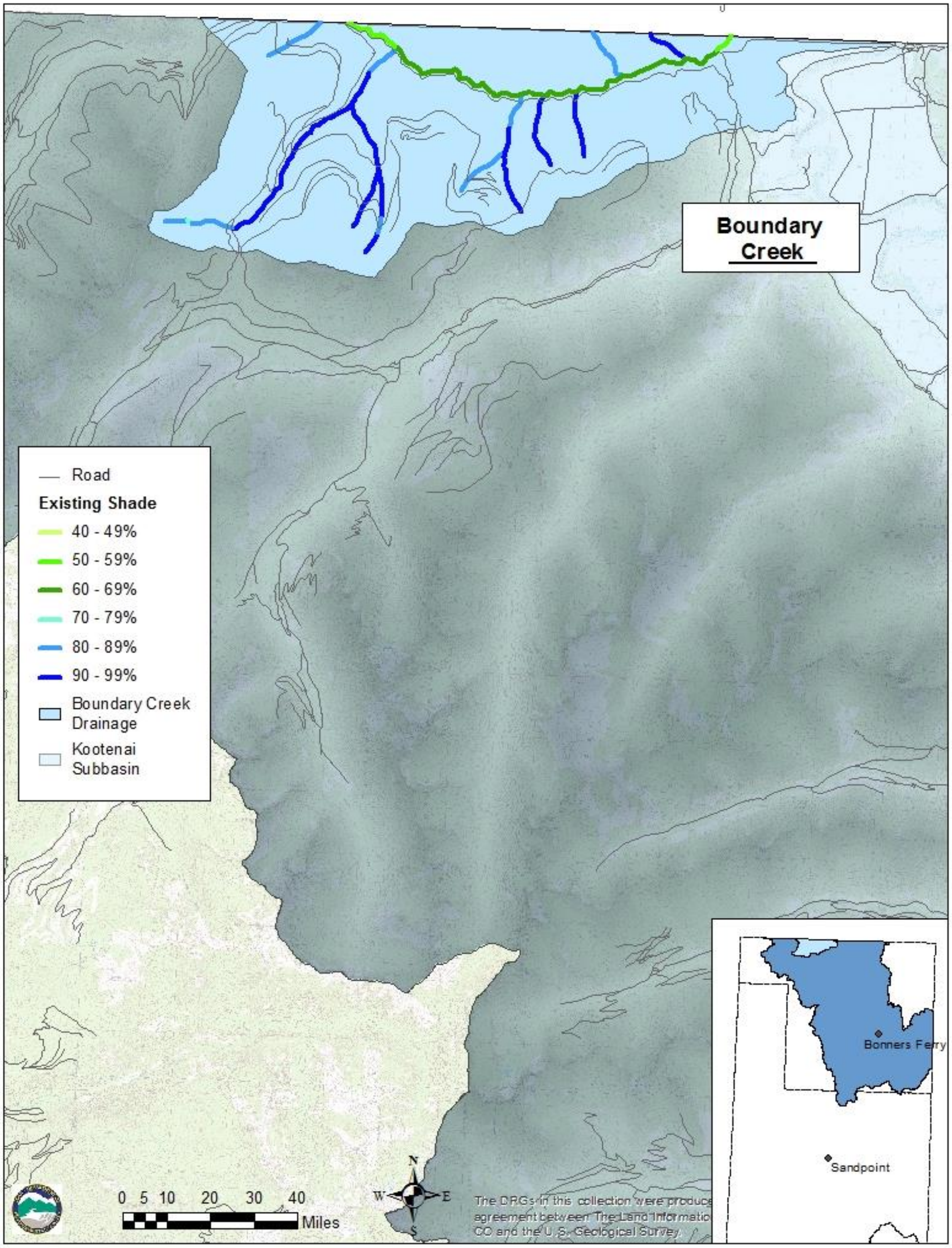

Figure A2. Boundary Creek—1st-, 2nd-, and 3rd-order stream segments (ID17010104PN002_02 and ID17010104PN002_03) existing shade levels.

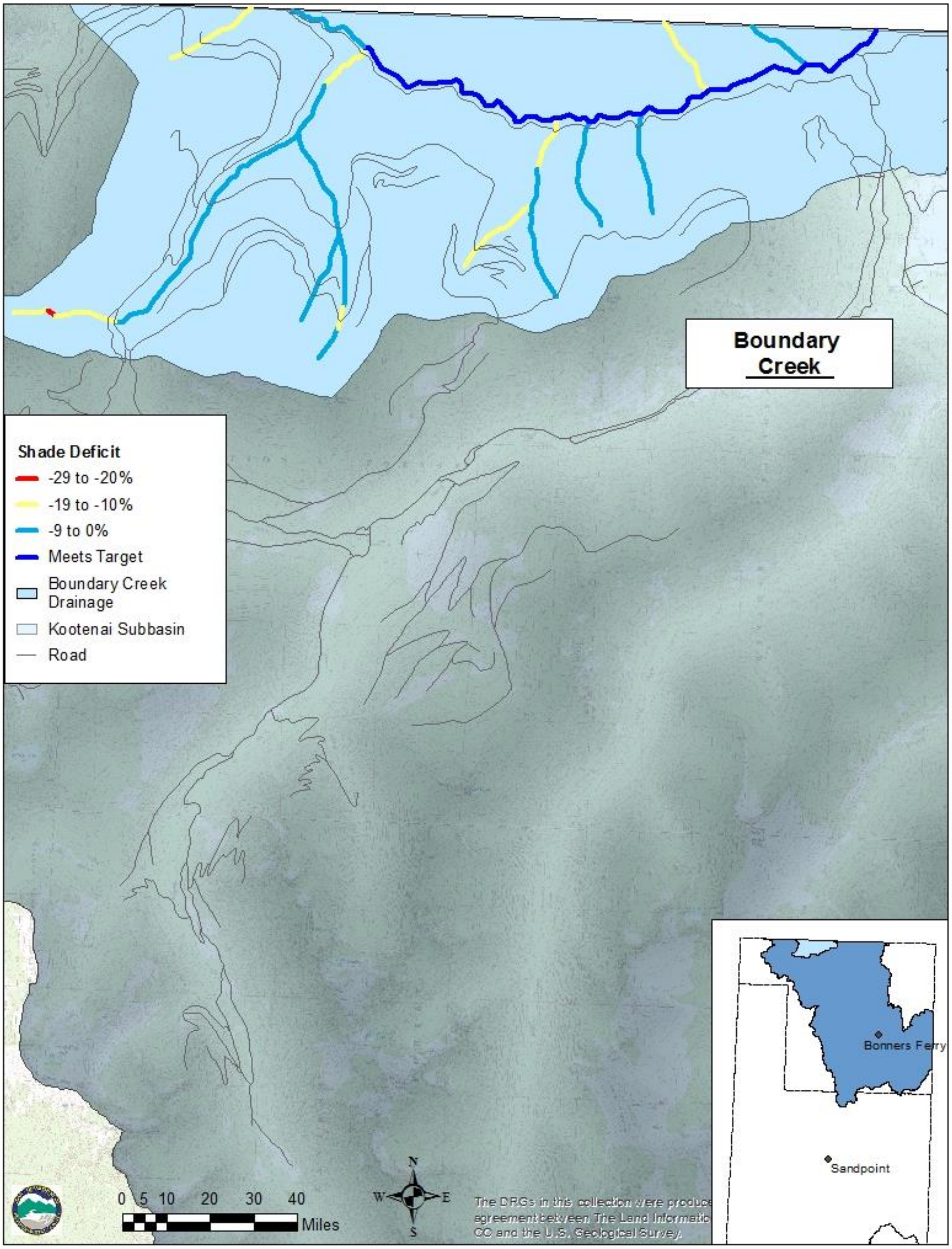

Figure A3. Boundary Creek—1st-, 2nd-, and 3rd-order stream segments (ID17010104PN 002_02 and ID17010104PN002_03) shade deficit levels.

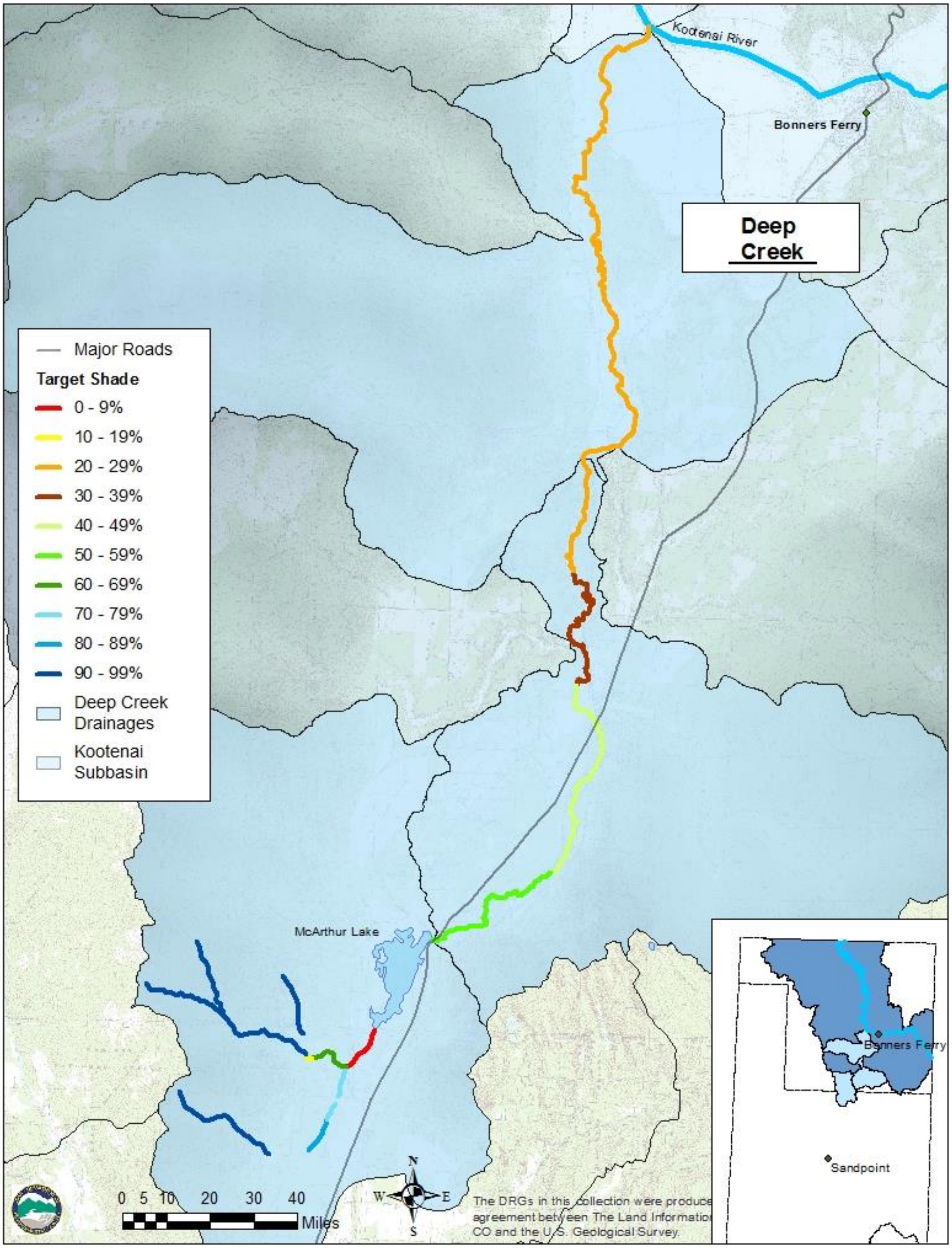

Figure A4. Deep Creek (ID17010104PN025_02, ID17010104PN022_03, ID17010104PN019_04, ID17010104PN018_04, and ID17010104PN015_04) target shade levels.

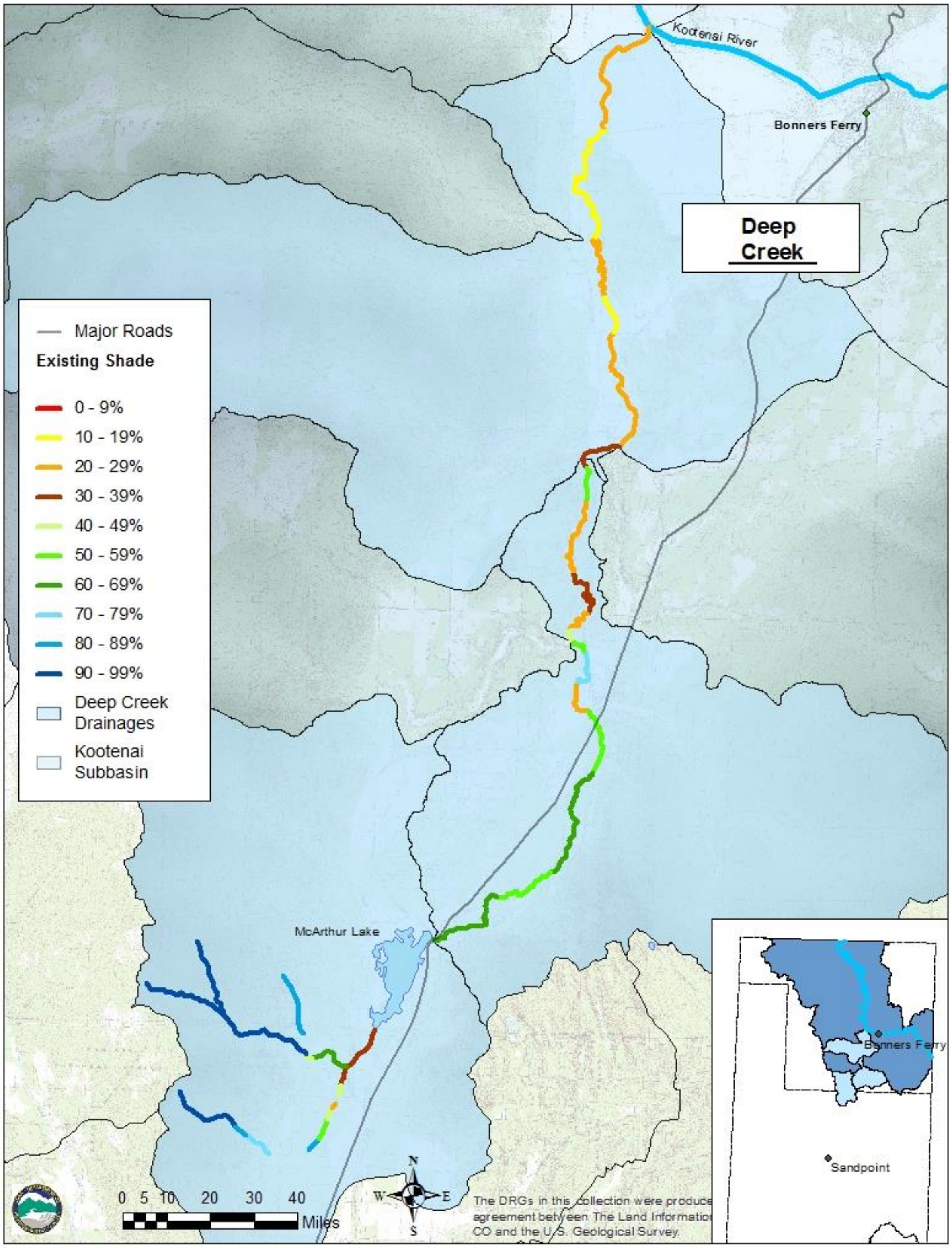

Figure A5. Deep Creek (ID17010104PN025_02, ID17010104PN022_03, ID17010104PN019_04, ID17010104PN018_04, and ID17010104PN015_04) existing shade levels.

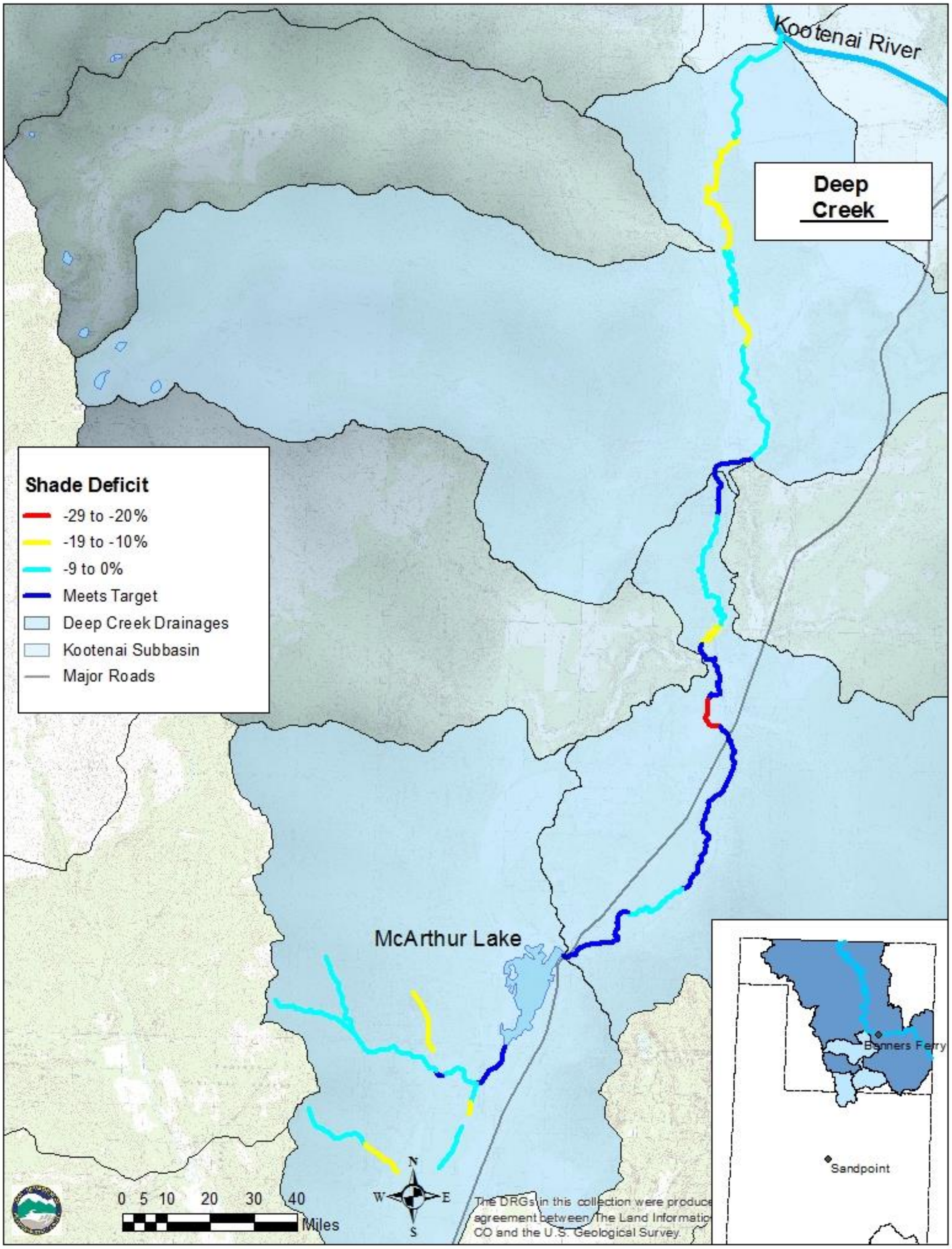

Figure A6. Deep Creek (ID17010104PN025_02, ID17010104PN022_03, ID17010104PN019_04, ID17010104PN018_04, and ID17010104PN015_04) shade deficit levels.

Appendix B. Stormwater

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 Clean Water Act purposes, including stormwater that is associated with municipal separate storm sewer systems (MS4s), industrial stormwater covered under the Multi-Sector General Permit (MSGP), and construction stormwater covered under the Construction General Permit (CGP).

Municipal Separate Storm Sewer Systems

Polluted stormwater runoff is commonly transported through 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 (i.e., storm drains, pipes, and ditches)
- 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 NPDES permit from EPA, implement a comprehensive municipal stormwater management program, and use 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 United States, the facility must be permitted under EPA's most recent 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 (see 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 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.

Post-construction 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.

Appendix C. Pollutant Trading

Trading Components

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

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

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

Watershed-Specific Environmental Protection

Trades must be implemented so that the overall water quality of the water bodies covered by the TMDL is protected. To do this, hydrologically based ratios are developed to ensure trades between sources distributed throughout TMDL water bodies result in environmentally equivalent or better outcomes at the point of environmental concern. Moreover, localized adverse impacts to water quality are not allowed.

Trading Framework

For pollutant trading to be authorized, it must be specifically mentioned within a TMDL document. After adoption of an EPA-approved TMDL, DEQ, in concert with the WAG, must develop a pollutant trading framework document. The framework would mesh with the implementation plan for the watershed that is the subject of the TMDL. The elements of a trading document are described in DEQ’s pollutant trading guidance (DEQ 2010).

Appendix D. Public Participation and Public Comments

This TMDL was developed with participation from the Kootenai Valley Resource Initiative (KVRI). The TMDL was reviewed and approved by KVRI on June 18, 2018. No public comments were received during the public comment period for this TMDL.

Appendix E. Distribution List

Kootenai Valley Resource Initiative

U.S. Environmental Protection Agency