Big Lost River Subbasin Temperature Total Maximum Daily Load

2016 Addendum and Five-Year Review

Hydrologic Unit Code 17040218

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Acknowledgments

Cover photo taken by Mark Shumar (Idaho Department of Environmental Quality) of the North Fork Big Lost River on September 10, 2015.

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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
AG Plan	Idaho Agricultural Pollution Abatement Plan
AU	assessment unit
BAG	basin advisory group
BMP	best management practice
BURP	Beneficial Use Reconnaissance Program
C	Celsius
CFR	Code of Federal Regulations
CGP	Construction General Permit
CWA	Clean Water Act
DEQ	Idaho Department of Environmental Quality
EPA	US Environmental Protection Agency
GIS	geographic information systems
HUC	hydrologic unit code
IDAPA	Refers to citations of Idaho administrative rules
KWh	kilowatt-hour
LA	load allocation
LC	load capacity
m	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 (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to CWA §303, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. 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 must be published every 2 years and is included as the list of Category 5 waters in the Integrated Report. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards.

This document addresses 17 assessment units (AUs) and associated water bodies in the Big Lost River subbasin that have been placed in Category 4a of Idaho's most recent federally approved Integrated Report, which require updating to the potential natural vegetation (PNV) temperature TMDL format as part of a 5-year review. This document addresses only the temperature TMDLs for these AUs. More information about these watersheds and the subbasin is available in the *Big Lost River Watershed Subbasin Assessment and TMDL* (DEQ 2004) and *Big Lost River Subbasin Total Maximum Daily Load Addendum and Five Year Review* (DEQ 2011).

This TMDL has been developed to comply with Idaho's TMDL requirements. A TMDL determines instream water quality targets, calculates load capacities, estimates existing pollutant sources, and allocates responsibility for load reductions needed to return listed waters to a condition meeting water quality standards.

Subbasin at a Glance

The Big Lost River subbasin (hydrologic unit code 17040218) is located in south-central Idaho centered above the town of Arco, Idaho (Figure A). For this subbasin, a large number of AUs are listed in two groups in Category 4a of the current Integrated Report for temperature pollution. The first group includes 11 AUs that received temperature TMDLs in the *Big Lost River Watershed Subbasin Assessment and TMDL* (DEQ 2004). These temperature TMDLs were produced using an older method of determining needed percent reductions without estimating a daily load. The second group includes 25 AUs that received temperature TMDLs using the updated PNV method in the *Big Lost River Subbasin Total Maximum Daily Load Addendum and Five Year Review* (DEQ 2011). The intent of the 2011 TMDL was to produce new temperature TMDLs for newly listed AUs, and it did not update the existing 2004 temperature TMDLs to PNV. This assessment updates those 2004 temperature TMDLs using PNV and includes daily loads.

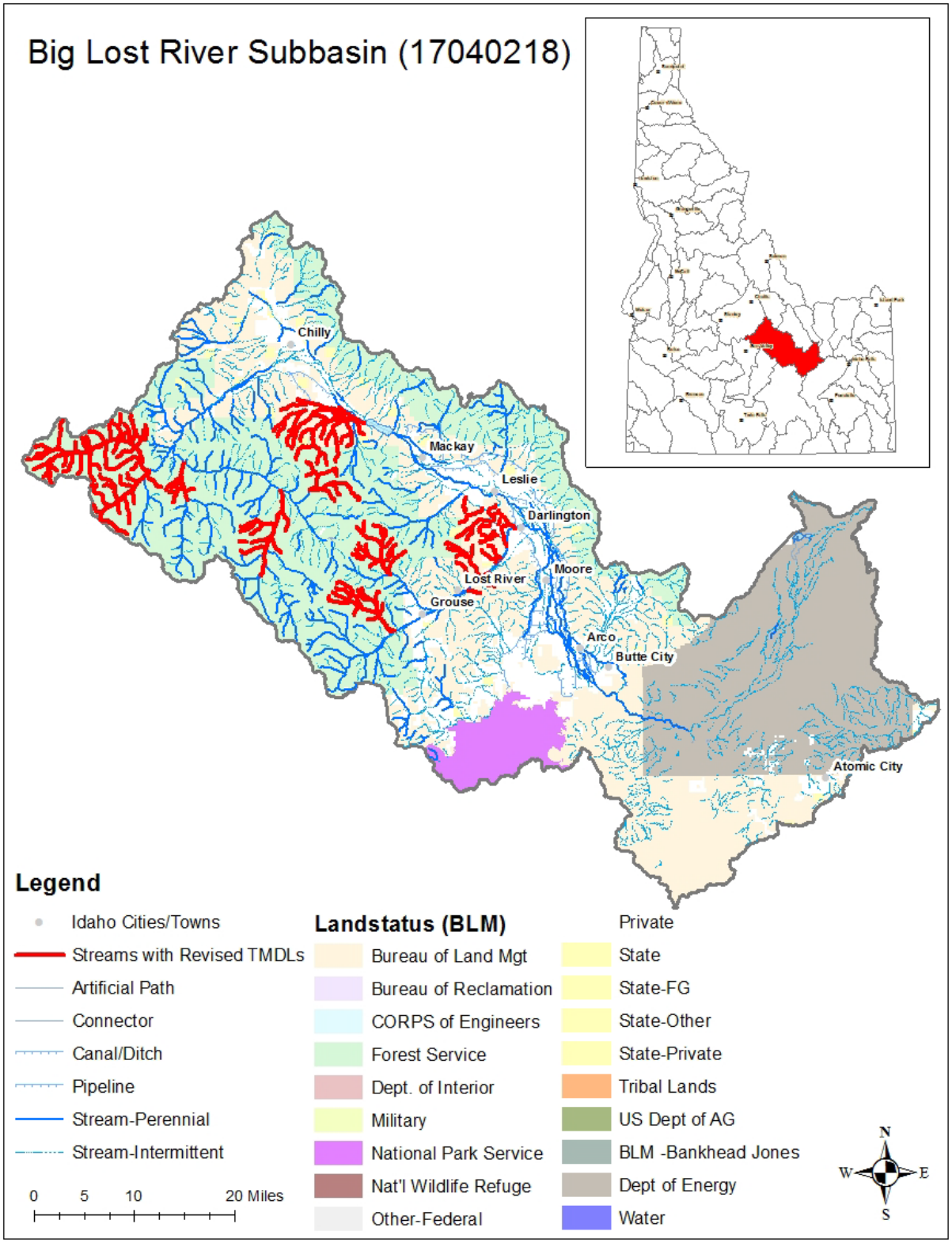

Figure A. Subbasin at a glance.

Key Findings

Seventeen AUs were placed on the 1998 §303(d) list of impaired waters, or subsequent lists, for reasons associated with temperature criteria violations, and the Idaho Department of Environmental Quality developed temperature TMDLs for these waters in 2004 (DEQ 2004). This addendum updates the 17 AUs with new temperature TMDLs.

Effective target shade levels were established for 17 AUs (original TMDLs did not identify AUs but considered watersheds by name as impaired) based on the concept of maximum shading under PNV resulting in natural background temperature levels. Shade targets were derived from effective shade curves developed for similar vegetation types in Idaho. Existing shade was determined from aerial photo interpretation that was partially field verified with Solar Pathfinder data. Target and existing shade levels were compared to determine the amount of shade needed to bring water bodies into compliance with temperature criteria in Idaho's water quality standards (IDAPA 58.01.02). A summary of assessment outcomes, including recommended changes to listing status in the next Integrated Report, is presented in Table A.

All AUs lack shade and have excess solar loads, except of the 3rd-order AU of Bear Creek, which did not show an excess load. Low-gradient, wide streams (Star Hope, Wildhorse, and Warm Springs Creeks) tended to have the highest excess loads. These systems are more accessible and were used more frequently for pasturing livestock and agricultural conversion. Percent reductions needed in solar loads to achieve target levels varied from 42% in Star Hope Creek to 0% in Bear Creek. Most AUs required reductions at 26% or less. Comparisons between 2004 and current reductions show slightly smaller percent reductions are needed in 2015.

Target shade levels for individual stream segments should be the goal managers strive for with future implementation plans. Managers should focus on the largest differences between existing and target shade as locations to prioritize implementation efforts.

Table A. Summary of assessment outcomes.

Water Body	Assessment Unit Number	Pollutant	TMDL Completed	Recommended Changes to Next Integrated Report	Justification
North Fork Big Lost River	ID17040218SK027_02 ID17040218SK027_03	Temperature	Yes	Add 2nd-order AU to 3rd-order AU already in Category 4a	Excess solar load from a lack of existing shade
Summit Creek	ID17040218SK028_02 ID17040218SK028_03	Temperature	Yes	Add 3rd-order AU to 2nd-order AU already in Category 4a	Excess solar load from a lack of existing shade
Wildhorse Creek	ID17040218SK030_02 ID17040218SK030_04	Temperature	Yes	Add 2nd-order AU to 4th-order AU already in Category 4a	Excess solar load from a lack of existing shade
Star Hope Creek	ID17040218SK035_02 ID17040218SK035_04 ID17040218SK036_04	Temperature	Yes	No changes, already in Category 4a	TMDL update
Corral Creek	ID17040218SK041_02	Temperature	Yes	No changes, already in Category 4a	TMDL update
Warm Springs Creek	ID17040218SK043_02 ID17040218SK043_03	Temperature	Yes	No changes, already in Category 4a	TMDL update
Antelope Creek/Darlington Canal tributaries	ID17040218SK046_02	Temperature	Yes	No changes, already in Category 4a	TMDL update
Cherry Creek	ID17040218SK050_02 ID17040218SK050_04	Temperature	Yes	In 2004 TMDL but was not added to Category 4; both AUs must be added	TMDL update
Bear Creek	ID17040218SK053_02 ID17040218SK053_03	Temperature	Yes	Add 2nd-order AU to 3rd order AU already in Category 4a	Excess solar load from a lack of existing shade

Public Participation

Input from the watershed advisory group and the general public will be provided after the public comment period.

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Introduction

This total maximum daily load (TMDL) and 5-year review addresses 9 water bodies and 17 assessment units (AUs) in the Big Lost River subbasin that have been placed in Category 4a of Idaho's most recent federally approved Integrated Report (DEQ 2014). The subbasin assessment characterizes and documents pollutant loads within the Big Lost River subbasin. While 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.

This subbasin assessment develops TMDLs for each pollutant of concern for the Big Lost River subbasin. The TMDL (section 5) is a plan to improve water quality by limiting pollutant loads. A TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (40 CFR 130). A TMDL is water body- and pollutant-specific and allocates allowable discharges of individual pollutants among the various sources discharging the pollutant.

For this subbasin, a large number of AUs are listed in two groups in Category 4a of the current Integrated Report for temperature pollution. The first group includes 11 AUs that received temperature TMDLs in the *Big Lost River Watershed Subbasin Assessment and TMDL* (DEQ 2004). These temperature TMDLs were produced using an older method of determining needed percent reductions without estimating a daily load. The second group includes 25 AUs that received temperature TMDLs using the updated potential natural vegetation (PNV) method in the *Big Lost River Subbasin Total Maximum Daily Load Addendum and Five Year Review* (DEQ 2011). The intent of the 2011 TMDL was to produce new temperature TMDLs for newly listed AUs, and it did not update those existing 2004 temperature TMDLs to PNV.

This document addresses 17 AUs in the Big Lost River subbasin placed in Category 4a of Idaho's most recent federally approved Integrated Report that require updating to the PNV temperature TMDL format as part of a 5-year review. This document only addresses the temperature TMDLs for these AUs. More information about these watersheds and the subbasin is available in the *Big Lost River Watershed Subbasin Assessment and TMDL* (DEQ 2004) and *Big Lost River Subbasin Total Maximum Daily Load Addendum and Five Year Review* (DEQ 2011).

Regulatory Requirements

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

Congress passed the Federal Water Pollution Control Act, or CWA, in 1972. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (33 USC §1251). The act and the programs it has generated have changed over the years as experience and perceptions of water quality have changed. CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was

protecting and managing waters to ensure "swimmable and fishable" conditions. These goals relate water quality to more than just chemistry.

CWA requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to CWA §303, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. DEQ must review those standards every 3 years, and EPA must approve Idaho's water quality standards. Idaho adopts water quality standards to protect public health and welfare, enhance water quality, and protect biological integrity. A water quality standard defines the goals of a water body by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

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.

Idaho Code §39-3611(7) requires a 5-year cyclic review process for Idaho TMDLs:

> The director shall review and reevaluate each TMDL, supporting subbasin assessment, implementation plan(s) and all available data periodically at intervals of no greater than five (5) years. Such reviews shall include the assessments required by section 39-3607, Idaho Code, and an evaluation of the water quality criteria, instream targets, pollutant allocations, assumptions and analyses upon which the TMDL and subbasin assessment were based. If the members of the watershed advisory group, with the concurrence of the basin advisory group, advise the director that the water quality standards, the subbasin assessment, or the implementation plan(s) are not attainable or are inappropriate based upon supporting data, the director shall initiate the process or processes to determine whether to make recommended modifications. The director shall report to the legislature annually the results of such reviews.

To meet the intent and purpose of Idaho Code §39-3611(7), this document reviews the 2011 addendum and 5-year review (DEQ 2011) and addresses water bodies in the Big Lost River subbasin that are in Idaho's most recent Category 4a of the Integrated Report (DEQ 2014). This report reviews the approved TMDL and implementation plan, considers the most current and applicable information in conformance with Idaho Code §39-3607, evaluates the appropriateness of the TMDL to current watershed conditions, evaluates the implementation plan, and consults with the watershed advisory group (WAG). An evaluation of the recommendations presented is provided. Final decisions for TMDL modifications are decided by the DEQ director. Approval of TMDL modifications is decided by EPA, with consultation by DEQ.

1 Subbasin Assessment—Subbasin Characterization

The Big Lost River subbasin (hydrologic unit code 17040218) is located in south-central Idaho centered north of the town of Arco, Idaho. The subbasin lies on the northern edge of the Snake River Plain and has a complex geology based on volcanism and range uplift. Most of this subbasin lies within Custer County, with about 25% in Butte County and a small portion in Jefferson County. The landownership, population, and economic status of the area have remained largely unchanged since the 2011 assessment. Land status is shown in Figure 1.

Further discussion of the physical, biological, and cultural characteristics is provided in the *Big Lost River Subbasin Total Maximum Daily Load Addendum and Five Year Review* (DEQ 2011).

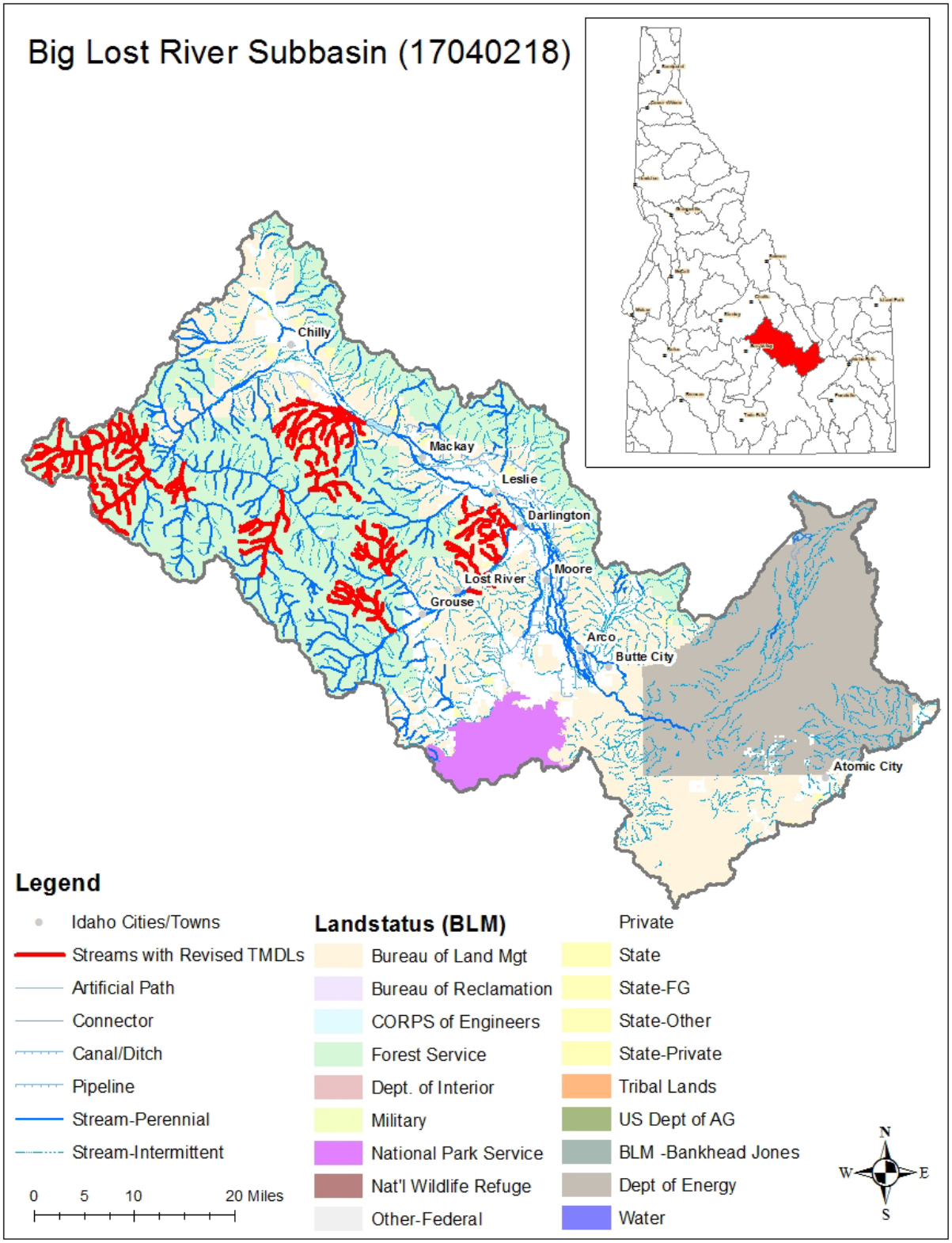

Figure 1. Big Lost River subbasin.

2 Subbasin Assessment—Water Quality Concerns and Status

2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

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

2.1.1 Assessment Units

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

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

2.1.2 Listed Waters

Waters listed under Category 4a of the Integrated Report for temperature TMDLs completed in 2004 that are being updated are identified below:

- North Fork Big Lost River: ID17040218SK027_02 and ID17040218SK027_03
- Summit Creek: ID17040218SK028_02 and ID17040218SK028_03
- Wildhorse Creek: ID17040218SK030_02 and ID17040218SK030_04
- Star Hope Creek: ID17040218SK035_02, ID17040218SK035_04, and ID17040218SK036_04
- Corral Creek: ID17040218SK041_02
- Warm Springs Creek: ID17040218SK043_02 and ID17040218SK043_03
- Antelope Creek/Darlington Canal tributaries: ID17040218SK046_02
- Cherry Creek: ID17040218SK050_02 and ID17040218SK050_04
- Bear Creek: ID17040218SK053_02 and ID17040218SK053_03

2.2 Applicable Water Quality Standards and Beneficial Uses

Idaho water quality standards (IDAPA 58.01.02) list beneficial uses and set water quality goals for waters of the state. Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses as described briefly in the following paragraphs. The *Water Body Assessment Guidance* (Grafe et al. 2002) 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 CWA are "those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards" (40 CFR 131.3). The existing instream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.051.01). Existing uses need to be protected, whether or not the level of water quality to fully support the uses currently exists. A practical application of this concept would be to apply the existing use of salmonid spawning to a water that supported salmonid spawning since November 28, 1975, but does not now due to other factors, such as blockage of migration, channelization, sedimentation, or excess heat.

2.2.2 Designated Uses

Designated uses under CWA are "those uses specified in water quality standards for each water body or segment, whether or not they are being attained" (40 CFR 131.3). Designated uses are simply uses officially recognized by the state. In Idaho, these include uses such as aquatic life support, recreation in and on the water, domestic water supply, and agricultural uses. Multiple uses often apply to the same water; in this case, water quality must be sufficiently maintained to meet the most sensitive use (designated or existing). Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning. Designated uses are described in the Idaho water quality standards (IDAPA 58.01.02.100) and specifically listed by water body in sections 110–160.

2.2.3 Undesignated Surface Waters

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 either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these so-called *presumed uses*, DEQ applies the numeric cold water criteria and primary or secondary contact recreation criteria to undesignated waters. If in addition to these presumed uses, an additional existing use (e.g., salmonid spawning) exists, then the additional numeric criteria for salmonid spawning would also apply (e.g., intergravel dissolved oxygen, temperature) because of the requirement to protect water quality for existing uses. However, if for example, cold water aquatic life is not found to be an existing use, a use

designation (rulemaking) to that effect is needed before some other aquatic life criteria (such as seasonal cold) can be applied in lieu of cold water criteria (IDAPA 58.01.02.101.01).

2.2.4 Beneficial Uses in the Subbasin

Refer to section 2.2 of the 2004 TMDL for the subbasin's beneficial uses (DEQ 2004).

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 1). For more about temperature criteria and natural background provisions relevant to the PNV approach, see Appendix A.

Table 1. Selected numeric criteria supportive of designated beneficial uses in Idaho water quality standards.

Parameter	Primary Contact Recreation	Secondary Contact Recreation	Cold Water Aquatic Life	Salmonid Spawning[a]
Water Quality Standards: IDAPA 58.01.02.250–251				
Temperature[b]	—	—	22 °C or less daily maximum; 19 °C or less daily average **Seasonal Cold Water**: Between summer solstice and autumn equinox: 26 °C or less daily maximum; 23 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average **Bull Trout**: Not to exceed 13 °C maximum weekly maximum temperature over warmest 7-day period, June–August; not to exceed 9 °C daily average in September and October
EPA Bull Trout Temperature Criteria: Water Quality Standards for Idaho, 40 CFR Part 131				
Temperature	—	—	—	7-day moving average of 10 °C or less maximum daily temperature for June–September

[a] During spawning and incubation periods for inhabiting species
[b] 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.

DEQ's procedure to determine whether a water body fully supports designated and existing beneficial uses is outlined in IDAPA 58.01.02.050.02. The procedure relies heavily upon biological parameters and is presented in detail in the *Water Body Assessment Guidance* (Grafe et al. 2002). This guidance requires DEQ to use the most complete data available to make beneficial use support status determinations (Figure 2).

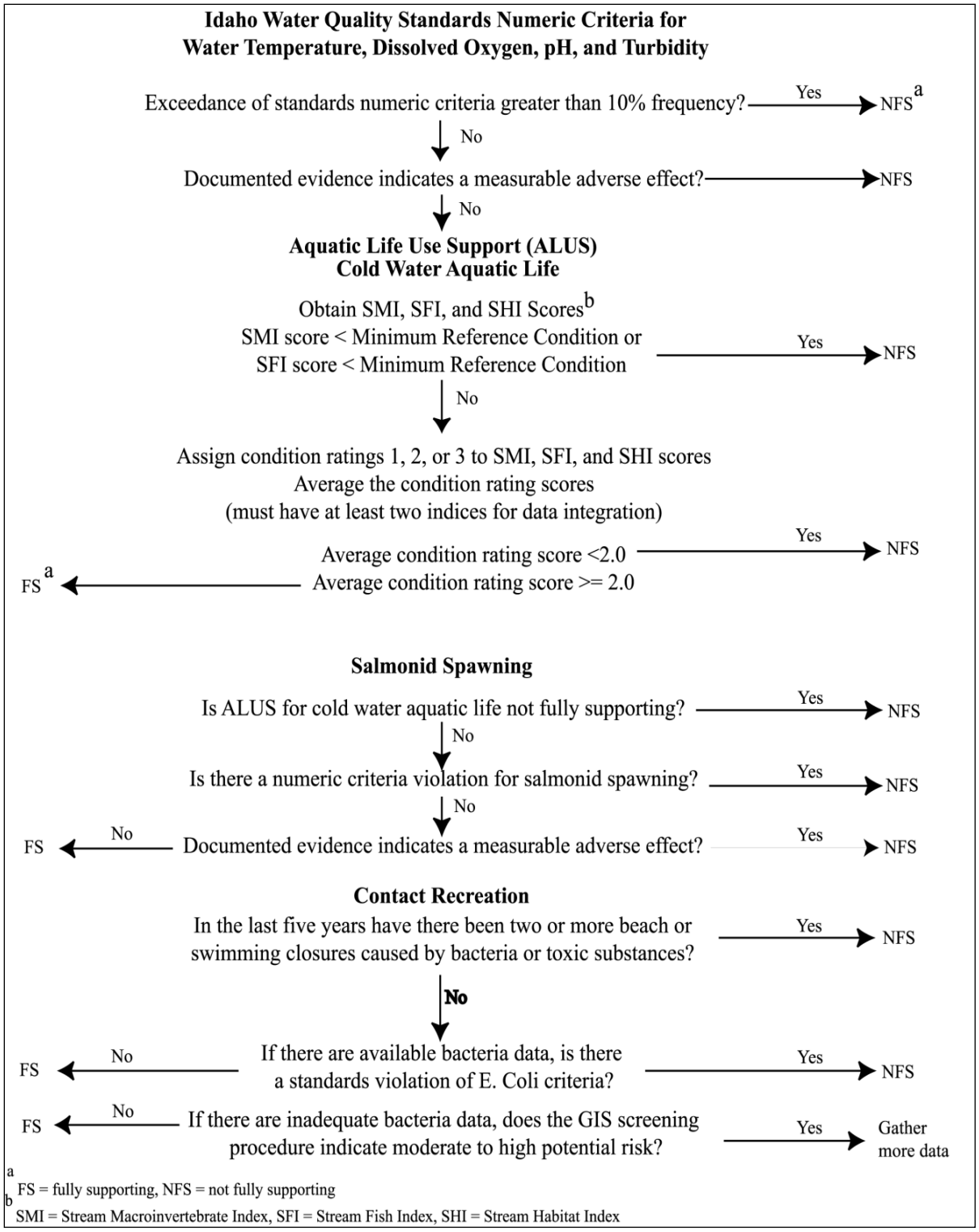

Figure 2. Determination steps and criteria for determining support status of beneficial uses in wadeable streams (Grafe et al. 2002).

2.3 Summary and Analysis of Existing Water Quality Data

No new data have been collected for these streams since the *Big Lost River Total Maximum Daily Load Addendum and Five Year Review* (DEQ 2011) other than that data necessary for conversion to PNV-style temperature TMDLs (i.e., shade, channel width, and plant communities). Data sources are provided in Appendix B.

3 Subbasin Assessment—Pollutant Source Inventory

Pollution within the Big Lost River subbasin is primarily from excess sediment, bacteria, and temperature. Load allocations and wasteload allocations were established in the *Big Lost River Subbasin Assessment and TMDL* approved by EPA in 2004 (DEQ 2004) and *Total Maximum Daily Load Addendum and Five Year Review* approved by EPA in 2011 (DEQ 2011).

The primary source of excess sediment, bacteria, and temperature in the Big Lost River subbasin is streambank erosion and vegetation loss from livestock grazing. The more bare and unstable streambanks become, the higher the volume of direct sediment delivery to the stream. Excess sediment in the substrate of a stream decreases natural hydrologic functioning and restricts habitat for aquatic wildlife. Unstable, eroding streambanks become denuded of vegetation. Higher vegetative cover holds streambanks together with root masses, but as streambanks erode and vegetative cover is lost, erosion is accelerated. Loss of vegetative cover increases solar radiation to the water surface. Without vegetative shading on the streambanks, the temperature of the stream increases and aquatic wildlife must seek out cooler refuges upstream or in alternate locations, which decreases available habitat. In areas with regular grazing, eroding streambanks can also deliver an excess bacteria load from domestic cattle.

3.1 Point Sources

Point sources of pollution are affiliated with known discrete discharges and are regulated through the National Pollution Discharge Elimination System (NPDES). Two point source sites exist in the TMDL waters addressed: the Idaho Department of Fish and Game's Mackay Fish Hatchery located at the source of Whiskey Creek, a tributary to Warm Springs Creek, and the Clear Springs Foods, Inc. Lost River Hatchery at the source of Warm Springs Creek, at Hamilton Springs. The two hatcheries received wasteload allocations for temperature in the 2004 TMDL (DEQ 2004) and those allocations are revised in this addendum and 5-year review.

3.2 Nonpoint Sources

Temperature load allocations in the 2004 TMDL were based on the percent reduction of the highest observed temperature exceedance for the spring or fall spawning period, whichever was greater, to attain water quality standards. Nonpoint source load allocations are modified to daily solar loads in this addendum and 5-year review.

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

Section 4 of the 2011 TMDL addendum and 5-year review lists recent water quality improvement projects throughout the subbasin (DEQ 2011).

5 Total Maximum Daily Loads

A TMDL prescribes an upper limit (i.e., load capacity) on discharge of a pollutant from all sources so as 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 regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (Water Quality Planning and Management, 40 CFR 130) require a margin of safety be a part of the TMDL. Practically, the margin of safety and natural background are both reductions in the load capacity available for allocation to pollutant sources.

Load capacity can be summarized by the following equation:

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

where:

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

The equation is written in this order because it represents the logical order in which a load analysis is conducted. First the load capacity is determined. Then the load capacity is broken down into its components. After the necessary margin of safety and natural background, if relevant, are quantified, the remainder is allocated among pollutant sources (i.e., the load allocation and wasteload allocation). When the breakdown and allocation are complete, the result is a TMDL, which must equal the load capacity.

The load capacity must be based on critical conditions—the conditions when water quality standards are most likely to be violated. If protective under critical conditions, a TMDL will be more than protective under other conditions. Because both load capacity and pollutant source loads vary, and not necessarily in concert, determining critical conditions can be more complicated than it may appear on the surface.

Another step in a load analysis is quantifying current pollutant loads by source. This step allows 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. 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, as is the case in this temperature TMDL. For certain pollutants whose effects are long term, such as temperature, EPA allows for seasonal or annual loads.

5.1 Instream Water Quality Targets

For the 17 AUs temperature TMDLs, we used a PNV approach. The Idaho water quality standards include a provision (IDAPA 58.01.02.200.09) that if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered a violation of water quality standards. In these situations, natural conditions essentially become the water quality standard, and for temperature TMDLs, the natural level of shade and channel width become the TMDL target. The instream temperature that results from attaining these conditions is consistent with the water quality standards, even if it exceeds numeric temperature criteria. See Appendix A for further discussion of water quality standards and natural background provisions.

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

5.1.1 Factors Controlling Water Temperature in Streams

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

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

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

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 (as long as no point sources or other anthropogenic sources of heat exist in the watershed) and are considered to be consistent with the Idaho water quality standards, even if they exceed numeric criteria by more than 0.3 °C.

5.1.2.1 Existing Shade Estimates

Existing shade was estimated for the 17 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 19 sites. The Solar Pathfinder is a device that allows tracing the outline of shade-producing objects on monthly solar path charts. The percentage of the sun's path covered by these objects is the effective shade on the stream at the location where the tracing is made. To adequately characterize the effective shade on a stream segment, ten traces are taken at systematic or random intervals along the length of the stream in question.

At each sampling location, the Solar Pathfinder was placed in the middle of the stream at about the bankfull water level. Ten traces were taken following the manufacturer's instructions (i.e., orient to south and level). Systematic sampling was used because it is easiest to accomplish without biasing the sampling location. For each sampled segment, the sampler started at a unique location, such as 50 to 100 meters (m) from a bridge or fence line, and proceeded upstream or downstream taking additional traces at fixed intervals (e.g., every 50 m, 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, recorded notes, and photographed the landscape of the stream at several unique locations while taking traces. Special attention was given to changes in riparian plant communities and the kinds of plant species (the large, dominant, shade-producing ones) were present. Densiometer readings can also be taken at the same location as Solar Pathfinder traces. These readings provide the potential to develop relationships between canopy cover and effective shade for a given stream.

In general, the original aerial photo interpretation tended to overestimate shade on streams. The average difference between original interpretation class and field verified class was 5% ± 6.12 [average ± 95% C.I.] (Table 2). Nine of the 19 sites showed overestimation, whereas four of the 19 sites showed underestimated shade. Site 1 on the North Fork Big Lost River was split in half because the field site crossed a boundary between two shade classes. Half the site had overestimated shade and half was accurately interpreted. Overall, seven locations were

accurately classified for existing shade. These data were used to correct the shade class at the specific field site locations and to “calibrate the eyes” for a second round of aerial photo interpretation to reduce error.

Table 2. Solar Pathfinder field verification results for the Big Lost River subbasin.

aerial class	pathfinder actual	pathfinder class	delta		Site Name
50	55.7	50	0		Cherry
40	37.5	30	10		Bear 1
50	72.5	70	-20		Bear 2
60	75.6	70	-10		Bear 3
30	22.2	20	10		Corral 1
50	61.7	60	-10		Corral 2
70	75.9	70	0		Coyote 1
30	42.2	40	-10		Coyote 2
80	59.1	50	30		Bellas 1
80	76.1	70	10		Bellas 2
0	1.3	0	0		Star Hope
80	43.3	40	40		Miller
20	20.5	20	0		NF 1a
10	6.8	0	10		NF 1b
20	13.1	10	10		NF 2
0	4.3	0	0		NF 3
0	5.5	0	0		NF 4
30	19.9	10	20		Summitt1
20	20.1	20	0		Summitt2
30	29.6	20	10		Summitt3
			5	average	
			13.95	std dev	
			6.12	95%CI	

5.1.2.2 Target Shade Determination

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

Natural Bankfull Widths

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

water surface in wider streams, and widened streams can also have less vegetative cover if shoreline vegetation has eroded away.

Since, existing bankfull width may not be discernible from aerial photo interpretation and may not reflect natural bankfull widths, this parameter must be estimated from available information. We used regional curves for the major basins in Idaho—developed from data compiled by Diane Hopster of the Idaho Department of Lands—to estimate natural bankfull width (Figure 3).

For each stream evaluated in the load analysis, natural bankfull width was estimated based on the drainage area of the Upper Snake basin curve from Figure 3. Although estimates from other curves were examined (i.e., Salmon basin, Payette/Weiser basin), the Upper Snake curve was ultimately chosen because of its proximity to the Big Lost River watershed and similarity in climate and geology. Existing width data should also be evaluated and compared to these curve estimates if such data are available. However, for the Big Lost River watershed, 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 be reasonably similar to natural bankfull width estimates from the Upper Snake basin curve and chose not to make natural widths any smaller than these Upper Snake basin estimates. In some instances (Star Hope and Wildhorse Creeks), current widths were substantially larger than basin estimates. Some of the differences in width are due to the amount of beaver dam activity on those streams. Natural bankfull width estimates for each stream in this analysis are presented in Appendix C, Table C-1. The load analysis tables in Appendix C contain a natural bankfull width and an existing bankfull width for every stream segment in the analysis based on the bankfull width results presented in Table C-1. Existing widths and natural widths are the same in load tables when there are no data to support making them differ.

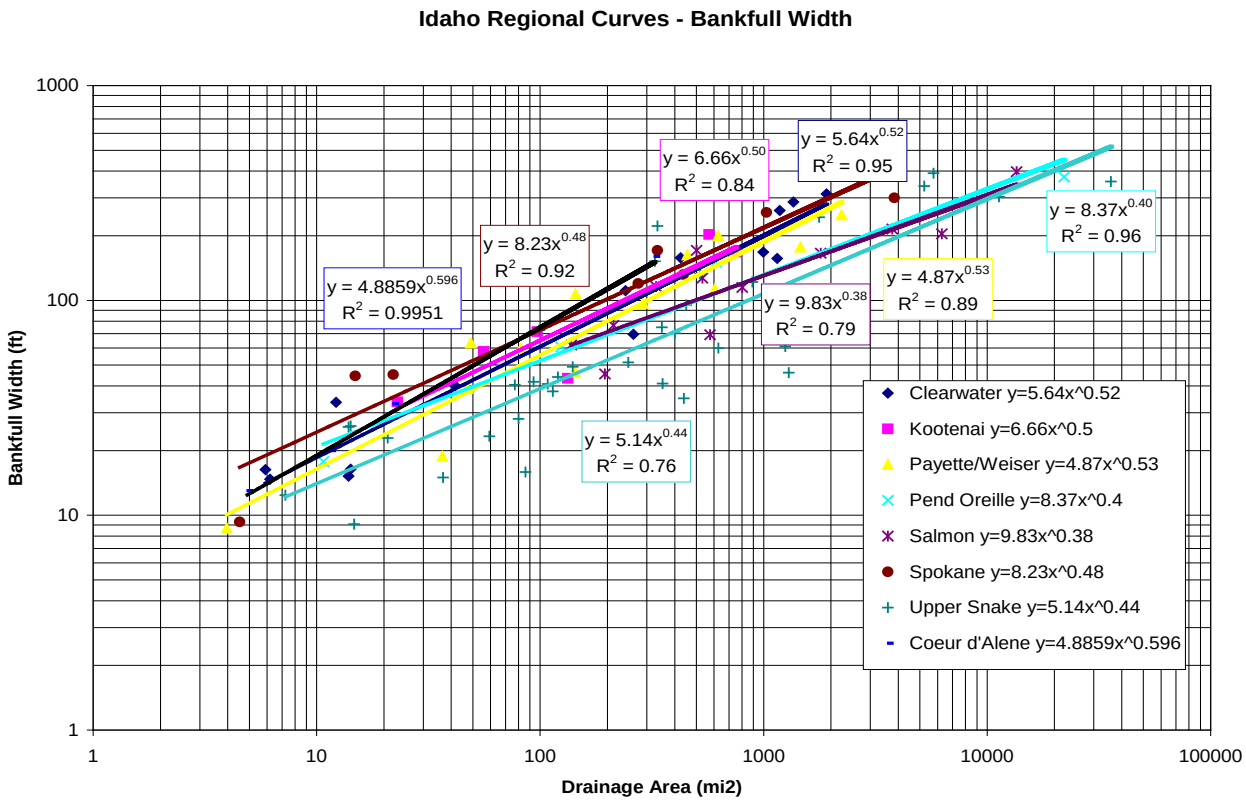

Figure 3. Bankfull width as a function of drainage area.

Design Conditions

The Big Lost River subbasin is located mostly within the Middle Rockies Level 3 Ecoregion, with the North Fork and portions of the East Fork extending into the Idaho Batholith Level 3 Ecoregion (McGrath et al. 2001). The majority of the Big Lost River below Bartlett Point, is in the Dry Intermontane Sagebrush Valleys Level 4 Ecoregion known for low precipitation due to high mountain rain-shadow and deep valley fill, both resulting in little surface drainage of water. Most of the East Fork Big Lost River, Antelope Creek, and Warm Springs Creek are in the Dry Gneissic-Schistose-Volcanic Hills Level 4 Ecoregion underlain by Quaternary and Tertiary volcanic rock. This area is slightly wetter than the Dry Intermontane region below it. Headwaters of Corral Creek and Bear Creek are likely in the Barren Hills Level 4 Ecoregion with open Douglas fir-lodgepole-subalpine fir forests and aspen groves in narrow elevation bands predominantly on north-facing slopes. Wildhorse Creek, Summit Creek, and North Fork Big Lost River, as well as a portion of the East Fork near the North Fork confluence are in the Dry Partly Wooded Mountains Level 4 Ecoregion of the Idaho Batholith Level 3 Ecoregion. This area is known for its mosaic of shrubland, open Douglas fir, and aspen forests.

Determining appropriate PNV for riparian areas along streams is often difficult given past histories and changing environments. For forested areas in upper portions of each watershed we relied upon potential vegetation descriptions provided by the Salmon-Challis National Forest. These headwater areas are primarily in dry Douglas fir without ponderosa pine and occasionally aspen groves, subalpine fir, and Douglas fir/lodgepole pine in gentle or steep terrain. For shrub-dominated riparian, we used an elevational zone concept with respect to dominant willow

communities. Those willow communities above 7,000-feet elevation were placed into the Drummond willow community type. Between 7,000 feet and 5,000 feet we used a Geyer willow community type. In lower Warm Springs Creek, we used the yellow willow community type. There were exceptions to this general pattern where it seemed appropriate, including specific reaches where willows of lower stature were put into a lemon willow community type, or areas of darker nonwillow vegetation that we chose to call alder. In the drier regions of the various watersheds, the dominant vegetation type near the stream channel was sagebrush/grass. These areas tended to have ephemeral or intermittent streams, but as long as a channel was present, they were included in the analysis. In many of the alpine headwater locations, especially above treeline, the alpine meadow or "grass" community type was selected.

Shade Curve Selection

To determine PNV shade targets for the Big Lost subbasin, effective shade curves from Salmon-Challis National Forest types and southern Idaho nonforest types were examined (Table 3) (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 Big Lost River subbasin, curves for the most similar vegetation type were selected for shade target determinations. In general, most tributary streams at high elevations start as grass meadow and/or rock/bare areas, then progress into various forest types first as subalpine fir types then as drier Douglas fir types. These streams will continue downstream into various shrub or aspen types depending on elevation and site characteristics. Streams in drier regions can start out in sagebrush/grass or grass meadow, move into shrub or aspen, and then back into sagebrush/grass before becoming completely ephemeral and disappearing into alluvium.

Table 3. Shade curves for target selection for the various vegetation types in the analysis.

Salmon-Challis National Forest Types	Southern Idaho Nonforest Types
Subalpine fir/moist	Mountain alder
Subalpine fir/dry-steep	Geyer willow/sedge
Subalpine fir/dry-gentle	Lemon willow
Subalpine fir/whitebark pine	Drummond willow/sedge
Subalpine fir/Douglas fir	Yellow willow
Douglas Fir/lodgepole-steep	Aspen
Douglas fir/lodgepole-gentle	Sagebrush/grass
Dry Douglas fir without Ponderosa pine	Graminoid (grass)
Whitebark pine	—

5.2 Load Capacity

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

We obtained solar load data from flat-plate collectors at the NREL weather stations in Boise and Pocatello, Idaho. The solar load data used in this TMDL analysis are spring/summer averages (i.e., an average load for the 6-month period from April through September). As such, load capacity calculations are also based on this 6-month period, which coincides with the time of year when stream temperatures are increasing, deciduous vegetation is in leaf, and fall spawning is occurring. During this period, temperatures may affect beneficial uses such as spring and fall salmonid spawning and cold water aquatic life criteria may be exceeded during summer months. Late July and early August typically represent the period of highest stream temperatures. However, solar gains can begin early in the spring and affect not only the highest temperatures reached later in the summer but also salmonid spawning temperatures in spring and fall.

In Appendix C, Tables C-2 to C-18 and Figures C-2, C-5, C-8, C-11, C-14, and C-17 show the PNV shade targets. The tables also show corresponding target summer loads (in kilowatt-hours per square meter per day [kWh/m^2/day] and kWh/day) that serve as the load capacities for the streams. Existing and target loads in kWh/day can be summed for the entire stream or portion of stream examined in a single load analysis table. These total loads are shown at the bottom of their respective columns in each table. Because load calculations involve stream segment area calculations, the segments channel width, which typically only has one or two significant figures, dictates the level of significance of the corresponding loads. One significant figure in the resulting load can create rounding errors when existing and target loads are subtracted. The totals row of each load table represents total loads with two significant figures in an attempt to reduce apparent rounding errors.

The AU with the largest target load (i.e., load capacity) was the Warm Springs Creek complex (ID17040218SK043_02) with 1.1 million kWh/day (Table C-13). The smallest target load was in the Wildhorse Creek tributaries AU (ID17040218SK030_02) with 23,000 kWh/day (Table C-15).

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. Currently, two NPDES-permitted point sources are found in the affected AUs. Like target shade, existing shade was converted to a solar load by multiplying the fraction of open stream by the solar radiation measured on a flat-plate collector at the NREL weather stations. Existing shade data are presented in Tables C-2 to C-18 and Figures C-1, C-4, C-7, C-10, C-13, and C-16. Like load capacities (target loads), existing loads in Tables C-2 to C-18 are presented on an area basis (kWh/m^2/day) and as a total load (kWh/day). Existing loads in kWh/day are also summed for the entire stream or portion of stream examined in a single load analysis table. The difference between target and existing load is also summed for the entire

table. If the existing load exceeds the target load, the difference becomes the excess load (i.e., shade deficit), which is discussed in section 5.4 and depicted in the shade deficit figures (Tables C-3, C-6, C-9, C-12, C-15, and C-18).

The AU with the largest existing load was the Warm Springs Creek complex (ID17040218SK043_02) with 1.4 million kWh/day (Table C-13). The smallest existing load was in the Wildhorse Creek tributaries AU (ID17040218SK030_02) with 28,000 kWh/day (Table C-15).

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 upon the target load for a given segment. In Appendix C, Tables C-2 to C-18 show the target shade and corresponding target summer load. This target load (i.e., load capacity) is necessary to achieve background conditions. No opportunity exists to further remove shade from the stream by any activity without exceeding its load capacity. Additionally, because this TMDL depends upon background conditions for achieving water quality standards, all tributaries to the waters examined must be in natural conditions to prevent excess heat loads to the system.

Table 4 shows the total existing, target, and excess loads and the average shade deficit for each water body examined. The size of a stream influences the size of the excess load. Large streams (3rd and 4th order) have higher existing and target loads by virtue of their larger channel widths. Table 4 lists the tributaries in order of their excess loads, from highest to lowest. Therefore, large tributaries tend to be listed first and small (2nd order) tributaries 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 C-3, C-6, C-9, C-12, C-15, and C-18), 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 also listed in Table 4 and provides a general level of comparison among streams.

Table 4. Total solar loads and average lack of shade for all waters.

Water Body	Assessment Unit Number	Total Existing Load	Total Target Load	Excess Load (% Reduction)	Average Shade Deficit (%)
		(kWh/day)			
Star Hope Creek	ID17040218SK035_04	1,200,000	690,000	500,000 (42)	-5
Warm Springs Creek	ID17040218SK043_02	1,400,000	1,100,000	320,000 (23)	-13
North Fork Big Lost River	ID17040218SK027_03	990,000	790,000	200,000 (20)	-17
Wildhorse Creek	ID17040218SK030_04	560,000	380,000	180,000 (32)	-7
Summit Creek and tributaries	ID17040218SK028_02	450,000	370,000	82,000 (18)	-11
Star Hope Creek	ID17040218SK036_04	340,000	270,000	66,000 (19)	-4
North Fork Big Lost River and tributaries	ID17040218SK027_02	370,000	320,000	48,000 (13)	-11
Cherry Creek	ID17040218SK050_04	120,000	74,000	42,000 (35)	-10
Cherry Creek	ID17040218SK050_02	140,000	98,000	37,000 (26)	-15
Bear Creek tributaries	ID17040218SK053_02	160,000	130,000	32,000 (20)	-13
Warm Springs Creek	ID17040218SK043_03	190,000	170,000	21,000 (11)	-11
Corral Creek	ID17040218SK041_02	190,000	170,000	18,000 (9)	-11
Star Hope Creek tributaries	ID17040218SK035_02	95,000	81,000	15,000 (16)	-9
Antelope Creek and Darlington tributaries	ID17040218SK046_02	290,000	270,000	15,000 (5)	-9
Summit Creek	ID17040218SK028_03	40,000	28,000	12,000 (30)	-16
Wildhorse Creek tributaries	ID17040218SK030_02	28,000	23,000	4,400 (16)	-8
Bear Creek	ID17040218SK053_03	130,000	130,000	0 (0)	-8

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

The lower 4th-order segment of Star Hope Creek (ID17040218SK035_04) had the largest excess load and the highest needed percent reduction (42%). This section of creek is dominated by the low statured lemon willow and tends to have low shade targets, hence shade deficits are not substantial (-5% on average). The stream appears to have been overwidened in that existing channel widths are much larger than are predicted by the regional hydrology curve. This phenomenon also occurs in the 4th-order section of Wildhorse Creek (ID17040218SK030_04), which occupies a similar position on the landscape. The upper 4th-order AU of Star Hope Creek (ID17040218SK036_04) is almost completely dominated by beaver ponds. We recognize these

ponds and do not penalize the stream for having wide channels due to beaver ponds. The relationship between beaver activity and channel width in these low-gradient streams is not clear. Star Hope and Wildhorse Creeks may be unfairly judged in this analysis. More work is needed during TMDL implementation to determine appropriate actions for these streams.

The 3rd-order section of the North Fork Big Lost River and the Warm Springs Creek complex of streams are next in line with high excess loads. Percent reductions needed are around 20%. Warm Springs Creek is driven by two large spring outlets, both of which have aquaculture facilities associated with the spring outlets. Warm Springs and Pole Stackyard Creeks flow through low-gradient pastures that appear to have been converted from shrub-dominated riparian to pasture grass. These agricultural activities affect shade levels to some degree, although Warm Springs Creek is naturally very wide.

Most other AUs lack shade to some degree, although shade deficits are not substantial. Percent reductions in solar load needed to achieve targets vary from 5% to 26%. The 3rd-order reach of Summit Creek (30% reduction) and the 4th-order reach of Cherry Creek (35% reduction) are the exceptions with more needed reductions. The Summit Creek AU is very small, only 890 meters long from the Kane Creek confluence to the mouth of Summit Creek.

The 3rd-order reach of Bear Creek had no excess load, despite lacking shade in some locations. Bear Creek has enough locations with substantial shade, greater than targets predict, to counteract losses in other parts of the stream resulting in a no net gain in solar load.

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%, a difference usually exists between the two. For example, 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. An automatic difference of 6% could be attributed to the margin of safety.

The original 2004 temperature TMDLs for these streams (DEQ 2004) used differences in temperature between the stream and criteria to produced percent reductions needed (DEQ 2004, Table 60). In the revised PNV temperature TMDLs, percent reductions are based on excess solar loads (differences between existing solar loads and target solar loads). Comparing the two is somewhat problematic and may not show realistic differences either in actual conditions (then versus now) or in techniques. A comparison of percent reductions between the two TMDLs for each stream system is provided in Table 5. These data suggest that percent reductions from a solar load basis are slightly less than from a temperature basis but are somewhat comparable.

Table 5. Percent reduction comparisons between the 2004 and 2015 TMDLs.

Stream Name	2004 % Reductions	2015 % Reductions
Corral Creek	37.5–40.1	9 (1 AU)
Star Hope Creek	33.8–36.9	16, 19, 42 (3 AUs)
Wildhorse Creek	20.6–22.2	16, 32 (2 AUs)
North Fork Big Lost River	30.3–31.6	13, 20 (2 AUs)
Summit Creek	22.4–27	18, 30 (2 AUs)
Warm Springs Creek	37.8–37.9	11, 23 (2 AUs)
Cherry Creek	30.4–45.4	26, 35 (2 AUs)
Bear Creek	33–36.4	0, 20 (2 AUs)

5.4.1 Water Diversion

Stream temperature may be affected by diversions of water for water rights purposes. Diversion of flow reduces the amount of water exposed to a given level of solar radiation in the stream channel, which can result in increased water temperature in that channel. Loss of flow in the channel also affects the ability of the near-stream environment to support shade-producing vegetation, resulting in an increase in solar load to the channel.

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

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

Additionally, Idaho water quality standards indicate the following:

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

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

5.4.2 Margin of Safety

The margin of safety in this TMDL is considered implicit in the design. Because the target is essentially background conditions, loads (shade levels) are allocated to lands adjacent to these

streams at natural background levels. Because shade levels are established at natural background or system potential levels, it is unrealistic to set shade targets at higher, or more conservative, levels. 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 include the 6-month period from April through September. This time period is when the combination of increasing air and water temperatures coincide with increasing solar inputs and vegetative shade. The critical time periods are April through June when spring salmonid spawning occurs, July and August when maximum temperatures may exceed cold water aquatic life criteria, and September when fall salmonid spawning is most likely to be affected by higher temperatures. Water temperature is not likely to be a problem for beneficial uses outside of this time period because of cooler weather and lower sun angle.

5.4.4 Reasonable Assurance

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

Idaho’s nonpoint source management program describes many of the voluntary and regulatory approaches the state will take to abate nonpoint pollution sources. One of the prominent programs described in the plan is the provision for public involvement, including basin advisory groups (BAGs) and WAGs. The Upper Snake BAG is the designated WAG for the Big Lost River subbasin.

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 6.

Table 6. State of Idaho's regulatory authority for nonpoint pollution sources.

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

Idaho uses a voluntary approach to address agricultural nonpoint sources; however, regulatory authority is found in the water quality standards (IDAPA 58.01.02.350.01–03). IDAPA 58.01.02.055.07 refers to the *Idaho Agricultural Pollution Abatement Plan* (Ag Plan) (ISWCC and DEQ 2015), which provides direction to the agricultural community regarding approved BMPs. A portion of the Ag Plan outlines responsible agencies or elected groups (soil and water 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 and water 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

Two known NPDES-permitted point sources exist in the affected watersheds and their wasteload allocations are addressed in Appendix D. If an additional point source is 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 and 58.01.02.401.01) should be involved (Appendix A).

Stormwater runoff is water from rain or snowmelt that does not immediately infiltrate into the ground and flows over or through natural or man-made storage or conveyance systems. When undeveloped areas are converted to land uses with impervious surfaces—such as buildings, parking lots, and roads—the natural hydrology of the land is altered and can result in increased surface runoff rates, volumes, and pollutant loads. Certain types of stormwater runoff are considered point source discharges for CWA purposes, including stormwater that is associated with municipal separate storm sewer systems (MS4s), industrial stormwater covered under the Multi-Sector General Permit (MSGP), and construction stormwater covered under the Construction General Permit (CGP).

5.4.5.1 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 United States
- Designed or used to collect or convey stormwater (including storm drains, pipes, ditches, etc.)
- Not a combined sewer
- Not part of a publicly owned treatment works (sewage treatment plant)

To prevent harmful pollutants from being washed or dumped into an MS4, operators must obtain an 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.

5.4.5.2 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 updated to reflect changes in site conditions, personnel, and stormwater infrastructure.

Industrial Facilities Discharging to Impaired Water Bodies

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

Also, because different industrial activities have sector-specific types of material that may be exposed to stormwater, EPA grouped the different regulated industries into 29 sectors, based on their typical activities. Part 8 of EPA's MSGP details the stormwater management practices and monitoring that are required for the different industrial sectors. EPA issued a new MSGP in 2015. 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 new MSGP will have specific monitoring requirements that must be followed.

5.4.5.3 Construction Stormwater

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.

Postconstruction Stormwater Management

Many communities throughout Idaho are currently developing rules for postconstruction stormwater management. Sediment is usually the main pollutant of concern in construction site stormwater. DEQ's *Catalog of Stormwater Best Management Practices for Idaho Cities and Counties* (DEQ 2005) should be used to select the proper suite of BMPs for the specific site, soils, climate, and project phasing to sufficiently meet the standards and requirements of the CGP and protect water quality. Where local ordinances have more stringent and site-specific standards, those are applicable.

5.4.6 Reserve for Growth

Given the nature of the pollutants and landscape, no allowances have been made for future growth. Such growth would come as a result of land use changes that would affect present day sources and types of pollutants and would be assessed in a future TMDL review.

5.5 Implementation Strategies

Implementation strategies for TMDLs produced using PNV-based shade and solar loads should incorporate the load analysis tables presented in this TMDL (Appendix C). These tables must 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. 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 to field verify existing shade for each stream segment to determine if shade differences are real and result from activities that are controllable. Information within this TMDL (maps and load analysis tables) should be used to guide and prioritize implementation

investigations. The information in this TMDL may need further adjustment to reflect new information and conditions in the future.

5.5.1 Time Frame

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

DEQ and the 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

The designated management agencies, WAG, DEQ, and other appropriate participants will plan BMPs specific to each impaired reach with a load allocation. The public will also have the opportunity to be involved with implementation planning. The plan will include measureable milestones and a timeline for implementation. Monitoring conducted with DEQ-approved methods will measure progress toward meeting Idaho's water quality standards. Target shade levels are provided for the entire reach of each stream with a temperature TMDL, so shade can be monitored anywhere in each applicable reach.

5.5.3 Implementation Monitoring Strategy

Effective shade monitoring can take place on any segment throughout the 17 AUs in the Big Lost River subbasin and be compared to existing shade estimates provided in Appendix C (Figures C-1, C-4, C-7, C-10, C-13, and C-16 and Tables C-2 to C-18). 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 under revision).

5.5.4.1 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.

5.5.4.2 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.

5.5.4.3 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).

6 Conclusions

Effective shade targets were established for 17 AUs and associated streams based on the concept of maximum shading under PNV resulting in natural background temperature levels. Shade targets were derived from effective shade curves developed for similar vegetation types in Idaho. Existing shade was determined from aerial photo interpretation and partially field verified with Solar Pathfinder data. Target and existing shade levels were compared to determine the amount of shade needed to bring water bodies into compliance with temperature criteria in Idaho's water quality standards (IDAPA 58.01.02). A summary of assessment outcomes, including recommended changes to listing status in the next Integrated Report, is presented in Table 7.

All AUs lack shade and have excess solar loads, except the 3rd-order AU of Bear Creek, which did not show an excess load. Low-gradient, wide streams (Star Hope, Wildhorse, and Warm Springs Creeks) have the highest excess loads. These systems are more accessible and are used more for livestock pasturing and agricultural conversion. Percent reductions needed in solar loads to achieve target levels varied from 42% in Star Hope Creek to 0% in Bear Creek. Most AUs required reductions at 26% or less. Comparisons between 2004 and current reductions show slightly smaller percent reductions are needed in 2015.

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.

The current wasteload allocations for IDFG's Mackay Fish Hatchery and Clear Springs Foods Lost River Hatchery on Warm Springs Creek are to meet the numeric state water quality standard including salmonid spawning temperatures during spring and fall months. Meeting this standard is not possible because the source water (11 °C at the Mackay Fish Hatchery) already exceeds the 9 °C daily average for salmonid spawning. However, to protect salmonid spawning to the extent practicable, DEQ is modifying the current temperature wasteload allocation for the hatcheries to the inflow daily average temperature plus 0.15 ºC for each facility.

Table 7. Summary of assessment outcomes.

Water Body	Assessment Unit Number	Pollutant	TMDL Completed	Recommended Changes to Next Integrated Report	Justification
North Fork Big Lost River	ID17040218SK027_02 ID17040218SK027_03	Temperature	Yes	Add 2nd-order AU to 3rd-order AU already in Category 4a	Excess solar load from a lack of existing shade
Summit Creek	ID17040218SK028_02 ID17040218SK028_03	Temperature	Yes	Add 3rd-order AU to 2nd-order AU already in Category 4a	Excess solar load from a lack of existing shade
Wildhorse Creek	ID17040218SK030_02 ID17040218SK030_04	Temperature	Yes	Add 2nd-order AU to 4th-order AU already in Category 4a	Excess solar load from a lack of existing shade
Star Hope Creek	ID17040218SK035_02 ID17040218SK035_04 ID17040218SK036_04	Temperature	Yes	No changes, already in Category 4a	TMDL update
Corral Creek	ID17040218SK041_02	Temperature	Yes	No changes, already in Category 4a	TMDL update
Warm Springs Creek	ID17040218SK043_02 ID17040218SK043_03	Temperature	Yes	No changes, already in Category 4a	TMDL update
Antelope Creek/Darlington Canal tributaries	ID17040218SK046_02	Temperature	Yes	No changes, already in Category 4a	TMDL update
Cherry Creek	ID17040218SK050_02 ID17040218SK050_04	Temperature	Yes	In 2004 TMDL but was not added to Category 4; both AUs must be added	TMDL update
Bear Creek	ID17040218SK053_02 ID17040218SK053_03	Temperature	Yes	Add 2nd-order AU to 3rd order AU already in Category 4a	Excess solar load from a lack of existing shade

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

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GIS Coverages

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

USDA – FSA Aerial Photography Field Office - 2011 National Agricultural Imagery Program (NAIP) 1.0m imagery

Glossary

§303(d)

Refers to section 303 subsection "d" of the Clean Water Act. Section 303(d) requires states to develop a list of water bodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to US Environmental Protection Agency approval.

Ambient

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

Anthropogenic

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

Assessment Unit (AU)

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

Beneficial Use

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

Beneficial Use Reconnaissance Program (BURP)

A program for conducting systematic biological and physical habitat surveys of water bodies in Idaho. BURP protocols address lakes, reservoirs, wadeable streams, and rivers.

Exceedance

A violation (according to DEQ policy) of the pollutant levels permitted by water quality criteria.

Fully Supporting

In compliance with water quality standards and within the range of biological reference conditions for all designated and exiting beneficial uses as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).

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* (Grafe et al. 2002).
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.

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

Water Quality Standards Applicable to Salmonid Spawning Temperature

Water quality standards for temperature are specific numeric values not to be exceeded during the salmonid spawning and egg incubation period, which varies by species. For spring-spawning salmonids, the default spawning and incubation period recognized by the Idaho Department of Environmental Quality (DEQ) is generally March 15 to July 15 (Grafe et al. 2002). Fall spawning can occur as early as September 1 and continue with incubation into the following spring up to June 1. Per IDAPA 58.01.02.250.02.f.ii., the following water quality criteria need to be met during that time period:

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

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

Natural Background Provisions

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

> When natural background conditions exceed any applicable water quality criteria set forth in Sections 210, 250, 251, 252, or 253, the applicable water quality criteria shall not apply; instead, there shall be no lowering of water quality from natural background conditions. Provided, however, that temperature may be increased above natural background conditions when allowed under Section 401. (IDAPA 58.01.02.200.09)

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

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Appendix B. Data Sources

Table B-1. Data sources for Big Lost River subbasin.

Water Body	Data Source	Type of Data	Collection Date
17 assessment units (see Section 6, Table 7 for stream names)	DEQ Idaho Falls Regional Office	Solar Pathfinder effective shade and stream width	Summer 2015
17 assessment units	DEQ Technical Services, State Office	Aerial photo interpretation of existing shade and stream width estimation	Summer/fall 2015
17 assessment units	DEQ IDASA Database	Temperature	Variable

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Appendix C. Bankfull Width Estimates, Target Solar Load Tables, and Shade Figures

Table C-1. Bankfull width estimates for streams in the load analysis.

Location	area (sq mi)	Upper Snake (m)	Salmon (m)	Payette/Weiser (m)	field data (m)
Bear Creek @ mouth	19	6	9	7	
Bear Creek ab Big Springs	18.4	6	9	7	
Bear Creek bl Death Canyon	15.1	5	8	6	6.3(96), 3.4(14)
Bear Creek ab Death Canyon	10.8	4	7	5	8.7(96)
Bear Creek at fork confluence	8.9	4	7	5	6.2(97)
Death Canyon @ mouth	4.3	3	5	3	
Left Fork Death Canyon	2.3	2	4	2	
Right Fork Death Canyon	1.5	2	3	2	
Right Fork Bear @ mouth	5	3	6	3	5(96)
Right Fork Bear ab Lone Pine Creek	1.9	2	4	2	
Lone Pine Creek @ mouth	2.4	2	4	2	
Middle Fork Bear ab Right Fork	3.9	3	5	3	7.7(96)
Left Fork Bear @ mouth	0.9	1	3	1	
Cherry Creek ab Left Fork	19.5	6	9	7	3.2(01)
Cherry Creek ab Middle Fork	8.8	4	7	5	2.6(01)
Middle Fork Cherry Creek @ mouth	5.9	3	6	4	
Middle Fork Cherry ab forked trib.	2.3	2	4	2	
Lupine Creek @ mouth	4.5	3	5	3	1.3(98), 2.1(01), 1.8(01)
Mud Lake Creek @ mouth	2	2	4	2	
Carcass Creek @ mouth	0.75	1	3	1	0.8(98)
Crawford Canyon @ mouth	1.8	2	4	2	
Richardson Canyon @ mouth	1.9	2	4	2	1.2(98)
Star Hope Creek @ mouth	75.9	11	16	15	20.1(01)
Star Hope Creek ab Ramsey Creek	66.7	10	15	14	18.7(01), 13.7(03)
Star Hope Creek ab Bellas Canyon	56	9	14	13	14.5(14)
Star Hope Creek bl Bear Canyon	12	5	8	6	5(01), 7.2(08)
Bellas Canyon @ mouth	3.1	3	5	3	4.7(96)
Howell Canyon @ mouth	2.2	2	4	2	
Ramsey Creek @ mouth	3.7	3	5	3	1.9 (01), 1.3(12)
Un-named (upper)	1.5	2	3	2	
Un-named (potholes)	0.82	1	3	1	
Corral Creek ab Coyote Creek	8.7	4	7	5	4.1(01), 2.4(12)
Corral Creek @ 8350ft	4.6	3	5	3	
Corral Creek @ 9290ft	1.6	2	4	2	
Corral Creek @ mouth	18.8	6	9	7	
Coyote Creek @ mouth	7.3	4	6	4	
Coyote Creek ab Horse Wallow Creek	2.9	3	4	3	
Horse Wallow Creek @ mouth	2.3	2	4	2	

Table C-1 (cont.) Bankfull width estimates for streams in the load analysis.

Location	area (sq mi)	Upper Snake (m)	Salmon (m)	Payette/Weiser (m)	field data (m)
Wildhorse Creek @ mouth	57	9	14	13	16.7(03)
Wildhorse Creek bl Fall Creek	49.5	9	13	12	13.1(01), 13.7(14)
Burnt Aspen Creek @ mouth	1.7	2	4	2	1.7(98)
Bailey Creek @ mouth	1.1	2	3	2	2(96)
Summit Creek @ mouth	45.8	8	13	11	
Summit Creek ab Kane Creek	25.8	7	10	8	6.6(01) bl Phi Kappa
Summit Creek bl Big Fall Creek	15.7	5	9	6	6.3(96) ab Big Fall
Summit Creek ab Little Fall Creek	6	3	6	4	
Park Creek @ mouth	1.14	2	3	2	
Little Fall Creek @ mouth	3.3	3	5	3	
Big Fall Creek @ mouth	3.9	3	5	3	4.3(96), 2.5(01)
Phi Kappa Creek @ mouth	2.7	2	4	3	4.7(96), 1.5(12)
7th Tributary @ mouth	1.8	2	4	2	
NF Big Lost River ab Summit Creek	60.6	10	14	13	9.6(11)
NF Big Lost River bl Blind Creek	18.2	6	9	7	6.5(15), 10.6(11)
NF Big Lost River ab Blind Creek	10.5	4	7	5	6(96)
Blind Creek @ mouth	7.7	4	7	4	
tirb to Blind Creek	7	4	6	4	3.7(96)
Hunter Creek @ mouth	4.2	3	5	3	4.7(96)
Bear Creek @ mouth	2.2	2	4	2	2.7(96)
Squib Canyon @ mouth	2.1	2	4	2	2(96)
Miller Canyon @ mouth	3.8	3	5	3	5.7(96)
Glide Canyon @ mouth	1.3	2	3	2	3.3(96)
Park Canyon @ mouth	2.1	2	4	2	3.3(96)
Corral Creek @ mouth	2	2	4	2	
Toolbox Creek @ mouth	1.4	2	3	2	2.7(96)
Chicken Creek @ mouth	3	3	5	3	2(96)
Horse Creek @ mouth	1.2	2	3	2	2(96)
Little Burnt Creek @ mouth	1.7	2	4	2	
Grasshopper Creek @ mouth	4.2	3	5	3	2.7(96)
Bartlett Creek @ mouth	3.7	3	5	3	3(98)
Warm Springs Creek bl Hamilton Springs					14.3(96)
Garden Creek @ mouth	3.7	3	5	3	
Boone Creek @ mouth	2.8	2	4	3	2.1(98)
Lehman Creek @ mouth	10.8	4	7	5	2.4(98) ab lowest trib
WF Lehman Creek	3.4	3	5	3	
EF Lehman Creek	4.2	3	5	3	
Hamilton Creek @ mouth	5	3	6	3	
Wood Canyon	2.1	2	4	2	
Marsh Canyon	8.9	4	7	5	
Sheep Canyon	4.2	3	5	3	
Granite Spring Canyon	2.4	2	4	2	

Table C-2. Existing and target solar loads for Antelope Creek/Darlington canal tributaries (ID17040218SK046_02).

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
046_02	Wood Canyon	1	430	sage/grass	65%	2.19	1	400	900	60%	2.51	1	400	1,000	100	-5%
046_02	Wood Canyon	2	370	aspen	100%	0.00	1	400	0	80%	1.25	1	400	500	500	-20%
046_02	Wood Canyon	3	370	sage/grass	65%	2.19	1	400	900	40%	3.76	1	400	2,000	1,000	-25%
046_02	Wood Canyon	4	320	aspen	100%	0.00	1	300	0	70%	1.88	1	300	600	600	-30%
046_02	Wood Canyon	5	3600	sage/grass	39%	3.82	2	7,000	30,000	20%	5.02	2	7,000	40,000	10,000	-19%
046_02	2nd trib	1	640	dry DF w/o Ppine	94%	0.38	1	600	200	90%	0.63	1	600	400	200	-4%
046_02	2nd trib	2	1300	rock/bare/ephemeral	0%	6.27	1	1,000	6,000	0%	6.27	1	1,000	6,000	0	0%
046_02	Marsh Canyon	1	1900	aspen	100%	0.00	1	2,000	0	90%	0.63	1	2,000	1,000	1,000	-10%
046_02	Marsh Canyon	2	360	aspen	100%	0.00	1	400	0	80%	1.25	1	400	500	500	-20%
046_02	Marsh Canyon	3	360	aspen	99%	0.06	2	700	40	80%	1.25	2	700	900	900	-19%
046_02	Marsh Canyon	4	320	sage/grass	39%	3.82	2	600	2,000	50%	3.14	2	600	2,000	0	0%
046_02	Marsh Canyon	5	760	aspen	99%	0.06	2	2,000	100	70%	1.88	2	2,000	4,000	4,000	-29%
046_02	Marsh Canyon	6	210	sage/grass	39%	3.82	2	400	2,000	40%	3.76	2	400	2,000	0	0%
046_02	Marsh Canyon	7	370	sage/grass	39%	3.82	2	700	3,000	30%	4.39	2	700	3,000	0	-9%
046_02	Marsh Canyon	8	4400	sage/grass	27%	4.58	3	10,000	50,000	20%	5.02	3	10,000	50,000	0	-7%
046_02	Marsh Canyon	9	1200	rock/bare/ephemeral	0%	6.27	4	5,000	30,000	0%	6.27	4	5,000	30,000	0	0%
046_02	1st to Marsh	1	1700	sage/grass	65%	2.19	1	2,000	4,000	60%	2.51	1	2,000	5,000	1,000	-5%
046_02	1st to Marsh	2	1500	aspen	100%	0.00	1	2,000	0	90%	0.63	1	2,000	1,000	1,000	-10%
046_02	2nd to Marsh	1	380	grass	55%	2.82	1	400	1,000	50%	3.14	1	400	1,000	0	-5%
046_02	2nd to Marsh	2	180	aspen	100%	0.00	1	200	0	90%	0.63	1	200	100	100	-10%
046_02	2nd to Marsh	3	1800	sage/grass	65%	2.19	1	2,000	4,000	40%	3.76	1	2,000	8,000	4,000	-25%
046_02	3rd to Marsh	1	2600	rock/bare/ephemeral	0%	6.27	1	3,000	20,000	0%	6.27	1	3,000	20,000	0	0%
046_02	4th trib	1	1200	dry DF w/o Ppine	94%	0.38	1	1,000	400	90%	0.63	1	1,000	600	200	-4%
046_02	4th trib	2	600	sage/grass	65%	2.19	1	600	1,000	60%	2.51	1	600	2,000	1,000	-5%
046_02	4th trib	3	1600	dry DF w/o Ppine	94%	0.38	1	2,000	800	90%	0.63	1	2,000	1,000	200	-4%
046_02	4th trib	4	440	sage/grass	65%	2.19	1	400	900	60%	2.51	1	400	1,000	100	-5%
046_02	4th trib	5	740	rock/bare/ephemeral	0%	6.27	1	700	4,000	0%	6.27	1	700	4,000	0	0%
046_02	5th trib	1	2400	sage/grass	65%	2.19	1	2,000	4,000	60%	2.51	1	2,000	5,000	1,000	-5%
046_02	Sheep Canyon	1	810	dry DF w/o Ppine	94%	0.38	1	800	300	90%	0.63	1	800	500	200	-4%
046_02	Sheep Canyon	2	1900	aspen	99%	0.06	2	4,000	300	80%	1.25	2	4,000	5,000	5,000	-19%
046_02	Sheep Canyon	3	250	sage/grass	39%	3.82	2	500	2,000	60%	2.51	2	500	1,000	(1,000)	0%
046_02	Sheep Canyon	4	3900	sage/grass	27%	4.58	3	10,000	50,000	50%	3.14	3	10,000	30,000	(20,000)	0%
046_02	trib to Sheep	1	1100	sage/grass	65%	2.19	1	1,000	2,000	60%	2.51	1	1,000	3,000	1,000	-5%
046_02	trib to Sheep	2	81	grass	55%	2.82	1	80	200	60%	2.51	1	80	200	0	0%
046_02	trib to Sheep	3	1500	sage/grass	39%	3.82	2	3,000	10,000	60%	2.51	2	3,000	8,000	(2,000)	0%
046_02	Granite Spring	1	1700	sage/grass	65%	2.19	1	2,000	4,000	60%	2.51	1	2,000	5,000	1,000	-5%
046_02	Granite Spring	2	3400	sage/grass	39%	3.82	2	7,000	30,000	30%	4.39	2	7,000	30,000	0	-9%
046_02	Dry Hollow	1	1000	sage/grass	65%	2.19	1	1,000	2,000	60%	2.51	1	1,000	3,000	1,000	-5%
046_02	Dry Hollow	2	1300	sage/grass	65%	2.19	1	1,000	2,000	40%	3.76	1	1,000	4,000	2,000	-25%
046_02	Dry Hollow	3	550	rock/bare/ephemeral	0%	6.27	1	600	4,000	0%	6.27	1	600	4,000	0	0%
							Totals		270,000					290,000	15,000	

Note: All assessment unit (AU) numbers start with ID17040218SK in all load tables (Tables C-2–C-18). Significant figures are controlled by the lowest level in the calculation, typically that of the channel width. Some rounding errors may result.

Table C-3. Existing and target solar loads for 2nd-order Bear Creek (ID17040218SK053_02).

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
053_02	LF Bear Creek	1	1100	sage/grass	65%	2.19	1	1,000	2,000	60%	2.51	1	1,000	3,000	1,000	-5%
053_02	LF Bear Creek	2	250	aspen	100%	0.00	1	300	0	90%	0.63	1	300	200	200	-10%
053_02	LF Bear Creek	3	220	Drummond willow	87%	0.82	1	200	200	70%	1.88	1	200	400	200	-17%
053_02	MF Bear Creek	1	490	grass	55%	2.82	1	500	1,000	50%	3.14	1	500	2,000	1,000	-5%
053_02	MF Bear Creek	2	490	subalpine fir/moist	96%	0.25	1	500	100	90%	0.63	1	500	300	200	-6%
053_02	MF Bear Creek	3	180	grass	55%	2.82	1	200	600	30%	4.39	1	200	900	300	-25%
053_02	MF Bear Creek	4	110	grass	55%	2.82	1	100	300	20%	5.02	1	100	500	200	-35%
053_02	MF Bear Creek	5	630	subalpine fir/moist	96%	0.25	1	600	200	90%	0.63	1	600	400	200	-6%
053_02	MF Bear Creek	6	240	subalpine fir/moist	96%	0.25	1	200	50	80%	1.25	1	200	300	300	-16%
053_02	MF Bear Creek	7	2300	subalpine fir/dry-steep	99%	0.06	2	5,000	300	90%	0.63	2	5,000	3,000	3,000	-9%
053_02	MF Bear Creek	8	540	aspen	99%	0.06	3	2,000	100	90%	0.63	3	2,000	1,000	900	-9%
053_02	MF Bear Creek	9	1300	aspen	99%	0.06	3	4,000	300	90%	0.63	3	4,000	3,000	3,000	-9%
053_02	MF Bear Creek	10	220	aspen	99%	0.06	3	700	40	50%	3.14	3	700	2,000	2,000	-49%
053_02	MF Bear Creek	11	100	alder	72%	1.76	3	300	500	70%	1.88	3	300	600	100	-2%
053_02	RF Bear Creek	1	940	grass	55%	2.82	1	900	3,000	50%	3.14	1	900	3,000	0	-5%
053_02	RF Bear Creek	2	270	whitebark pine	99%	0.06	1	300	20	90%	0.63	1	300	200	200	-9%
053_02	RF Bear Creek	3	400	Drummond willow	87%	0.82	1	400	300	90%	0.63	1	400	300	0	3%
053_02	RF Bear Creek	4	540	DF/lodgepole-gentle	100%	0.00	1	500	0	90%	0.63	1	500	300	300	-10%
053_02	RF Bear Creek	5	1400	Drummond willow	76%	1.50	2	3,000	5,000	80%	1.25	2	3,000	4,000	(1,000)	0%
053_02	RF Bear Creek	6	430	Drummond willow	76%	1.50	2	900	1,000	50%	3.14	2	900	3,000	2,000	-26%
053_02	RF Bear Creek	7	1400	Drummond willow	56%	2.76	3	4,000	10,000	30%	4.39	3	4,000	20,000	10,000	-26%
053_02	RF Bear Creek	8	1100	alder	72%	1.76	3	3,000	5,000	70%	1.88	3	3,000	6,000	1,000	-2%
053_02	Lone Pine Creek	1	1500	grass	55%	2.82	1	2,000	6,000	50%	3.14	1	2,000	6,000	0	-5%
053_02	Lone Pine Creek	2	920	subalpine fir/dry-steep	99%	0.06	1	900	60	90%	0.63	1	900	600	500	-9%
053_02	Lone Pine Creek	3	610	dry DF w/o Ppine	94%	0.38	2	1,000	400	90%	0.63	2	1,000	600	200	-4%
053_02	Lone Pine Creek	4	380	aspen	99%	0.06	2	800	50	80%	1.25	2	800	1,000	1,000	-19%
053_02	Lone Pine Creek	5	530	Drummond willow	76%	1.50	2	1,000	2,000	80%	1.25	2	1,000	1,000	(1,000)	0%
053_02	trib to Lone Pine	1	500	rock/bare/ephemeral	0%	6.27	1	500	3,000	0%	6.27	1	500	3,000	0	0%
053_02	trib to Lone Pine	2	1800	sage/grass	65%	2.19	1	2,000	4,000	50%	3.14	1	2,000	6,000	2,000	-15%
053_02	trib to Lone Pine	3	750	Drummond willow	87%	0.82	1	800	700	60%	2.51	1	800	2,000	1,000	-27%
053_02	LF Death Canyon	1	220	aspen	100%	0.00	1	200	0	80%	1.25	1	200	300	300	-20%
053_02	LF Death Canyon	2	2100	sage/grass	39%	3.82	2	4,000	20,000	60%	2.51	2	4,000	10,000	(10,000)	0%
053_02	LF Death Canyon	3	780	sage/grass	39%	3.82	2	2,000	8,000	40%	3.76	2	2,000	8,000	0	0%
053_02	RF Death Canyon	1	170	sage/grass	65%	2.19	1	200	400	60%	2.51	1	200	500	100	-5%
053_02	RF Death Canyon	2	170	sage/grass	65%	2.19	1	200	400	60%	2.51	1	200	500	100	-5%
053_02	RF Death Canyon	3	2600	sage/grass	39%	3.82	2	5,000	20,000	40%	3.76	2	5,000	20,000	0	0%
053_02	Death Canyon	1	470	Geyer willow	82%	1.13	2	900	1,000	80%	1.25	2	900	1,000	0	-2%
053_02	Death Canyon	2	710	Geyer willow	82%	1.13	2	1,000	1,000	50%	3.14	2	1,000	3,000	2,000	-32%
053_02	Death Canyon	3	680	Geyer willow	64%	2.26	3	2,000	5,000	50%	3.14	3	2,000	6,000	1,000	-14%
053_02	Death Canyon	4	360	Geyer willow	64%	2.26	3	1,000	2,000	40%	3.76	3	1,000	4,000	2,000	-24%
053_02	Death Canyon	5	460	Geyer willow	64%	2.26	3	1,000	2,000	50%	3.14	3	1,000	3,000	1,000	-14%
053_02	trib to Death Canyon	1	870	grass	55%	2.82	1	900	3,000	50%	3.14	1	900	3,000	0	-5%
053_02	trib to Death Canyon	2	780	Drummond willow	87%	0.82	1	800	700	60%	2.51	1	800	2,000	1,000	-27%
053_02	trib to Death Canyon	3	780	sage/grass	39%	3.82	2	2,000	8,000	40%	3.76	2	2,000	8,000	0	0%
053_02	trib to Death Canyon	4	220	Geyer willow	82%	1.13	2	400	500	50%	3.14	2	400	1,000	500	-32%
053_02	Coyote Canyon	1	2100	sage/grass	65%	2.19	1	2,000	4,000	50%	3.14	1	2,000	6,000	2,000	-15%
053_02	un-named	1	230	grass	55%	2.82	1	200	600	50%	3.14	1	200	600	0	-5%
053_02	un-named	2	800	dry DF w/o Ppine	94%	0.38	1	800	300	80%	1.25	1	800	1,000	700	-14%
053_02	un-named	3	410	Geyer willow	93%	0.44	1	400	200	30%	4.39	1	400	2,000	2,000	-63%
053_02	un-named	4	1100	sage/grass	39%	3.82	2	2,000	8,000	40%	3.76	2	2,000	8,000	0	0%
							Totals		130,000					160,000	32,000	

Table C-4. Existing and target solar loads for 3rd-order Bear Creek (ID17040218SK053_03).

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
053_03	Bear Creek	1	1600	alder	59%	2.57	4	6,000	20,000	70%	1.88	4	6,000	10,000	(10,000)	0%
053_03	Bear Creek	2	1200	Geyer willow	53%	2.95	4	5,000	10,000	70%	1.88	4	5,000	9,000	(1,000)	0%
053_03	Bear Creek	3	430	Geyer willow	45%	3.45	5	2,000	7,000	40%	3.76	5	2,000	8,000	1,000	-5%
053_03	Bear Creek	4	250	Geyer willow	45%	3.45	5	1,000	3,000	60%	2.51	5	1,000	3,000	0	0%
053_03	Bear Creek	5	530	Geyer willow	45%	3.45	5	3,000	10,000	40%	3.76	5	3,000	10,000	0	-5%
053_03	Bear Creek	6	230	Geyer willow	45%	3.45	5	1,000	3,000	20%	5.02	5	1,000	5,000	2,000	-25%
053_03	Bear Creek	7	1300	Geyer willow	45%	3.45	5	7,000	20,000	30%	4.39	5	7,000	30,000	10,000	-15%
053_03	Bear Creek	8	350	Geyer willow	40%	3.76	6	2,000	8,000	60%	2.51	6	2,000	5,000	(3,000)	0%
053_03	Bear Creek	9	150	Geyer willow	40%	3.76	6	900	3,000	30%	4.39	6	900	4,000	1,000	-10%
053_03	Bear Creek	10	900	Geyer willow	40%	3.76	6	5,000	20,000	30%	4.39	6	5,000	20,000	0	-10%
053_03	Bear Creek	11	800	Geyer willow	40%	3.76	6	5,000	20,000	60%	2.51	6	5,000	10,000	(10,000)	0%
053_03	Bear Creek	12	420	Geyer willow	40%	3.76	6	3,000	10,000	10%	5.64	6	3,000	20,000	10,000	-30%
							Totals		130,000					130,000	0	

Table C-5. Existing and target solar loads for Corral Creek (ID17040218SK041_02).

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
041_02	Corral Creek	1	700	grass	55%	2.82	1	700	2,000	50%	3.14	1	700	2,000	0	-5%
041_02	Corral Creek	2	580	subalpine fir/moist	96%	0.25	1	600	200	90%	0.63	1	600	400	200	-6%
041_02	Corral Creek	3	420	grass	55%	2.82	1	400	1,000	40%	3.76	1	400	2,000	1,000	-15%
041_02	Corral Creek	4	360	Drummond willow	76%	1.50	2	700	1,000	80%	1.25	2	700	900	(100)	0%
041_02	Corral Creek	5	410	Drummond willow	76%	1.50	2	800	1,000	60%	2.51	2	800	2,000	1,000	-16%
041_02	Corral Creek	6	900	Drummond willow	76%	1.50	2	2,000	3,000	70%	1.88	2	2,000	4,000	1,000	-6%
041_02	Corral Creek	7	170	grass	31%	4.33	2	300	1,000	40%	3.76	2	300	1,000	0	0%
041_02	Corral Creek	8	400	subalpine fir/moist	96%	0.25	2	800	200	80%	1.25	2	800	1,000	800	-16%
041_02	Corral Creek	9	450	Drummond willow	76%	1.50	2	900	1,000	80%	1.25	2	900	1,000	0	0%
041_02	Corral Creek	10	280	Drummond willow	76%	1.50	2	600	900	60%	2.51	2	600	2,000	1,000	-16%
041_02	Corral Creek	11	320	beaver ponds	20%	5.02	2	600	3,000	20%	5.02	2	600	3,000	0	0%
041_02	Corral Creek	12	1200	Drummond willow	56%	2.76	3	4,000	10,000	60%	2.51	3	4,000	10,000	0	0%
041_02	Corral Creek	13	300	beaver ponds	30%	4.39	3	900	4,000	30%	4.39	3	900	4,000	0	0%
041_02	Corral Creek	14	1200	Drummond willow	56%	2.76	3	4,000	10,000	60%	2.51	3	4,000	10,000	0	0%
041_02	Corral Creek	15	570	Drummond willow	45%	3.45	4	2,000	7,000	40%	3.76	4	2,000	8,000	1,000	-5%
041_02	Corral Creek	16	900	Drummond willow	45%	3.45	4	4,000	10,000	50%	3.14	4	4,000	10,000	0	0%
041_02	Corral Creek	17	390	Drummond willow	45%	3.45	4	2,000	7,000	60%	2.51	4	2,000	5,000	(2,000)	0%
041_02	Corral Creek	18	740	beaver ponds	20%	5.02	4	3,000	20,000	20%	5.02	4	3,000	20,000	0	0%
041_02	1st to Corral	1	1000	grass	55%	2.82	1	1,000	3,000	50%	3.14	1	1,000	3,000	0	-5%
041_02	1st to Corral	2	1200	grass	55%	2.82	1	1,000	3,000	30%	4.39	1	1,000	4,000	1,000	-25%
041_02	1st to Corral	3	270	dry DF w/o Ppine	94%	0.38	2	500	200	80%	1.25	2	500	600	400	-14%
041_02	1st to Corral	4	290	sage/grass	39%	3.82	2	600	2,000	50%	3.14	2	600	2,000	0	0%
041_02	2nd to Corral	1	450	dry DF w/o Ppine	94%	0.38	1	500	200	80%	1.25	1	500	600	400	-14%
041_02	2nd to Corral	2	330	grass	55%	2.82	1	300	800	50%	3.14	1	300	900	100	-5%
041_02	2nd to Corral	3	790	Drummond willow	87%	0.82	1	800	700	50%	3.14	1	800	3,000	2,000	-37%
041_02	2nd to Corral	4	950	sage/grass	39%	3.82	2	2,000	8,000	30%	4.39	2	2,000	9,000	1,000	-9%
041_02	2nd to Corral	5	550	sage/grass	39%	3.82	2	1,000	4,000	20%	5.02	2	1,000	5,000	1,000	-19%
041_02	2nd to Corral	6	170	Drummond willow	76%	1.50	2	300	500	50%	3.14	2	300	900	400	-26%
041_02	Coyote Creek	1	260	Drummond willow	87%	0.82	1	300	200	80%	1.25	1	300	400	200	-7%
041_02	Coyote Creek	2	810	sage/grass	65%	2.19	1	800	2,000	50%	3.14	1	800	3,000	1,000	-15%
041_02	Coyote Creek	3	1100	grass	55%	2.82	1	1,000	3,000	30%	4.39	1	1,000	4,000	1,000	-25%
041_02	Coyote Creek	4	430	Drummond willow	76%	1.50	2	900	1,000	40%	3.76	2	900	3,000	2,000	-36%
041_02	Coyote Creek	5	1100	Drummond willow	76%	1.50	2	2,000	3,000	70%	1.88	2	2,000	4,000	1,000	-6%
041_02	Coyote Creek	6	940	grass	21%	4.95	3	3,000	10,000	30%	4.39	3	3,000	10,000	0	0%
041_02	Coyote Creek	7	970	Drummond willow	56%	2.76	3	3,000	8,000	40%	3.76	3	3,000	10,000	2,000	-16%
041_02	Coyote Creek	8	640	Drummond willow	45%	3.45	4	3,000	10,000	70%	1.88	4	3,000	6,000	(4,000)	0%
041_02	Coyote Creek	9	470	Drummond willow	45%	3.45	4	2,000	7,000	50%	3.14	4	2,000	6,000	(1,000)	0%
041_02	Coyote Creek	10	45	Drummond willow	45%	3.45	4	200	700	0%	6.27	4	200	1,000	300	-45%
041_02	Coyote Creek	11	300	Drummond willow	45%	3.45	4	1,000	3,000	40%	3.76	4	1,000	4,000	1,000	-5%
041_02	Coyote Creek	12	240	Drummond willow	45%	3.45	4	1,000	3,000	30%	4.39	4	1,000	4,000	1,000	-15%
041_02	Coyote Creek	13	69	beaver ponds	0%	6.27	4	300	2,000	0%	6.27	4	300	2,000	0	0%
041_02	Coyote Creek	14	340	Drummond willow	45%	3.45	4	1,000	3,000	50%	3.14	4	1,000	3,000	0	0%
041_02	Horse Wallow	1	740	aspen	100%	0.00	1	700	0	90%	0.63	1	700	400	400	-10%
041_02	Horse Wallow	2	540	Drummond willow	87%	0.82	1	500	400	80%	1.25	1	500	600	200	-7%
041_02	Horse Wallow	3	150	Drummond willow	87%	0.82	1	200	200	0%	6.27	1	200	1,000	800	-87%
041_02	Horse Wallow	4	420	Drummond willow	87%	0.82	1	400	300	70%	1.88	1	400	800	500	-17%
041_02	Horse Wallow	5	400	Drummond willow	76%	1.50	2	800	1,000	80%	1.25	2	800	1,000	0	0%
041_02	Horse Wallow	6	310	Drummond willow	76%	1.50	2	600	900	70%	1.88	2	600	1,000	100	-6%
041_02	Horse Wallow	7	130	Drummond willow	76%	1.50	2	300	500	60%	2.51	2	300	800	300	-16%
041_02	Horse Wallow	8	680	sage/grass	39%	3.82	2	1,000	4,000	40%	3.76	2	1,000	4,000	0	0%
041_02	trib to Horse Wallow	1	680	dry DF w/o Ppine	94%	0.38	1	700	300	90%	0.63	1	700	400	100	-4%
041_02	trib to Horse Wallow	2	500	Drummond willow	87%	0.82	1	500	400	80%	1.25	1	500	600	200	-7%
041_02	trib to Horse Wallow	3	280	Drummond willow	87%	0.82	1	300	200	70%	1.88	1	300	600	400	-17%
041_02	trib to Horse Wallow	4	240	sage/grass	65%	2.19	1	200	400	50%	3.14	1	200	600	200	-15%
							Totals		170,000					190,000	18,000	

Table C-6. Existing and target solar loads for 2nd-order North Fork Big Lost River (ID17040218SK027_02).

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
027_02	1st trib to NF	1	450	grass	55%	2.82	1	500	1,000	50%	3.14	1	500	2,000	1,000	-5%
027_02	1st trib to NF	2	1200	subalpine fir/moist	96%	0.25	1	1,000	300	90%	0.63	1	1,000	600	300	-6%
027_02	2nd trib to NF	1	680	rock/bare/ephemeral	0%	6.27	1	700	4,000	0%	6.27	1	700	4,000	0	0%
027_02	2nd trib to NF	2	370	grass	55%	2.82	1	400	1,000	50%	3.14	1	400	1,000	0	-5%
027_02	2nd trib to NF	3	730	subalpine fir/WBP	100%	0.00	1	700	0	90%	0.63	1	700	400	400	-10%
027_02	2nd trib to NF	4	1400	subalpine fir/moist	96%	0.25	1	1,000	300	90%	0.63	1	1,000	600	300	-6%
027_02	Hunter Creek	1	510	rock/bare/ephemeral	0%	6.27	1	500	3,000	0%	6.27	1	500	3,000	0	0%
027_02	Hunter Creek	2	170	grass	55%	2.82	1	200	600	50%	3.14	1	200	600	0	-5%
027_02	Hunter Creek	3	280	subalpine fir/WBP	100%	0.00	1	300	0	90%	0.63	1	300	200	200	-10%
027_02	Hunter Creek	4	64	grass	55%	2.82	1	60	200	70%	1.88	1	60	100	(100)	0%
027_02	Hunter Creek	5	2000	dry DF w/o Ppine	94%	0.38	2	4,000	2,000	90%	0.63	2	4,000	3,000	1,000	-4%
027_02	Hunter Creek	6	2100	dry DF w/o Ppine	92%	0.50	3	6,000	3,000	90%	0.63	3	6,000	4,000	1,000	-2%
027_02	Blind Creek	1	550	grass	55%	2.82	1	600	2,000	50%	3.14	1	600	2,000	0	-5%
027_02	Blind Creek	2	1200	Drummond willow	87%	0.82	1	1,000	800	70%	1.88	1	1,000	2,000	1,000	-17%
027_02	Blind Creek	3	390	DF/lodgepole-steep	98%	0.13	1	400	50	90%	0.63	1	400	300	300	-8%
027_02	Blind Creek	4	640	Drummond willow	45%	3.45	4	3,000	10,000	70%	1.88	4	3,000	6,000	(4,000)	0%
027_02	tribs to Blind	1	1400	grass	55%	2.82	1	1,000	3,000	50%	3.14	1	1,000	3,000	0	-5%
027_02	tribs to Blind	2	1200	subalpine fir/DF	100%	0.00	1	1,000	0	90%	0.63	1	1,000	600	600	-10%
027_02	tribs to Blind	3	450	rock/bare/ephemeral	0%	6.27	1	500	3,000	0%	6.27	1	500	3,000	0	0%
027_02	tribs to Blind	4	310	grass	55%	2.82	1	300	800	50%	3.14	1	300	900	100	-5%
027_02	tribs to Blind	5	1100	subalpine fir/DF	100%	0.00	1	1,000	0	90%	0.63	1	1,000	600	600	-10%
027_02	tribs to Blind	6	190	DF/lodgepole-gentle	100%	0.00	2	400	0	90%	0.63	2	400	300	300	-10%
027_02	tribs to Blind	7	260	Drummond willow	76%	1.50	2	500	800	60%	2.51	2	500	1,000	200	-16%
027_02	tribs to Blind	8	440	subalpine fir/moist	96%	0.25	2	900	200	80%	1.25	2	900	1,000	800	-16%
027_02	tribs to Blind	9	360	grass	55%	2.82	1	400	1,000	50%	3.14	1	400	1,000	0	-5%
027_02	tribs to Blind	10	460	Drummond willow	87%	0.82	1	500	400	80%	1.25	1	500	600	200	-7%
027_02	tribs to Blind	11	890	subalpine fir/DF	100%	0.00	2	2,000	0	90%	0.63	2	2,000	1,000	1,000	-10%
027_02	tribs to Blind	12	490	dry DF w/o Ppine	92%	0.50	3	1,000	500	70%	1.88	3	1,000	2,000	2,000	-22%
027_02	tribs to Blind	13	580	lemon willow	35%	4.08	3	2,000	8,000	50%	3.14	3	2,000	6,000	(2,000)	0%
027_02	tribs to Blind	14	1400	rock/bare/ephemeral	0%	6.27	1	1,000	6,000	0%	6.27	1	1,000	6,000	0	0%
027_02	tribs to Blind	15	220	grass	55%	2.82	1	200	600	50%	3.14	1	200	600	0	-5%
027_02	tribs to Blind	16	200	subalpine fir/DF	100%	0.00	1	200	0	90%	0.63	1	200	100	100	-10%
027_02	tribs to Blind	17	140	rock/bare/ephemeral	10%	5.64	1	100	600	10%	5.64	1	100	600	0	0%
027_02	tribs to Blind	18	190	grass	31%	4.33	2	400	2,000	30%	4.39	2	400	2,000	0	-1%
027_02	tribs to Blind	19	1700	subalpine fir/moist	96%	0.25	2	3,000	800	90%	0.63	2	3,000	2,000	1,000	-6%
027_02	tribs to Blind	20	290	beaver ponds	0%	6.27	4	1,000	6,000	0%	6.27	4	1,000	6,000	0	0%
027_02	tribs to Blind	21	310	lemon willow	27%	4.58	4	1,000	5,000	40%	3.76	4	1,000	4,000	(1,000)	0%
027_02	tribs to Blind	22	1200	lemon willow	27%	4.58	4	5,000	20,000	30%	4.39	4	5,000	20,000	0	0%
027_02	tribs to Blind	23	350	lemon willow	27%	4.58	4	1,000	5,000	60%	2.51	4	1,000	3,000	(2,000)	0%
027_02	tribs to Blind	24	500	lemon willow	27%	4.58	4	2,000	9,000	40%	3.76	4	2,000	8,000	(1,000)	0%

Table C-6 (cont.) Existing and target solar loads for 2nd-order North Fork Big Lost River (ID17040218SK027_02).

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
027_02	Bear Creek	1	580	grass	55%	2.82	1	600	2,000	50%	3.14	1	600	2,000	0	-5%
027_02	Bear Creek	2	580	subalpine fir/moist	96%	0.25	1	600	200	90%	0.63	1	600	400	200	-6%
027_02	Bear Creek	3	180	grass	55%	2.82	1	200	600	30%	4.39	1	200	900	300	-25%
027_02	Bear Creek	4	450	Drummond willow	87%	0.82	1	500	400	70%	1.88	1	500	900	500	-17%
027_02	Bear Creek	5	670	subalpine fir/dry-steep	99%	0.06	2	1,000	60	90%	0.63	2	1,000	600	500	-9%
027_02	Bear Creek	6	460	Drummond willow	76%	1.50	2	900	1,000	80%	1.25	2	900	1,000	0	0%
027_02	Bear Creek	7	820	DF/lodgepole-gentle	100%	0.00	2	2,000	0	90%	0.63	2	2,000	1,000	1,000	-10%
027_02	Bear Creek	8	250	Drummond willow	76%	1.50	2	500	800	80%	1.25	2	500	600	(200)	0%
027_02	Bear Creek	9	80	Drummond willow	76%	1.50	2	200	300	70%	1.88	2	200	400	100	-6%
027_02	6th trib to NF	1	1100	sage/grass	65%	2.19	1	1,000	2,000	60%	2.51	1	1,000	3,000	1,000	-5%
027_02	6th trib to NF	2	350	aspen	100%	0.00	1	400	0	80%	1.25	1	400	500	500	-20%
027_02	6th trib to NF	3	330	sage/grass	65%	2.19	1	300	700	20%	5.02	1	300	2,000	1,000	-45%
027_02	6th trib to NF	4	54	beaver ponds	0%	6.27	1	50	300	0%	6.27	1	50	300	0	0%
027_02	Squib Canyon	1	460	grass	55%	2.82	1	500	1,000	50%	3.14	1	500	2,000	1,000	-5%
027_02	Squib Canyon	2	400	Drummond willow	87%	0.82	1	400	300	80%	1.25	1	400	500	200	-7%
027_02	Squib Canyon	3	240	grass	55%	2.82	1	200	600	50%	3.14	1	200	600	0	-5%
027_02	Squib Canyon	4	250	Drummond willow	87%	0.82	1	300	200	80%	1.25	1	300	400	200	-7%
027_02	Squib Canyon	5	190	Drummond willow	87%	0.82	1	200	200	30%	4.39	1	200	900	700	-57%
027_02	Squib Canyon	6	110	dry DF w/o Ppine	94%	0.38	1	100	40	80%	1.25	1	100	100	60	-14%
027_02	Squib Canyon	7	87	Drummond willow	87%	0.82	1	90	70	30%	4.39	1	90	400	300	-57%
027_02	Squib Canyon	8	180	dry DF w/o Ppine	94%	0.38	2	400	200	80%	1.25	2	400	500	300	-14%
027_02	Squib Canyon	9	180	Drummond willow	76%	1.50	2	400	600	30%	4.39	2	400	2,000	1,000	-46%
027_02	Squib Canyon	10	220	dry DF w/o Ppine	94%	0.38	2	400	200	80%	1.25	2	400	500	300	-14%
027_02	Squib Canyon	11	1100	dry DF w/o Ppine	94%	0.38	2	2,000	800	90%	0.63	2	2,000	1,000	200	-4%
027_02	Squib Canyon	12	290	Drummond willow	76%	1.50	2	600	900	60%	2.51	2	600	2,000	1,000	-16%
027_02	8th trib to NF	1	1400	sage/grass	65%	2.19	1	1,000	2,000	60%	2.51	1	1,000	3,000	1,000	-5%
027_02	8th trib to NF	2	280	sage/grass	65%	2.19	1	300	700	40%	3.76	1	300	1,000	300	-25%
027_02	Glide Canyon	1	230	grass	55%	2.82	1	200	600	50%	3.14	1	200	600	0	-5%
027_02	Glide Canyon	2	200	dry DF w/o Ppine	94%	0.38	1	200	80	80%	1.25	1	200	300	200	-14%
027_02	Glide Canyon	3	340	sage/grass	65%	2.19	1	300	700	40%	3.76	1	300	1,000	300	-25%
027_02	Glide Canyon	4	830	dry DF w/o Ppine	94%	0.38	1	800	300	90%	0.63	1	800	500	200	-4%
027_02	Glide Canyon	5	480	dry DF w/o Ppine	94%	0.38	2	1,000	400	90%	0.63	2	1,000	600	200	-4%
027_02	Glide Canyon	6	240	Drummond willow	76%	1.50	2	500	800	40%	3.76	2	500	2,000	1,000	-36%
027_02	trib to Glide Canyon	1	340	sage/grass	65%	2.19	1	300	700	60%	2.51	1	300	800	100	-5%
027_02	trib to Glide Canyon	2	1600	dry DF w/o Ppine	94%	0.38	1	2,000	800	90%	0.63	1	2,000	1,000	200	-4%
027_02	Miller Canyon	1	260	grass	55%	2.82	1	300	800	50%	3.14	1	300	900	100	-5%
027_02	Miller Canyon	2	440	rock/bare/ephemeral	0%	6.27	1	400	3,000	0%	6.27	1	400	3,000	0	0%
027_02	Miller Canyon	3	500	grass	55%	2.82	1	500	1,000	50%	3.14	1	500	2,000	1,000	-5%
027_02	Miller Canyon	4	330	subalpine fir/moist	96%	0.25	1	300	80	90%	0.63	1	300	200	100	-6%
027_02	Miller Canyon	5	190	grass	55%	2.82	1	200	600	50%	3.14	1	200	600	0	-5%
027_02	Miller Canyon	6	470	Drummond willow	76%	1.50	2	900	1,000	80%	1.25	2	900	1,000	0	0%
027_02	Miller Canyon	7	530	DF/lodgepole-gentle	100%	0.00	2	1,000	0	90%	0.63	2	1,000	600	600	-10%
027_02	Miller Canyon	8	420	Drummond willow	76%	1.50	2	800	1,000	70%	1.88	2	800	2,000	1,000	-6%
027_02	Miller Canyon	9	2000	dry DF w/o Ppine	92%	0.50	3	6,000	3,000	70%	1.88	3	6,000	10,000	7,000	-22%
027_02	Miller Canyon	10	330	Drummond willow	56%	2.76	3	1,000	3,000	40%	3.76	3	1,000	4,000	1,000	-16%

Table C-6 (cont.) Existing and target solar loads for 2nd-order North Fork Big Lost River (ID17040218SK027_02).

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
027_02	trib to Miller Canyon	1	1700	grass	55%	2.82	1	2,000	6,000	50%	3.14	1	2,000	6,000	0	-5%
027_02	trib to Miller Canyon	2	460	DF/lodgepole-gentle	100%	0.00	1	500	0	90%	0.63	1	500	300	300	-10%
027_02	Park Canyon	1	930	grass	55%	2.82	1	900	3,000	50%	3.14	1	900	3,000	0	-5%
027_02	Park Canyon	2	1300	subalpine fir/moist	96%	0.25	1	1,000	300	90%	0.63	1	1,000	600	300	-6%
027_02	Park Canyon	3	630	dry DF w/o Ppine	94%	0.38	2	1,000	400	90%	0.63	2	1,000	600	200	-4%
027_02	Park Canyon	4	520	Drummond willow	76%	1.50	2	1,000	2,000	70%	1.88	2	1,000	2,000	0	-6%
027_02	Corral Creek	1	670	rock/bare/ephemeral	0%	6.27	1	700	4,000	0%	6.27	1	700	4,000	0	0%
027_02	Corral Creek	2	1000	grass	55%	2.82	1	1,000	3,000	50%	3.14	1	1,000	3,000	0	-5%
027_02	Corral Creek	3	410	sage/grass	65%	2.19	1	400	900	60%	2.51	1	400	1,000	100	-5%
027_02	Corral Creek	4	1200	DF/lodgepole-steep	98%	0.13	2	2,000	300	90%	0.63	2	2,000	1,000	700	-8%
027_02	Corral Creek	5	1000	dry DF w/o Ppine	94%	0.38	2	2,000	800	90%	0.63	2	2,000	1,000	200	-4%
027_02	Toolbox Creek	1	300	dry DF w/o Ppine	94%	0.38	1	300	100	90%	0.63	1	300	200	100	-4%
027_02	Toolbox Creek	2	340	grass	55%	2.82	1	300	800	50%	3.14	1	300	900	100	-5%
027_02	Toolbox Creek	3	190	dry DF w/o Ppine	94%	0.38	1	200	80	90%	0.63	1	200	100	20	-4%
027_02	Toolbox Creek	4	430	grass	55%	2.82	1	400	1,000	50%	3.14	1	400	1,000	0	-5%
027_02	Toolbox Creek	5	820	Drummond willow	76%	1.50	2	2,000	3,000	70%	1.88	2	2,000	4,000	1,000	-6%
027_02	Toolbox Creek	6	360	Drummond willow	76%	1.50	2	700	1,000	30%	4.39	2	700	3,000	2,000	-46%
027_02	Toolbox Creek	7	120	Drummond willow	76%	1.50	2	200	300	80%	1.25	2	200	300	0	0%
027_02	Chicken Creek	1	76	sage/grass	65%	2.19	1	80	200	60%	2.51	1	80	200	0	-5%
027_02	Chicken Creek	2	300	Drummond willow	87%	0.82	1	300	200	80%	1.25	1	300	400	200	-7%
027_02	Chicken Creek	3	83	Drummond willow	87%	0.82	1	80	70	30%	4.39	1	80	400	300	-57%
027_02	Chicken Creek	4	360	Drummond willow	87%	0.82	1	400	300	80%	1.25	1	400	500	200	-7%
027_02	Chicken Creek	5	110	Drummond willow	87%	0.82	1	100	80	50%	3.14	1	100	300	200	-37%
027_02	Chicken Creek	6	280	Drummond willow	87%	0.82	1	300	200	80%	1.25	1	300	400	200	-7%
027_02	Chicken Creek	7	84	Drummond willow	87%	0.82	1	80	70	40%	3.76	1	80	300	200	-47%
027_02	Chicken Creek	8	130	Drummond willow	87%	0.82	1	100	80	70%	1.88	1	100	200	100	-17%
027_02	Chicken Creek	9	150	sage/grass	65%	2.19	1	200	400	30%	4.39	1	200	900	500	-35%
027_02	Chicken Creek	10	190	Drummond willow	87%	0.82	1	200	200	70%	1.88	1	200	400	200	-17%
027_02	Chicken Creek	11	110	sage/grass	39%	3.82	2	200	800	50%	3.14	2	200	600	(200)	0%
027_02	Chicken Creek	12	1200	Drummond willow	76%	1.50	2	2,000	3,000	70%	1.88	2	2,000	4,000	1,000	-6%
027_02	Chicken Creek	13	740	Drummond willow	76%	1.50	2	1,000	2,000	80%	1.25	2	1,000	1,000	(1,000)	0%
027_02	Chicken Creek	14	730	Drummond willow	56%	2.76	3	2,000	6,000	70%	1.88	3	2,000	4,000	(2,000)	0%
027_02	Chicken Creek	15	85	Drummond willow	56%	2.76	3	300	800	40%	3.76	3	300	1,000	200	-16%
027_02	Chicken Creek	16	380	Drummond willow	56%	2.76	3	1,000	3,000	30%	4.39	3	1,000	4,000	1,000	-26%
027_02	Chicken Creek	17	73	Drummond willow	56%	2.76	3	200	600	70%	1.88	3	200	400	(200)	0%
027_02	Chicken Creek	18	380	sage/grass	27%	4.58	3	1,000	5,000	20%	5.02	3	1,000	5,000	0	-7%
027_02	trib to Chicken	1	630	sage/grass	65%	2.19	1	600	1,000	60%	2.51	1	600	2,000	1,000	-5%
027_02	trib to Chicken	2	670	dry DF w/o Ppine	94%	0.38	1	700	300	90%	0.63	1	700	400	100	-4%
027_02	trib to Chicken	3	320	Drummond willow	87%	0.82	1	300	200	80%	1.25	1	300	400	200	-7%
027_02	14th trib to NF	1	450	grass	55%	2.82	1	500	1,000	50%	3.14	1	500	2,000	1,000	-5%
027_02	14th trib to NF	2	1000	DF/lodgepole-steep	98%	0.13	1	1,000	100	90%	0.63	1	1,000	600	500	-8%
027_02	14th trib to NF	3	670	Drummond willow	87%	0.82	1	700	600	80%	1.25	1	700	900	300	-7%
027_02	Zipper Creek	1	760	sage/grass	65%	2.19	1	800	2,000	60%	2.51	1	800	2,000	0	-5%
027_02	Zipper Creek	2	400	aspen	100%	0.00	1	400	0	80%	1.25	1	400	500	500	-20%
027_02	Zipper Creek	3	310	Drummond willow	87%	0.82	1	300	200	80%	1.25	1	300	400	200	-7%

Table C-6 (cont.) Existing and target solar loads for 2nd-order North Fork Big Lost River (ID17040218SK027_02).

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
027_02	Horse Creek	1	1500	sage/grass	65%	2.19	1	2,000	4,000	60%	2.51	1	2,000	5,000	1,000	-5%
027_02	Horse Creek	2	550	Drummond willow	76%	1.50	2	1,000	2,000	80%	1.25	2	1,000	1,000	(1,000)	0%
027_02	Horse Creek	3	440	Drummond willow	76%	1.50	2	900	1,000	60%	2.51	2	900	2,000	1,000	-16%
027_02	Horse Creek	4	58	Drummond willow	76%	1.50	2	100	200	30%	4.39	2	100	400	200	-46%
027_02	Horse Creek	5	560	Drummond willow	76%	1.50	2	1,000	2,000	60%	2.51	2	1,000	3,000	1,000	-16%
027_02	Horse Creek	6	330	Drummond willow	76%	1.50	2	700	1,000	30%	4.39	2	700	3,000	2,000	-46%
027_02	Horse Creek	7	56	sage/grass	39%	3.82	2	100	400	20%	5.02	2	100	500	100	-19%
027_02	17th trib to NF	1	270	Drummond willow	87%	0.82	1	300	200	50%	3.14	1	300	900	700	-37%
027_02	17th trib to NF	2	450	aspen	100%	0.00	1	500	0	80%	1.25	1	500	600	600	-20%
027_02	17th trib to NF	3	760	Drummond willow	87%	0.82	1	800	700	50%	3.14	1	800	3,000	2,000	-37%
027_02	17th trib to NF	4	320	Drummond willow	87%	0.82	1	300	200	70%	1.88	1	300	600	400	-17%
027_02	Little Burnt Creek	1	1100	subalpine fir/dry-steep	99%	0.06	1	1,000	60	90%	0.63	1	1,000	600	500	-9%
027_02	Little Burnt Creek	2	100	grass	55%	2.82	1	100	300	50%	3.14	1	100	300	0	-5%
027_02	Little Burnt Creek	3	540	DF/lodgepole-steep	98%	0.13	1	500	60	90%	0.63	1	500	300	200	-8%
027_02	Little Burnt Creek	4	740	Drummond willow	76%	1.50	2	1,000	2,000	80%	1.25	2	1,000	1,000	(1,000)	0%
027_02	Little Burnt Creek	5	120	Drummond willow	76%	1.50	2	200	300	60%	2.51	2	200	500	200	-16%
027_02	Little Burnt Creek	6	1000	Drummond willow	76%	1.50	2	2,000	3,000	70%	1.88	2	2,000	4,000	1,000	-6%
027_02	Little Burnt Creek	7	150	Drummond willow	76%	1.50	2	300	500	50%	3.14	2	300	900	400	-26%
027_02	Little Burnt Creek	8	47	Drummond willow	76%	1.50	2	90	100	70%	1.88	2	90	200	100	-6%
027_02	Little Burnt Creek	9	50	beaver ponds	0%	6.27	2	100	600	0%	6.27	2	100	600	0	0%
027_02	Little Burnt Creek	10	48	Drummond willow	76%	1.50	2	100	200	30%	4.39	2	100	400	200	-46%
027_02	Grasshopper Creek	1	1500	grass	55%	2.82	1	2,000	6,000	50%	3.14	1	2,000	6,000	0	-5%
027_02	Grasshopper Creek	2	490	Drummond willow	87%	0.82	1	500	400	60%	2.51	1	500	1,000	600	-27%
027_02	Grasshopper Creek	3	560	grass	31%	4.33	2	1,000	4,000	50%	3.14	2	1,000	3,000	(1,000)	0%
027_02	Grasshopper Creek	4	2200	sage/grass	39%	3.82	2	4,000	20,000	40%	3.76	2	4,000	20,000	0	0%
027_02	Grasshopper Creek	5	1500	Drummond willow	56%	2.76	3	5,000	10,000	70%	1.88	3	5,000	9,000	(1,000)	0%
027_02	Grasshopper Creek	6	100	sage/grass	27%	4.58	3	300	1,000	30%	4.39	3	300	1,000	0	0%
027_02	Grasshopper Creek	7	100	Drummond willow	56%	2.76	3	300	800	70%	1.88	3	300	600	(200)	0%
027_02	Grasshopper Creek	8	200	sage/grass	27%	4.58	3	600	3,000	20%	5.02	3	600	3,000	0	-7%
027_02	Grasshopper Creek	9	300	Drummond willow	56%	2.76	3	900	2,000	70%	1.88	3	900	2,000	0	0%
027_02	tribs to Grasshopper	1	430	sage/grass	65%	2.19	1	400	900	60%	2.51	1	400	1,000	100	-5%
027_02	tribs to Grasshopper	2	190	Drummond willow	87%	0.82	1	200	200	80%	1.25	1	200	300	100	-7%
027_02	tribs to Grasshopper	3	200	Drummond willow	87%	0.82	1	200	200	70%	1.88	1	200	400	200	-17%
027_02	tribs to Grasshopper	4	60	Drummond willow	87%	0.82	1	60	50	30%	4.39	1	60	300	300	-57%
027_02	tribs to Grasshopper	5	330	Drummond willow	87%	0.82	1	300	200	80%	1.25	1	300	400	200	-7%
027_02	tribs to Grasshopper	6	240	Drummond willow	87%	0.82	1	200	200	30%	4.39	1	200	900	700	-57%
027_02	tribs to Grasshopper	7	690	Drummond willow	76%	1.50	2	1,000	2,000	70%	1.88	2	1,000	2,000	0	-6%
027_02	tribs to Grasshopper	8	450	grass	31%	4.33	2	900	4,000	30%	4.39	2	900	4,000	0	-1%
027_02	tribs to Grasshopper	9	500	sage/grass	39%	3.82	2	1,000	4,000	30%	4.39	2	1,000	4,000	0	-9%
027_02	tribs to Grasshopper	10	160	grass	31%	4.33	2	300	1,000	30%	4.39	2	300	1,000	0	-1%
027_02	tribs to Grasshopper	11	250	Drummond willow	76%	1.50	2	500	800	50%	3.14	2	500	2,000	1,000	-26%
027_02	tribs to Grasshopper	12	190	sage/grass	65%	2.19	1	200	400	60%	2.51	1	200	500	100	-5%
027_02	tribs to Grasshopper	13	270	Drummond willow	87%	0.82	1	300	200	80%	1.25	1	300	400	200	-7%
027_02	tribs to Grasshopper	14	1400	sage/grass	65%	2.19	1	1,000	2,000	60%	2.51	1	1,000	3,000	1,000	-5%
027_02	tribs to Grasshopper	15	94	Drummond willow	87%	0.82	1	90	70	80%	1.25	1	90	100	30	-7%

Table C-6 (cont.) Existing and target solar loads for 2nd-order North Fork Big Lost River (ID17040218SK027_02).

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
027_02	Bartlett Creek	1	170	grass	55%	2.82	1	200	600	50%	3.14	1	200	600	0	-5%
027_02	Bartlett Creek	2	570	subalpine fir/moist	96%	0.25	1	600	200	90%	0.63	1	600	400	200	-6%
027_02	Bartlett Creek	3	130	grass	55%	2.82	1	100	300	50%	3.14	1	100	300	0	-5%
027_02	Bartlett Creek	4	260	grass	55%	2.82	1	300	800	70%	1.88	1	300	600	(200)	0%
027_02	Bartlett Creek	5	330	subalpine fir/moist	96%	0.25	1	300	80	90%	0.63	1	300	200	100	-6%
027_02	Bartlett Creek	6	370	grass	55%	2.82	1	400	1,000	50%	3.14	1	400	1,000	0	-5%
027_02	Bartlett Creek	7	1300	DF/lodgepole-steep	98%	0.13	2	3,000	400	90%	0.63	2	3,000	2,000	2,000	-8%
027_02	Bartlett Creek	8	430	Drummond willow	76%	1.50	2	900	1,000	80%	1.25	2	900	1,000	0	0%
027_02	Bartlett Creek	9	100	Drummond willow	76%	1.50	2	200	300	50%	3.14	2	200	600	300	-26%
027_02	Bartlett Creek	10	920	DF/lodgepole-steep	98%	0.13	3	3,000	400	90%	0.63	3	3,000	2,000	2,000	-8%
027_02	Bartlett Creek	11	940	Drummond willow	56%	2.76	3	3,000	8,000	80%	1.25	3	3,000	4,000	(4,000)	0%
027_02	Bartlett Creek	12	290	Drummond willow	56%	2.76	3	900	2,000	50%	3.14	3	900	3,000	1,000	-6%
027_02	Bartlett Creek	13	190	Drummond willow	56%	2.76	3	600	2,000	20%	5.02	3	600	3,000	1,000	-36%
027_02	last trib to NF	1	2100	DF/lodgepole-steep	98%	0.13	1	2,000	300	90%	0.63	1	2,000	1,000	700	-8%
027_02	last trib to NF	2	130	Drummond willow	76%	1.50	2	300	500	60%	2.51	2	300	800	300	-16%
027_02	last trib to NF	3	74	Drummond willow	76%	1.50	2	100	200	30%	4.39	2	100	400	200	-46%
027_02	last trib to NF	4	150	Drummond willow	76%	1.50	2	300	500	80%	1.25	2	300	400	(100)	0%
027_02	NF Big Lost River	1	880	rock/bare/ephemeral	0%	6.27	1	900	6,000	0%	6.27	1	900	6,000	0	0%
027_02	NF Big Lost River	2	290	grass	55%	2.82	1	300	800	60%	2.51	1	300	800	0	0%
027_02	NF Big Lost River	3	320	subalpine fir/WBP	100%	0.00	1	300	0	90%	0.63	1	300	200	200	-10%
027_02	NF Big Lost River	4	330	grass	55%	2.82	1	300	800	60%	2.51	1	300	800	0	0%
027_02	NF Big Lost River	5	430	subalpine fir/moist	96%	0.25	2	900	200	90%	0.63	2	900	600	400	-6%
027_02	NF Big Lost River	6	310	grass	31%	4.33	2	600	3,000	50%	3.14	2	600	2,000	(1,000)	0%
027_02	NF Big Lost River	7	860	subalpine fir/DF	100%	0.00	2	2,000	0	90%	0.63	2	2,000	1,000	1,000	-10%
027_02	NF Big Lost River	8	970	subalpine fir/moist	95%	0.31	3	3,000	900	90%	0.63	3	3,000	2,000	1,000	-5%
027_02	NF Big Lost River	9	1300	subalpine fir/moist	95%	0.31	3	4,000	1,000	80%	1.25	3	4,000	5,000	4,000	-15%
027_02	NF Big Lost River	10	250	subalpine fir/moist	93%	0.44	4	1,000	400	90%	0.63	4	1,000	600	200	-3%
027_02	NF Big Lost River	11	1500	Drummond willow	45%	3.45	4	6,000	20,000	80%	1.25	4	6,000	8,000	(10,000)	0%
							Totals		320,000					370,000	48,000	

Table C-7. Existing and target solar loads for 3rd-order North Fork Big Lost River (ID17040218SK027_03).

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
027_03	NF Big Lost River	1	1000	Drummond willow	33%	4.20	6	6,000	30,000	60%	2.51	6	6,000	20,000	(10,000)	0%
027_03	NF Big Lost River	2	240	Drummond willow	33%	4.20	6	1,000	4,000	30%	4.39	6	1,000	4,000	0	-3%
027_03	NF Big Lost River	3	200	Drummond willow	33%	4.20	6	1,000	4,000	10%	5.64	6	1,000	6,000	2,000	-23%
027_03	NF Big Lost River	4	81	Drummond willow	33%	4.20	6	500	2,000	30%	4.39	6	500	2,000	0	-3%
027_03	NF Big Lost River	5	210	Drummond willow	33%	4.20	6	1,000	4,000	20%	5.02	6	1,000	5,000	1,000	-13%
027_03	NF Big Lost River	6	500	Drummond willow	33%	4.20	6	3,000	10,000	10%	5.64	6	3,000	20,000	10,000	-23%
027_03	NF Big Lost River	7	440	Drummond willow	33%	4.20	6	3,000	10,000	20%	5.02	6	3,000	20,000	10,000	-13%
027_03	NF Big Lost River	8	870	Drummond willow	33%	4.20	6	5,000	20,000	30%	4.39	6	5,000	20,000	0	-3%
027_03	NF Big Lost River	9	830	Drummond willow	33%	4.20	6	5,000	20,000	20%	5.02	6	5,000	30,000	10,000	-13%
027_03	NF Big Lost River	10	2200	Drummond willow	29%	4.45	7	20,000	90,000	10%	5.64	7	20,000	100,000	10,000	-19%
027_03	NF Big Lost River	11	150	Drummond willow	29%	4.45	7	1,000	4,000	0%	6.27	7	1,000	6,000	2,000	-29%
027_03	NF Big Lost River	12	680	Drummond willow	29%	4.45	7	5,000	20,000	30%	4.39	7	5,000	20,000	0	0%
027_03	NF Big Lost River	13	1250	Drummond willow	29%	4.45	7	9,000	40,000	0%	6.27	7	9,000	60,000	20,000	-29%
027_03	NF Big Lost River	14	240	Drummond willow	26%	4.64	8	2,000	9,000	0%	6.27	8	2,000	10,000	1,000	-26%
027_03	NF Big Lost River	15	160	Drummond willow	26%	4.64	8	1,000	5,000	20%	5.02	8	1,000	5,000	0	-6%
027_03	NF Big Lost River	16	1200	Drummond willow	26%	4.64	8	10,000	50,000	0%	6.27	8	10,000	60,000	10,000	-26%
027_03	NF Big Lost River	17	410	Drummond willow	26%	4.64	8	3,000	10,000	10%	5.64	8	3,000	20,000	10,000	-16%
027_03	NF Big Lost River	18	350	Drummond willow	26%	4.64	8	3,000	10,000	0%	6.27	8	3,000	20,000	10,000	-26%
027_03	NF Big Lost River	19	150	Drummond willow	26%	4.64	8	1,000	5,000	10%	5.64	8	1,000	6,000	1,000	-16%
027_03	NF Big Lost River	20	780	Drummond willow	26%	4.64	8	6,000	30,000	0%	6.27	8	6,000	40,000	10,000	-26%
027_03	NF Big Lost River	21	430	Drummond willow	26%	4.64	8	3,000	10,000	10%	5.64	8	3,000	20,000	10,000	-16%
027_03	NF Big Lost River	22	340	Drummond willow	26%	4.64	8	3,000	10,000	0%	6.27	8	3,000	20,000	10,000	-26%
027_03	NF Big Lost River	23	540	Drummond willow	23%	4.83	9	5,000	20,000	10%	5.64	9	5,000	30,000	10,000	-13%
027_03	NF Big Lost River	24	260	Drummond willow	23%	4.83	9	2,000	10,000	0%	6.27	9	2,000	10,000	0	-23%
027_03	NF Big Lost River	25	410	Drummond willow	23%	4.83	9	4,000	20,000	10%	5.64	9	4,000	20,000	0	-13%
027_03	NF Big Lost River	26	890	Drummond willow	23%	4.83	9	8,000	40,000	0%	6.27	9	8,000	50,000	10,000	-23%
027_03	NF Big Lost River	27	64	Drummond willow	23%	4.83	9	600	3,000	10%	5.64	9	600	3,000	0	-13%
027_03	NF Big Lost River	28	1300	Drummond willow	23%	4.83	9	10,000	50,000	0%	6.27	9	10,000	60,000	10,000	-23%
027_03	NF Big Lost River	29	190	Drummond willow	23%	4.83	9	2,000	10,000	10%	5.64	9	2,000	10,000	0	-13%
027_03	NF Big Lost River	30	1400	Drummond willow	23%	4.83	9	10,000	50,000	0%	6.27	9	10,000	60,000	10,000	-23%
027_03	NF Big Lost River	31	1400	Drummond willow	21%	4.95	10	14,000	69,000	0%	6.27	10	14,000	88,000	19,000	-21%
027_03	NF Big Lost River	32	100	Drummond willow	21%	4.95	10	1,000	5,000	10%	5.64	10	1,000	5,600	600	-11%
027_03	NF Big Lost River	33	560	Drummond willow	21%	4.95	10	5,600	28,000	0%	6.27	10	5,600	35,000	7,000	-21%
027_03	NF Big Lost River	34	130	Drummond willow	21%	4.95	10	1,300	6,400	10%	5.64	10	1,300	7,300	900	-11%
027_03	NF Big Lost River	35	480	Drummond willow	21%	4.95	10	4,800	24,000	0%	6.27	10	4,800	30,000	6,000	-21%
027_03	NF Big Lost River	36	490	Drummond willow	21%	4.95	10	4,900	24,000	10%	5.64	10	4,900	28,000	4,000	-11%
027_03	NF Big Lost River	37	260	Drummond willow	21%	4.95	10	2,600	13,000	0%	6.27	10	2,600	16,000	3,000	-21%
027_03	NF Big Lost River	38	420	Drummond willow	21%	4.95	10	4,200	21,000	10%	5.64	10	4,200	24,000	3,000	-11%
							Totals		790,000					990,000	200,000	

Table C-8. Existing and target solar loads for 2nd-order Star Hope Creek (ID17040218SK035_02).

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
035_02	Bellas Canyon	1	140	subalpine fir/moist	98%	0.13	1	100	10	90%	0.63	1	100	60	50	-8%
035_02	Bellas Canyon	2	220	grass	55%	2.82	1	200	600	50%	3.14	1	200	600	0	-5%
035_02	Bellas Canyon	3	190	subalpine fir/moist	96%	0.25	1	200	50	80%	1.25	1	200	300	300	-16%
035_02	Bellas Canyon	4	400	grass	55%	2.82	1	400	1,000	50%	3.14	1	400	1,000	0	-5%
035_02	Bellas Canyon	5	1840	subalpine fir/moist	96%	0.25	2	4,000	1,000	90%	0.63	2	4,000	3,000	2,000	-6%
035_02	Bellas Canyon	6	1180	dry DF w/o Ppine	92%	0.50	3	4,000	2,000	90%	0.63	3	4,000	3,000	1,000	-2%
035_02	Bellas Canyon	7	290	dry DF w/o Ppine	92%	0.50	3	900	500	80%	1.25	3	900	1,000	500	-12%
035_02	Bellas Canyon	8	410	lemon willow	35%	4.08	3	1,000	4,000	50%	3.14	3	1,000	3,000	(1,000)	0%
035_02	Howell Canyon	1	1300	rock/bare/ephemeral	0%	6.27	1	1,000	6,000	0%	6.27	1	1,000	6,000	0	0%
035_02	Howell Canyon	2	2100	DF/lodgepole-gentle	100%	0.00	1	2,000	0	90%	0.63	1	2,000	1,000	1,000	-10%
035_02	Howell Canyon	3	180	beaver ponds	60%	2.51	2	400	1,000	60%	2.51	2	400	1,000	0	0%
035_02	Howell Canyon	4	320	lemon willow	49%	3.20	2	600	2,000	80%	1.25	2	600	800	(1,000)	0%
035_02	Howell Canyon	5	280	beaver ponds	60%	2.51	2	600	2,000	60%	2.51	2	600	2,000	0	0%
035_02	Howell Canyon	6	600	lemon willow	49%	3.20	2	1,000	3,000	60%	2.51	2	1,000	3,000	0	0%
035_02	un-named trib	1	700	sage/grass	65%	2.19	1	700	2,000	50%	3.14	1	700	2,000	0	-15%
035_02	un-named trib	2	1300	grass	55%	2.82	1	1,000	3,000	30%	4.39	1	1,000	4,000	1,000	-25%
035_02	un-named trib	3	840	sage/grass	39%	3.82	2	2,000	8,000	40%	3.76	2	2,000	8,000	0	0%
035_02	Ramey Creek	1	560	grass	55%	2.82	1	600	2,000	50%	3.14	1	600	2,000	0	-5%
035_02	Ramey Creek	2	220	subalpine fir/moist	96%	0.25	1	200	50	90%	0.63	1	200	100	50	-6%
035_02	Ramey Creek	3	930	grass/whitebark pine	80%	1.25	1	900	1,000	80%	1.25	1	900	1,000	0	0%
035_02	Ramey Creek	4	310	grass	55%	2.82	1	300	800	50%	3.14	1	300	900	100	-5%
035_02	Ramey Creek	5	1100	subalpine fir/WBP	100%	0.00	1	1,000	0	80%	1.25	1	1,000	1,000	1,000	-20%
035_02	Ramey Creek	6	760	Drummond willow	76%	1.50	2	2,000	3,000	70%	1.88	2	2,000	4,000	1,000	-6%
035_02	Ramey Creek	7	380	sage/grass	39%	3.82	2	800	3,000	30%	4.39	2	800	4,000	1,000	-9%
035_02	Ramey Creek	8	300	Drummond willow	76%	1.50	2	600	900	70%	1.88	2	600	1,000	100	-6%
035_02	Ramey Creek	9	43	Drummond willow	56%	2.76	3	100	300	30%	4.39	3	100	400	100	-26%
035_02	Ramey Creek	10	260	Drummond willow	56%	2.76	3	800	2,000	70%	1.88	3	800	2,000	0	0%
035_02	Ramey Creek	11	760	DF/lodgepole-gentle	99%	0.06	3	2,000	100	80%	1.25	3	2,000	3,000	3,000	-19%
035_02	Ramey Creek	12	810	lemon willow	35%	4.08	3	2,000	8,000	60%	2.51	3	2,000	5,000	(3,000)	0%
035_02	Ramey Creek	13	190	lemon willow	35%	4.08	3	600	2,000	0%	6.27	3	600	4,000	2,000	-35%
035_02	Ramey Creek	14	160	lemon willow	35%	4.08	3	500	2,000	40%	3.76	3	500	2,000	0	0%
035_02	1st to Ramey	1	700	rock/bare/ephemeral	0%	6.27	1	700	4,000	0%	6.27	1	700	4,000	0	0%
035_02	1st to Ramey	2	980	grass	55%	2.82	1	1,000	3,000	50%	3.14	1	1,000	3,000	0	-5%
035_02	1st to Ramey	3	190	Drummond willow	87%	0.82	1	200	200	80%	1.25	1	200	300	100	-7%
035_02	1st to Ramey	4	250	subalpine fir/WBP	99%	0.06	2	500	30	80%	1.25	2	500	600	600	-19%
035_02	1st to Ramey	5	150	grass	31%	4.33	2	300	1,000	50%	3.14	2	300	900	(100)	0%
035_02	1st to Ramey	6	320	subalpine fir/WBP	99%	0.06	2	600	40	80%	1.25	2	600	800	800	-19%
035_02	2nd to Ramey	1	1330	subalpine fir/WBP	100%	0.00	1	1,000	0	90%	0.63	1	1,000	600	600	-10%
035_02	2nd to Ramey	2	1320	subalpine fir/moist	96%	0.25	2	3,000	800	90%	0.63	2	3,000	2,000	1,000	-6%
035_02	2nd to Ramey	3	150	grass	31%	4.33	2	300	1,000	30%	4.39	2	300	1,000	0	-1%
035_02	2nd to Ramey	4	63	Drummond willow	76%	1.50	2	100	200	60%	2.51	2	100	300	100	-16%
035_02	un-named potholes	1	2800	sage/grass	65%	2.19	1	3,000	7,000	60%	2.51	1	3,000	8,000	1,000	-5%
035_02	un-named potholes	2	620	grass	55%	2.82	1	600	2,000	30%	4.39	1	600	3,000	1,000	-25%
035_02	un-named potholes	3	200	lemon willow	80%	1.25	1	200	300	60%	2.51	1	200	500	200	-20%
							Totals		81,000					95,000	15,000	

Table C-9. Existing and target solar loads for lower 4th-order Star Hope Creek (ID17040218SK035_04).

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
035_04	Star Hope Creek	1	55	lemon willow	12%	5.52	9	500	3,000	20%	5.02	14	800	4,000	1,000	0%
035_04	Star Hope Creek	2	150	lemon willow	12%	5.52	9	1,000	6,000	10%	5.64	14	2,000	10,000	4,000	-2%
035_04	Star Hope Creek	3	300	lemon willow	12%	5.52	9	3,000	20,000	10%	5.64	14	4,000	20,000	0	-2%
035_04	Star Hope Creek	4	350	lemon willow	12%	5.52	9	3,000	20,000	10%	5.64	14	5,000	30,000	10,000	-2%
035_04	Star Hope Creek	5	420	lemon willow	12%	5.52	9	4,000	20,000	0%	6.27	14	6,000	40,000	20,000	-12%
035_04	Star Hope Creek	6	150	lemon willow	12%	5.52	9	1,000	6,000	10%	5.64	14	2,000	10,000	4,000	-2%
035_04	Star Hope Creek	7	690	lemon willow	12%	5.52	9	6,000	30,000	0%	6.27	14	10,000	60,000	30,000	-12%
035_04	Star Hope Creek	8	240	lemon willow	12%	5.52	9	2,000	10,000	0%	6.27	14	3,000	20,000	10,000	-12%
035_04	Star Hope Creek	9	220	lemon willow	12%	5.52	9	2,000	10,000	10%	5.64	14	3,000	20,000	10,000	-2%
035_04	Star Hope Creek	10	200	lemon willow	12%	5.52	9	2,000	10,000	20%	5.02	14	3,000	20,000	10,000	0%
035_04	Star Hope Creek	11	140	lemon willow	12%	5.52	9	1,000	6,000	0%	6.27	14	2,000	10,000	4,000	-12%
035_04	Star Hope Creek	12	1100	lemon willow	12%	5.52	9	10,000	60,000	10%	5.64	14	20,000	100,000	40,000	-2%
035_04	Star Hope Creek	13	160	lemon willow	11%	5.58	10	1,600	8,900	0%	6.27	14	2,200	14,000	5,100	-11%
035_04	Star Hope Creek	14	270	lemon willow	11%	5.58	10	2,700	15,000	10%	5.64	14	3,800	21,000	6,000	-1%
035_04	Star Hope Creek	15	220	lemon willow	11%	5.58	10	2,200	12,000	10%	5.64	15	3,300	19,000	7,000	-1%
035_04	Star Hope Creek	16	350	lemon willow	11%	5.58	10	3,500	20,000	10%	5.64	15	5,300	30,000	10,000	-1%
035_04	Star Hope Creek	17	410	lemon willow	11%	5.58	10	4,100	23,000	10%	5.64	15	6,200	35,000	12,000	-1%
035_04	Star Hope Creek	18	570	lemon willow	11%	5.58	10	5,700	32,000	0%	6.27	15	8,600	54,000	22,000	-11%
035_04	Star Hope Creek	19	360	lemon willow	11%	5.58	10	3,600	20,000	10%	5.64	16	5,800	33,000	13,000	-1%
035_04	Star Hope Creek	20	1200	lemon willow	11%	5.58	10	12,000	67,000	0%	6.27	16	19,000	120,000	53,000	-11%
035_04	Star Hope Creek	21	110	lemon willow	11%	5.58	10	1,100	6,100	0%	6.27	17	1,900	12,000	5,900	-11%
035_04	Star Hope Creek	22	730	lemon willow	10%	5.64	11	8,000	45,000	0%	6.27	17	12,000	75,000	30,000	-10%
035_04	Star Hope Creek	23	260	lemon willow	10%	5.64	11	2,900	16,000	10%	5.64	17	4,400	25,000	9,000	0%
035_04	Star Hope Creek	24	1400	lemon willow	10%	5.64	11	15,000	85,000	0%	6.27	18	25,000	160,000	75,000	-10%
035_04	Star Hope Creek	25	190	lemon willow	10%	5.64	11	2,100	12,000	10%	5.64	19	3,600	20,000	8,000	0%
035_04	Star Hope Creek	26	1700	lemon willow	10%	5.64	11	19,000	110,000	0%	6.27	19	32,000	200,000	90,000	-10%
035_04	Star Hope Creek	27	270	lemon willow	10%	5.64	11	3,000	17,000	10%	5.64	20	5,400	30,000	13,000	0%
							Totals		690,000					1,200,000	500,000	

Table C-10. Existing and target solar loads for upper 4th-order Star Hope Creek (ID17040218SK036_04).

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
036_04	Star Hope Creek	1	110	beaver ponds	0%	6.27	5	600	4,000	0%	6.27	5	600	4,000	0	0%
036_04	Star Hope Creek	2	1400	lemon willow	22%	4.89	5	7,000	30,000	20%	5.02	5	7,000	40,000	10,000	-2%
036_04	Star Hope Creek	3	78	beaver ponds	0%	6.27	20	1,600	10,000	0%	6.27	20	1,600	10,000	0	0%
036_04	Star Hope Creek	4	180	lemon willow	18%	5.14	6	1,000	5,000	20%	5.02	7	1,000	5,000	0	0%
036_04	Star Hope Creek	5	360	lemon willow	18%	5.14	6	2,000	10,000	10%	5.64	7	3,000	20,000	10,000	-8%
036_04	Star Hope Creek	6	53	lemon willow	18%	5.14	6	300	2,000	0%	6.27	7	400	3,000	1,000	-18%
036_04	Star Hope Creek	7	180	beaver ponds	0%	6.27	16	2,900	18,000	0%	6.27	16	2,900	18,000	0	0%
036_04	Star Hope Creek	8	620	lemon willow	16%	5.27	7	4,000	20,000	10%	5.64	9	6,000	30,000	10,000	-6%
036_04	Star Hope Creek	9	210	lemon willow	16%	5.27	7	1,000	5,000	20%	5.02	9	2,000	10,000	5,000	0%
036_04	Star Hope Creek	10	67	lemon willow	16%	5.27	7	500	3,000	10%	5.64	9	600	3,000	0	-6%
036_04	Star Hope Creek	11	710	lemon willow	16%	5.27	7	5,000	30,000	20%	5.02	9	6,000	30,000	0	0%
036_04	Star Hope Creek	12	140	beaver ponds	0%	6.27	15	2,100	13,000	0%	6.27	15	2,100	13,000	0	0%
036_04	Star Hope Creek	13	890	lemon willow	14%	5.39	8	7,000	40,000	0%	6.27	11	10,000	60,000	20,000	-14%
036_04	Star Hope Creek	14	48	beaver ponds	0%	6.27	16	770	4,800	0%	6.27	16	770	4,800	0	0%
036_04	Star Hope Creek	15	400	lemon willow	12%	5.52	9	4,000	20,000	10%	5.64	13	5,000	30,000	10,000	-2%
036_04	Star Hope Creek	16	440	beaver ponds	0%	6.27	20	8,800	55,000	0%	6.27	20	8,800	55,000	0	0%
							Totals		270,000					340,000	66,000	

Table C-11. Existing and target solar loads for 2nd-order Summit Creek (ID17040218SK028_02).

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
028_02	Park Creek	1	1300	sage/grass	65%	2.19	1	1,000	2,000	60%	2.51	1	1,000	3,000	1,000	-5%
028_02	Park Creek	2	590	grass	31%	4.33	2	1,000	4,000	30%	4.39	2	1,000	4,000	0	-1%
028_02	Park Creek	3	96	Drummond willow	76%	1.50	2	200	300	70%	1.88	2	200	400	100	-6%
028_02	Park Creek	4	120	beaver ponds	0%	6.27	2	200	1,000	0%	6.27	2	200	1,000	0	0%
028_02	Park Creek	5	350	Drummond willow	76%	1.50	2	700	1,000	70%	1.88	2	700	1,000	0	-6%
028_02	Little Fall Creek	1	880	grass	55%	2.82	1	900	3,000	50%	3.14	1	900	3,000	0	-5%
028_02	Little Fall Creek	2	720	lemon willow	80%	1.25	1	700	900	70%	1.88	1	700	1,000	100	-10%
028_02	Little Fall Creek	3	220	lemon willow	80%	1.25	1	200	300	60%	2.51	1	200	500	200	-20%
028_02	Little Fall Creek	4	360	lemon willow	80%	1.25	1	400	500	50%	3.14	1	400	1,000	500	-30%
028_02	Little Fall Creek	5	450	grass	31%	4.33	2	900	4,000	30%	4.39	2	900	4,000	0	-1%
028_02	Little Fall Creek	6	1100	Drummond willow	76%	1.50	2	2,000	3,000	50%	3.14	2	2,000	6,000	3,000	-26%
028_02	Little Fall Creek	7	820	grass	31%	4.33	2	2,000	9,000	30%	4.39	2	2,000	9,000	0	-1%
028_02	Little Fall Creek	8	520	Drummond willow	56%	2.76	3	2,000	6,000	40%	3.76	3	2,000	8,000	2,000	-16%
028_02	Little Fall Creek	9	200	Drummond willow	56%	2.76	3	600	2,000	50%	3.14	3	600	2,000	0	-6%
028_02	Little Fall Creek	10	150	grass	21%	4.95	3	500	2,000	30%	4.39	3	500	2,000	0	0%
028_02	Little Fall Creek	11	190	Drummond willow	56%	2.76	3	600	2,000	50%	3.14	3	600	2,000	0	-6%
028_02	Little Fall Creek	12	620	dry DF w/o Ppine	92%	0.50	3	2,000	1,000	70%	1.88	3	2,000	4,000	3,000	-22%
028_02	Little Fall Creek	13	410	sage/grass	27%	4.58	3	1,000	5,000	20%	5.02	3	1,000	5,000	0	-7%
028_02	3rd trib to Summit	1	84	grass	55%	2.82	1	80	200	50%	3.14	1	80	300	100	-5%
028_02	3rd trib to Summit	2	1600	subalpine fir/moist	96%	0.25	1	2,000	500	90%	0.63	1	2,000	1,000	500	-6%
028_02	3rd trib to Summit	3	160	dry DF w/o Ppine	94%	0.38	1	200	80	70%	1.88	1	200	400	300	-24%
028_02	Big Fall Creek	1	1100	rock/bare/ephemeral	0%	6.27	1	1,000	6,000	0%	6.27	1	1,000	6,000	0	0%
028_02	Big Fall Creek	2	510	Drummond willow	87%	0.82	1	500	400	50%	3.14	1	500	2,000	2,000	-37%
028_02	Big Fall Creek	3	310	subalpine fir/moist	96%	0.25	1	300	80	90%	0.63	1	300	200	100	-6%
028_02	Big Fall Creek	4	700	Drummond willow	76%	1.50	2	1,000	2,000	60%	2.51	2	1,000	3,000	1,000	-16%
028_02	Big Fall Creek	5	890	dry DF w/o Ppine	94%	0.38	2	2,000	800	80%	1.25	2	2,000	3,000	2,000	-14%
028_02	Big Fall Creek	6	330	Drummond willow	76%	1.50	2	700	1,000	60%	2.51	2	700	2,000	1,000	-16%
028_02	Big Fall Creek	7	320	dry DF w/o Ppine	92%	0.50	3	1,000	500	90%	0.63	3	1,000	600	100	-2%
028_02	Big Fall Creek	8	230	Drummond willow	56%	2.76	3	700	2,000	30%	4.39	3	700	3,000	1,000	-26%
028_02	Big Fall Creek	9	220	Drummond willow	56%	2.76	3	700	2,000	50%	3.14	3	700	2,000	0	-6%
028_02	Big Fall Creek	10	850	dry DF w/o Ppine	92%	0.50	3	3,000	2,000	80%	1.25	3	3,000	4,000	2,000	-12%
028_02	Big Fall Creek	11	310	Drummond willow	56%	2.76	3	900	2,000	30%	4.39	3	900	4,000	2,000	-26%
028_02	Big Fall Creek	12	190	dry DF w/o Ppine	92%	0.50	3	600	300	70%	1.88	3	600	1,000	700	-22%
028_02	trib to Big Fall	1	1100	grass	55%	2.82	1	1,000	3,000	50%	3.14	1	1,000	3,000	0	-5%
028_02	trib to Big Fall	2	610	subalpine fir/moist	96%	0.25	1	600	200	80%	1.25	1	600	800	600	-16%
028_02	trib to Big Fall	3	500	Drummond willow	87%	0.82	1	500	400	70%	1.88	1	500	900	500	-17%
028_02	Phi Kappa Creek	1	1800	grass	55%	2.82	1	2,000	6,000	50%	3.14	1	2,000	6,000	0	-5%
028_02	Phi Kappa Creek	2	1200	Drummond willow	76%	1.50	2	2,000	3,000	70%	1.88	2	2,000	4,000	1,000	-6%
028_02	Phi Kappa Creek	3	260	Drummond willow	76%	1.50	2	500	800	30%	4.39	2	500	2,000	1,000	-46%
028_02	Phi Kappa Creek	4	470	Drummond willow	76%	1.50	2	900	1,000	80%	1.25	2	900	1,000	0	0%
028_02	Phi Kappa Creek	5	410	DF/lodgepole-steep	98%	0.13	2	800	100	90%	0.63	2	800	500	400	-8%
028_02	Phi Kappa Creek	6	320	subalpine fir/moist	96%	0.25	2	600	200	90%	0.63	2	600	400	200	-6%
028_02	Phi Kappa Creek	7	360	sage/grass	39%	3.82	2	700	3,000	10%	5.64	2	700	4,000	1,000	-29%

Table C-11 (cont.) Existing and target solar loads for 2nd-order of Summit Creek (ID17040218SK028_02).

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
028_02	6th trib to Summit	1	810	rock/bare/ephemeral	0%	6.27	1	800	5,000	0%	6.27	1	800	5,000	0	0%
028_02	6th trib to Summit	2	520	dry DF w/o Ppine	94%	0.38	1	500	200	90%	0.63	1	500	300	100	-4%
028_02	6th trib to Summit	3	840	rock/bare/ephemeral	0%	6.27	1	800	5,000	0%	6.27	1	800	5,000	0	0%
028_02	7th trib to Summit	1	890	grass	55%	2.82	1	900	3,000	50%	3.14	1	900	3,000	0	-5%
028_02	7th trib to Summit	2	1000	sage/grass	65%	2.19	1	1,000	2,000	30%	4.39	1	1,000	4,000	2,000	-35%
028_02	7th trib to Summit	3	1400	Drummond willow	76%	1.50	2	3,000	5,000	50%	3.14	2	3,000	9,000	4,000	-26%
028_02	7th trib to Summit	4	520	sage/grass	39%	3.82	2	1,000	4,000	20%	5.02	2	1,000	5,000	1,000	-19%
028_02	8th trib to Summit	1	940	grass	55%	2.82	1	900	3,000	50%	3.14	1	900	3,000	0	-5%
028_02	8th trib to Summit	2	500	sage/grass	65%	2.19	1	500	1,000	50%	3.14	1	500	2,000	1,000	-15%
028_02	8th trib to Summit	3	650	Drummond willow	87%	0.82	1	700	600	70%	1.88	1	700	1,000	400	-17%
028_02	8th trib to Summit	4	720	sage/grass	65%	2.19	1	700	2,000	30%	4.39	1	700	3,000	1,000	-35%
028_02	9th trib to Summit	1	2100	dry DF w/o Ppine	94%	0.38	1	2,000	800	90%	0.63	1	2,000	1,000	200	-4%
028_02	9th trib to Summit	2	97	dry DF w/o Ppine	94%	0.38	2	200	80	90%	0.63	2	200	100	20	-4%
028_02	9th trib to Summit	3	770	grass	31%	4.33	2	2,000	9,000	50%	3.14	2	2,000	6,000	(3,000)	0%
028_02	9th trib to Summit	4	340	sage/grass	39%	3.82	2	700	3,000	30%	4.39	2	700	3,000	0	-9%
028_02	Summit Creek	1	1600	lemon willow	80%	1.25	1	2,000	3,000	80%	1.25	1	2,000	3,000	0	0%
028_02	Summit Creek	2	860	lemon willow	80%	1.25	1	900	1,000	50%	3.14	1	900	3,000	2,000	-30%
028_02	Summit Creek	3	1400	Drummond willow	76%	1.50	2	3,000	5,000	80%	1.25	2	3,000	4,000	(1,000)	0%
028_02	Summit Creek	4	390	Drummond willow	76%	1.50	2	800	1,000	60%	2.51	2	800	2,000	1,000	-16%
028_02	Summit Creek	5	220	dry DF w/o Ppine	94%	0.38	2	400	200	80%	1.25	2	400	500	300	-14%
028_02	Summit Creek	6	270	lemon willow	49%	3.20	2	500	2,000	50%	3.14	2	500	2,000	0	0%
028_02	Summit Creek	7	2200	dry DF w/o Ppine	92%	0.50	3	7,000	4,000	80%	1.25	3	7,000	9,000	5,000	-12%
028_02	Summit Creek	8	310	Drummond willow	56%	2.76	3	900	2,000	60%	2.51	3	900	2,000	0	0%
028_02	Summit Creek	9	300	Drummond willow	56%	2.76	3	900	2,000	50%	3.14	3	900	3,000	1,000	-6%
028_02	Summit Creek	10	260	Drummond willow	45%	3.45	4	1,000	3,000	30%	4.39	4	1,000	4,000	1,000	-15%
028_02	Summit Creek	11	190	Drummond willow	45%	3.45	4	800	3,000	50%	3.14	4	800	3,000	0	0%
028_02	Summit Creek	12	86	Drummond willow	45%	3.45	4	300	1,000	30%	4.39	4	300	1,000	0	-15%
028_02	Summit Creek	13	130	Drummond willow	45%	3.45	4	500	2,000	60%	2.51	4	500	1,000	(1,000)	0%
028_02	Summit Creek	14	150	Drummond willow	45%	3.45	4	600	2,000	40%	3.76	4	600	2,000	0	0%
028_02	Summit Creek	15	170	Drummond willow	45%	3.45	4	700	2,000	60%	2.51	4	700	2,000	0	0%
028_02	Summit Creek	16	640	Drummond willow	45%	3.45	4	3,000	10,000	10%	5.64	4	3,000	20,000	10,000	-35%
028_02	Summit Creek	17	850	Drummond willow	45%	3.45	4	3,000	10,000	20%	5.02	4	3,000	20,000	10,000	-25%
028_02	Summit Creek	18	520	Drummond willow	38%	3.89	5	3,000	10,000	20%	5.02	5	3,000	20,000	10,000	-18%
028_02	Summit Creek	19	120	Drummond willow	38%	3.89	5	600	2,000	30%	4.39	5	600	3,000	1,000	-8%
028_02	Summit Creek	20	340	Drummond willow	38%	3.89	5	2,000	8,000	50%	3.14	5	2,000	6,000	(2,000)	0%
028_02	Summit Creek	21	470	Drummond willow	38%	3.89	5	2,000	8,000	20%	5.02	5	2,000	10,000	2,000	-18%
028_02	Summit Creek	22	280	Drummond willow	38%	3.89	5	1,000	4,000	50%	3.14	5	1,000	3,000	(1,000)	0%
028_02	Summit Creek	23	270	ponds	0%	6.27	5	1,000	6,000	10%	5.64	5	1,000	6,000	0	0%
028_02	Summit Creek	24	410	Drummond willow	38%	3.89	5	2,000	8,000	10%	5.64	5	2,000	10,000	2,000	-28%
028_02	Summit Creek	25	720	Drummond willow	33%	4.20	6	4,000	20,000	20%	5.02	6	4,000	20,000	0	-13%
028_02	Summit Creek	26	290	Drummond willow	33%	4.20	6	2,000	8,000	30%	4.39	6	2,000	9,000	1,000	-3%
028_02	Summit Creek	27	310	Drummond willow	33%	4.20	6	2,000	8,000	20%	5.02	6	2,000	10,000	2,000	-13%
028_02	Summit Creek	28	210	Drummond willow	33%	4.20	6	1,000	4,000	30%	4.39	6	1,000	4,000	0	-3%
028_02	Summit Creek	29	320	Drummond willow	33%	4.20	6	2,000	8,000	10%	5.64	6	2,000	10,000	2,000	-23%
028_02	Summit Creek	30	700	Drummond willow	33%	4.20	6	4,000	20,000	30%	4.39	6	4,000	20,000	0	-3%
028_02	Summit Creek	31	1700	Drummond willow	29%	4.45	7	10,000	40,000	30%	4.39	7	10,000	40,000	0	0%
028_02	Summit Creek	32	120	Drummond willow	29%	4.45	7	800	4,000	10%	5.64	7	800	5,000	1,000	-19%
028_02	Summit Creek	33	720	Drummond willow	29%	4.45	7	5,000	20,000	30%	4.39	7	5,000	20,000	0	0%
028_02	Summit Creek	34	190	Drummond willow	29%	4.45	7	1,000	4,000	10%	5.64	7	1,000	6,000	2,000	-19%
028_02	Summit Creek	35	200	Drummond willow	29%	4.45	7	1,000	4,000	30%	4.39	7	1,000	4,000	0	0%
							Totals		370,000					450,000	82,000	

Table C-12. Existing and target solar loads for 3rd-order Summit Creek (ID17040218SK028_03).

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
028_03	Summit Creek	1	370	Drummond willow	26%	4.64	8	3,000	10,000	20%	5.02	8	3,000	20,000	10,000	-6%
028_03	Summit Creek	2	280	Drummond willow	26%	4.64	8	2,000	9,000	0%	6.27	8	2,000	10,000	1,000	-26%
028_03	Summit Creek	3	240	Drummond willow	26%	4.64	8	2,000	9,000	10%	5.64	8	2,000	10,000	1,000	-16%
							Totals		28,000					40,000	12,000	

Table C-13. Existing and target solar loads for 2nd-order Warm Springs Creek (ID17040218SK043_02).

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
043_02	Warm Springs Creek	1	160	Yellow willow	16%	5.27	14	2,200	12,000	20%	5.02	14	2,200	11,000	(1,000)	0%
043_02	Warm Springs Creek	2	190	Yellow willow	16%	5.27	14	2,700	14,000	10%	5.64	14	2,700	15,000	1,000	-6%
043_02	Warm Springs Creek	3	410	Yellow willow	16%	5.27	14	5,700	30,000	0%	6.27	14	5,700	36,000	6,000	-16%
043_02	Warm Springs Creek	4	110	Yellow willow	16%	5.27	14	1,500	7,900	10%	5.64	14	1,500	8,500	600	-6%
043_02	Warm Springs Creek	5	2000	Yellow willow	16%	5.27	14	28,000	150,000	0%	6.27	14	28,000	180,000	30,000	-16%
043_02	Warm Springs Creek	6	510	Yellow willow	16%	5.27	14	7,100	37,000	10%	5.64	14	7,100	40,000	3,000	-6%
043_02	Warm Springs Creek	7	520	Yellow willow	16%	5.27	14	7,300	38,000	0%	6.27	14	7,300	46,000	8,000	-16%
043_02	Warm Springs Creek	8	770	Yellow willow	21%	4.95	11	8,500	42,000	10%	5.64	11	8,500	48,000	6,000	-11%
043_02	Warm Springs Creek	9	1100	Yellow willow	21%	4.95	11	12,000	59,000	0%	6.27	11	12,000	75,000	16,000	-21%
043_02	Warm Springs Creek	10	6200	Yellow willow	27%	4.58	8	50,000	200,000	0%	6.27	8	50,000	300,000	100,000	-27%
043_02	Pole Stackyard Creek	1	1800	Yellow willow	34%	4.14	6	10,000	40,000	0%	6.27	6	10,000	60,000	20,000	-34%
043_02	Pole Stackyard Creek	2	300	Yellow willow	34%	4.14	6	2,000	8,000	10%	5.64	6	2,000	10,000	2,000	-24%
043_02	Pole Stackyard Creek	3	120	Yellow willow	34%	4.14	6	700	3,000	0%	6.27	6	700	4,000	1,000	-34%
043_02	Pole Stackyard Creek	4	760	Yellow willow	34%	4.14	6	5,000	20,000	10%	5.64	6	5,000	30,000	10,000	-24%
043_02	Pole Stackyard Creek	5	440	Yellow willow	34%	4.14	6	3,000	10,000	0%	6.27	6	3,000	20,000	10,000	-34%
043_02	Pole Stackyard Creek	6	280	Yellow willow	34%	4.14	6	2,000	8,000	10%	5.64	6	2,000	10,000	2,000	-24%
043_02	Pole Stackyard Creek	7	1100	Yellow willow	34%	4.14	6	7,000	30,000	0%	6.27	6	7,000	40,000	10,000	-34%
043_02	Pole Stackyard Creek	8	260	Yellow willow	24%	4.77	9	2,000	10,000	10%	5.64	9	2,000	10,000	0	-14%
043_02	Mackay hatchery to Warm Springs	1	310	Yellow willow	30%	4.39	7	2,000	9,000	0%	6.27	7	2,000	10,000	1,000	-30%
043_02	Mackay hatchery to Warm Springs	2	240	Yellow willow	30%	4.39	7	2,000	9,000	40%	3.76	7	2,000	8,000	(1,000)	0%
043_02	Mackay hatchery to Warm Springs	3	570	Yellow willow	30%	4.39	7	4,000	20,000	0%	6.27	7	4,000	30,000	10,000	-30%
043_02	Mackay hatchery to Warm Springs	4	110	Yellow willow	30%	4.39	7	800	4,000	50%	3.14	7	800	3,000	(1,000)	0%
043_02	Mackay hatchery to Warm Springs	5	2700	Yellow willow	30%	4.39	7	20,000	90,000	0%	6.27	7	20,000	100,000	10,000	-30%
043_02	Mackay hatchery to canal	1	3900	Yellow willow	39%	3.82	5	20,000	80,000	0%	6.27	5	20,000	100,000	20,000	-39%
043_02	Garden Creek	1	290	grass	55%	2.82	1	300	800	60%	2.51	1	300	800	0	0%
043_02	Garden Creek	2	580	aspen	100%	0.00	1	600	0	90%	0.63	1	600	400	400	-10%
043_02	Garden Creek	3	310	Drummond willow	87%	0.82	1	300	200	80%	1.25	1	300	400	200	-7%
043_02	Garden Creek	4	1100	alder	91%	0.56	1	1,000	600	90%	0.63	1	1,000	600	0	-1%
043_02	Garden Creek	5	1700	aspen	99%	0.06	2	3,000	200	80%	1.25	2	3,000	4,000	4,000	-19%
043_02	Garden Creek	6	210	Drummond willow	76%	1.50	2	400	600	40%	3.76	2	400	2,000	1,000	-36%
043_02	Garden Creek	7	380	Drummond willow	56%	2.76	3	1,000	3,000	50%	3.14	3	1,000	3,000	0	-6%
043_02	Garden Creek	8	1300	sage/grass	27%	4.58	3	4,000	20,000	40%	3.76	3	4,000	20,000	0	0%
043_02	Garden Creek	9	590	sage/grass	27%	4.58	3	2,000	9,000	20%	5.02	3	2,000	10,000	1,000	-7%
043_02	trib to Garden	1	170	dry DF w/o Ppine	96%	0.25	1	200	50	90%	0.63	1	200	100	50	-6%
043_02	trib to Garden	2	420	grass	55%	2.82	1	400	1,000	60%	2.51	1	400	1,000	0	0%
043_02	trib to Garden	3	510	Drummond willow	87%	0.82	1	500	400	80%	1.25	1	500	600	200	-7%
043_02	trib to Garden	4	980	alder	91%	0.56	1	1,000	600	90%	0.63	1	1,000	600	0	-1%
043_02	trib to Garden	5	810	sage/grass	65%	2.19	1	800	2,000	60%	2.51	1	800	2,000	0	-5%

Table C-13 (cont.) Existing and target solar loads for 2nd-order Warm Springs Creek (ID17040218SK043_02).

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
043_02	Boone Creek	1	790	Drummond willow	87%	0.82	1	800	700	90%	0.63	1	800	500	(200)	0%
043_02	Boone Creek	2	680	aspen	100%	0.00	1	700	0	90%	0.63	1	700	400	400	-10%
043_02	Boone Creek	3	710	Drummond willow	87%	0.82	1	700	600	90%	0.63	1	700	400	(200)	0%
043_02	Boone Creek	4	920	aspen	100%	0.00	1	900	0	90%	0.63	1	900	600	600	-10%
043_02	Boone Creek	5	2500	aspen	99%	0.06	2	5,000	300	80%	1.25	2	5,000	6,000	6,000	-19%
043_02	Boone Creek	6	860	sage/grass	39%	3.82	2	2,000	8,000	40%	3.76	2	2,000	8,000	0	0%
043_02	trib to Boone	1	300	DF/lodgepole-gentle	100%	0.00	1	300	0	90%	0.63	1	300	200	200	-10%
043_02	trib to Boone	2	1000	grass	55%	2.82	1	1,000	3,000	60%	2.51	1	1,000	3,000	0	0%
043_02	trib to Boone	3	1600	aspen	100%	0.00	1	2,000	0	90%	0.63	1	2,000	1,000	1,000	-10%
043_02	West Fork Lehman Creek	1	370	grass	55%	2.82	1	400	1,000	60%	2.51	1	400	1,000	0	0%
043_02	West Fork Lehman Creek	2	610	dry DF w/o Ppine	96%	0.25	1	600	200	90%	0.63	1	600	400	200	-6%
043_02	West Fork Lehman Creek	3	1500	aspen	99%	0.06	2	3,000	200	90%	0.63	2	3,000	2,000	2,000	-9%
043_02	West Fork Lehman Creek	4	1600	alder	86%	0.88	2	3,000	3,000	80%	1.25	2	3,000	4,000	1,000	-6%
043_02	West Fork Lehman Creek	5	590	aspen	99%	0.06	3	2,000	100	90%	0.63	3	2,000	1,000	900	-9%
043_02	East Fork Lehman Creek	1	250	Drummond willow	87%	0.82	1	300	200	90%	0.63	1	300	200	0	0%
043_02	East Fork Lehman Creek	2	250	grass	55%	2.82	1	300	800	60%	2.51	1	300	800	0	0%
043_02	East Fork Lehman Creek	3	670	Drummond willow	87%	0.82	1	700	600	80%	1.25	1	700	900	300	-7%
043_02	East Fork Lehman Creek	4	360	grass	55%	2.82	1	400	1,000	60%	2.51	1	400	1,000	0	0%
043_02	East Fork Lehman Creek	5	1800	aspen	99%	0.06	2	4,000	300	80%	1.25	2	4,000	5,000	5,000	-19%
043_02	East Fork Lehman Creek	6	1100	aspen	99%	0.06	3	3,000	200	90%	0.63	3	3,000	2,000	2,000	-9%
043_02	trib to EF Lehman	1	1900	aspen	100%	0.00	1	2,000	0	80%	1.25	1	2,000	3,000	3,000	-20%
043_02	1st trib to Lehman	1	340	aspen	100%	0.00	1	300	0	90%	0.63	1	300	200	200	-10%
043_02	1st trib to Lehman	2	1200	aspen	100%	0.00	1	1,000	0	80%	1.25	1	1,000	1,000	1,000	-20%
043_02	1st trib to Lehman	3	1100	sage/grass	65%	2.19	1	1,000	2,000	30%	4.39	1	1,000	4,000	2,000	-35%
043_02	1st trib to Lehman	4	550	sage/grass	65%	2.19	1	600	1,000	20%	5.02	1	600	3,000	2,000	-45%
043_02	Lehman Creek	1	2100	aspen	97%	0.19	4	8,000	2,000	80%	1.25	4	8,000	10,000	8,000	-17%
043_02	Lehman Creek	2	260	pond	0%	6.27	4	1,000	6,000	0%	6.27	4	1,000	6,000	0	0%
043_02	Lehman Creek	3	69	aspen	97%	0.19	4	300	60	90%	0.63	4	300	200	100	-7%
043_02	Lehman Creek	4	610	aspen	97%	0.19	4	2,000	400	80%	1.25	4	2,000	3,000	3,000	-17%
043_02	Lehman Creek	5	140	Drummond willow	45%	3.45	4	600	2,000	60%	2.51	4	600	2,000	0	0%
043_02	Lehman Creek	6	210	pond	0%	6.27	4	800	5,000	0%	6.27	4	800	5,000	0	0%
043_02	trib to Hamilton	1	660	grass	55%	2.82	1	700	2,000	60%	2.51	1	700	2,000	0	0%
043_02	trib to Hamilton	2	2300	sage/grass	39%	3.82	2	5,000	20,000	40%	3.76	2	5,000	20,000	0	0%
043_02	Hamilton Creek	1	590	dry DF w/o Ppine	96%	0.25	1	600	200	90%	0.63	1	600	400	200	-6%
043_02	Hamilton Creek	2	530	grass	55%	2.82	1	500	1,000	70%	1.88	1	500	900	(100)	0%
043_02	Hamilton Creek	3	1400	aspen	100%	0.00	1	1,000	0	80%	1.25	1	1,000	1,000	1,000	-20%
043_02	Hamilton Creek	4	300	sage/grass	65%	2.19	1	300	700	60%	2.51	1	300	800	100	-5%
043_02	Hamilton Creek	5	640	sage/grass	39%	3.82	2	1,000	4,000	20%	5.02	2	1,000	5,000	1,000	-19%
043_02	Hamilton Creek	6	300	aspen	99%	0.06	2	600	40	80%	1.25	2	600	800	800	-19%
043_02	Hamilton Creek	7	280	aspen	99%	0.06	2	600	40	50%	3.14	2	600	2,000	2,000	-49%
043_02	Hamilton Creek	8	390	aspen	99%	0.06	2	800	50	80%	1.25	2	800	1,000	1,000	-19%
043_02	Hamilton Creek	9	220	sage/grass	39%	3.82	2	400	2,000	30%	4.39	2	400	2,000	0	-9%
043_02	Hamilton Creek	10	96	aspen	99%	0.06	2	200	10	80%	1.25	2	200	300	300	-19%
043_02	Hamilton Creek	11	540	sage/grass	39%	3.82	2	1,000	4,000	30%	4.39	2	1,000	4,000	0	-9%
043_02	Hamilton Creek	12	440	sage/grass	27%	4.58	3	1,000	5,000	40%	3.76	3	1,000	4,000	(1,000)	0%
043_02	Hamilton Creek	13	2300	sage/grass	27%	4.58	3	7,000	30,000	20%	5.02	3	7,000	40,000	10,000	-7%
							Totals		1,100,000					1,400,000	320,000	

Table C-14. Existing and target solar loads for 3rd-order Warm Springs Creek (ID17040218SK043_03).

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
043_03	Warm Springs Creek	1	780	yellow willow	19%	5.08	12	9,400	48,000	0%	6.27	12	9,400	59,000	11,000	-19%
043_03	Warm Springs Creek	3	610	yellow willow	12%	5.52	20	12,000	66,000	0%	6.27	20	12,000	75,000	9,000	-12%
043_03	Warm Springs Creek	4	510	yellow willow	12%	5.52	20	10,000	55,000	10%	5.64	20	10,000	56,000	1,000	-2%
							Totals		170,000					190,000	21,000	

Table C-15. Existing and target solar loads for 2nd-order Wildhorse Creek (ID17040218SK030_02).

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
030_02	un-named tributary	1	1600	rock/bare/ephemeral	0%	6.27	1	2,000	10,000	0%	6.27	1	2,000	10,000	0	0%
030_02	Burnt Aspen Creek	1	1100	subalpine fir/moist	96%	0.25	1	1,000	300	90%	0.63	1	1,000	600	300	-6%
030_02	Burnt Aspen Creek	2	430	sage/grass	65%	2.19	1	400	900	50%	3.14	1	400	1,000	100	-15%
030_02	Burnt Aspen Creek	3	740	subalpine fir/moist	96%	0.25	2	1,000	300	90%	0.63	2	1,000	600	300	-6%
030_02	Burnt Aspen Creek	4	340	sage/grass	39%	3.82	2	700	3,000	30%	4.39	2	700	3,000	0	-9%
030_02	Burnt Aspen Creek	5	84	lemon willow	49%	3.20	2	200	600	70%	1.88	2	200	400	(200)	0%
030_02	trib to Burnt Aspen	1	480	subalpine fir/dry-steep	99%	0.06	1	500	30	90%	0.63	1	500	300	300	-9%
030_02	trib to Burnt Aspen	2	1300	dry DF w/o Ppine	94%	0.38	1	1,000	400	90%	0.63	1	1,000	600	200	-4%
030_02	trib to Burnt Aspen	3	490	sage/grass	65%	2.19	1	500	1,000	50%	3.14	1	500	2,000	1,000	-15%
030_02	un-named tributary	1	400	DF/lodgepole-steep	98%	0.13	1	400	50	90%	0.63	1	400	300	300	-8%
030_02	un-named tributary	2	1000	dry DF w/o Ppine	94%	0.38	1	1,000	400	90%	0.63	1	1,000	600	200	-4%
030_02	un-named tributary	3	300	dry DF w/o Ppine	94%	0.38	1	300	100	80%	1.25	1	300	400	300	-14%
030_02	un-named tributary	4	100	sage/grass	65%	2.19	1	100	200	50%	3.14	1	100	300	100	-15%
030_02	Bailey Creek	1	500	subalpine fir/dry-gentle	100%	0.00	1	500	0	90%	0.63	1	500	300	300	-10%
030_02	Bailey Creek	2	1100	subalpine fir/moist	96%	0.25	1	1,000	300	90%	0.63	1	1,000	600	300	-6%
030_02	Bailey Creek	3	1400	subalpine fir/moist	96%	0.25	2	3,000	800	90%	0.63	2	3,000	2,000	1,000	-6%
030_02	Bailey Creek	4	160	lemon willow	49%	3.20	2	300	1,000	50%	3.14	2	300	900	(100)	0%
030_02	Bailey Creek	5	580	sage/grass	39%	3.82	2	1,000	4,000	30%	4.39	2	1,000	4,000	0	-9%
							Totals		23,000					28,000	4,400	

Table C-16. Existing and target solar loads for 3rd-order Wildhorse Creek (ID17040218SK030_04).

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
030_04	Wildhorse Creek	1	690	lemon willow	12%	5.52	9	6,000	30,000	0%	6.27	13	9,000	60,000	30,000	-12%
030_04	Wildhorse Creek	2	57	lemon willow	12%	5.52	9	500	3,000	10%	5.64	13	700	4,000	1,000	-2%
030_04	Wildhorse Creek	3	350	lemon willow	12%	5.52	9	3,000	20,000	0%	6.27	13	5,000	30,000	10,000	-12%
030_04	Wildhorse Creek	4	180	lemon willow	12%	5.52	9	2,000	10,000	10%	5.64	13	2,000	10,000	0	-2%
030_04	Wildhorse Creek	5	170	lemon willow	12%	5.52	9	2,000	10,000	0%	6.27	13	2,000	10,000	0	-12%
030_04	Wildhorse Creek	6	170	lemon willow	12%	5.52	9	2,000	10,000	10%	5.64	13	2,000	10,000	0	-2%
030_04	Wildhorse Creek	7	1700	lemon willow	12%	5.52	9	20,000	100,000	0%	6.27	14	20,000	100,000	0	-12%
030_04	Wildhorse Creek	8	180	lemon willow	22%	4.89	5	900	4,000	40%	3.76	5	900	3,000	(1,000)	0%
030_04	Wildhorse Creek	9	110	beaver ponds	0%	6.27	9	1,000	6,000	0%	6.27	9	1,000	6,000	0	0%
030_04	Wildhorse Creek	10	180	beaver ponds	10%	5.64	9	2,000	10,000	10%	5.64	9	2,000	10,000	0	0%
030_04	Wildhorse Creek	11	1400	lemon willow	12%	5.52	9	10,000	60,000	0%	6.27	15	20,000	100,000	40,000	-12%
030_04	Wildhorse Creek	12	1300	lemon willow	12%	5.52	9	10,000	60,000	0%	6.27	16	20,000	100,000	40,000	-12%
030_04	Wildhorse Creek	13	170	lemon willow	12%	5.52	9	2,000	10,000	10%	5.64	16	3,000	20,000	10,000	-2%
030_04	Wildhorse Creek	14	1000	lemon willow	12%	5.52	9	9,000	50,000	0%	6.27	16	20,000	100,000	50,000	-12%
							Totals		380,000					560,000	180,000	

Table C-17. Existing and target solar loads for 2nd-order Cherry Creek (ID17040218SK050_02).

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
050_02	trib to Lupine	1	2000	sage/grass	65%	2.19	1	2,000	4,000	60%	2.51	1	2,000	5,000	1,000	-5%
050_02	Lupine Creek	1	450	sage/grass	65%	2.19	1	500	1,000	60%	2.51	1	500	1,000	0	-5%
050_02	Lupine Creek	2	1200	grass	55%	2.82	1	1,000	3,000	50%	3.14	1	1,000	3,000	0	-5%
050_02	Lupine Creek	3	1100	Drummond willow	76%	1.50	2	2,000	3,000	80%	1.25	2	2,000	3,000	0	0%
050_02	Lupine Creek	4	2400	alder	86%	0.88	2	5,000	4,000	70%	1.88	2	5,000	9,000	5,000	-16%
050_02	Lupine Creek	5	56	Drummond willow	56%	2.76	3	200	600	70%	1.88	3	200	400	(200)	0%
050_02	Lupine Creek	6	54	beaver pond	20%	5.02	3	200	1,000	20%	5.02	3	200	1,000	0	0%
050_02	Lupine Creek	7	420	Geyer willow	64%	2.26	3	1,000	2,000	60%	2.51	3	1,000	3,000	1,000	-4%
050_02	Blue Rock	1	1130	rock/bare/epemeral	0%	6.27	1	1,000	6,000	0%	6.27	1	1,000	6,000	0	0%
050_02	Blue Rock	2	880	sage/grass	65%	2.19	1	900	2,000	60%	2.51	1	900	2,000	0	-5%
050_02	Blue Rock	3	1000	sage/grass	39%	3.82	2	2,000	8,000	60%	2.51	2	2,000	5,000	(3,000)	0%
050_02	Mud Lake	1	940	sage/grass	65%	2.19	1	900	2,000	60%	2.51	1	900	2,000	0	-5%
050_02	Mud Lake	2	480	grass	55%	2.82	1	500	1,000	50%	3.14	1	500	2,000	1,000	-5%
050_02	Mud Lake	3	250	aspen	100%	0.00	1	300	0	80%	1.25	1	300	400	400	-20%
050_02	Mud Lake	4	210	Drummond willow	76%	1.50	2	400	600	50%	3.14	2	400	1,000	400	-26%
050_02	Mud Lake	5	1500	sage/grass	39%	3.82	2	3,000	10,000	40%	3.76	2	3,000	10,000	0	0%
050_02	Carcass Creek	1	360	sage/grass	65%	2.19	1	400	900	60%	2.51	1	400	1,000	100	-5%
050_02	Carcass Creek	2	300	Drummond willow	87%	0.82	1	300	200	60%	2.51	1	300	800	600	-27%
050_02	Carcass Creek	3	560	aspen	100%	0.00	1	600	0	80%	1.25	1	600	800	800	-20%
050_02	Carcass Creek	4	200	aspen	100%	0.00	1	200	0	90%	0.63	1	200	100	100	-10%
050_02	Carcass Creek	5	330	aspen	100%	0.00	1	300	0	70%	1.88	1	300	600	600	-30%
050_02	Carcass Creek	6	720	sage/grass	65%	2.19	1	700	2,000	30%	4.39	1	700	3,000	1,000	-35%
050_02	MF Cherry Creek	1	850	rock/bare/epemeral	0%	6.27	1	900	6,000	0%	6.27	1	900	6,000	0	0%
050_02	MF Cherry Creek	2	1200	alder	91%	0.56	1	1,000	600	70%	1.88	1	1,000	2,000	1,000	-21%
050_02	MF Cherry Creek	3	340	alder	86%	0.88	2	700	600	80%	1.25	2	700	900	300	-6%
050_02	MF Cherry Creek	4	510	aspen	99%	0.06	2	1,000	60	80%	1.25	2	1,000	1,000	900	-19%
050_02	MF Cherry Creek	5	440	alder	86%	0.88	2	900	800	60%	2.51	2	900	2,000	1,000	-26%
050_02	1st to MF Cherry	1	150	sage/grass	65%	2.19	1	200	400	60%	2.51	1	200	500	100	-5%
050_02	1st to MF Cherry	2	180	grass	55%	2.82	1	200	600	50%	3.14	1	200	600	0	-5%
050_02	1st to MF Cherry	3	440	dry DF w/o Ppine	94%	0.38	1	400	200	80%	1.25	1	400	500	300	-14%
050_02	1st to MF Cherry	4	1200	alder	91%	0.56	1	1,000	600	60%	2.51	1	1,000	3,000	2,000	-31%
050_02	2nd to MF Cherry	1	750	sage/grass	65%	2.19	1	800	2,000	60%	2.51	1	800	2,000	0	-5%
050_02	2nd to MF Cherry	2	560	grass	55%	2.82	1	600	2,000	50%	3.14	1	600	2,000	0	-5%
050_02	2nd to MF Cherry	3	1100	alder	91%	0.56	1	1,000	600	70%	1.88	1	1,000	2,000	1,000	-21%
050_02	2nd to MF Cherry	4	580	Drummond willow	87%	0.82	1	600	500	50%	3.14	1	600	2,000	2,000	-37%
050_02	3rd to MF Cherry	1	300	sage/grass	65%	2.19	1	300	700	60%	2.51	1	300	800	100	-5%
050_02	3rd to MF Cherry	2	810	Drummond willow	87%	0.82	1	800	700	70%	1.88	1	800	2,000	1,000	-17%
050_02	3rd to MF Cherry	3	520	Drummond willow	87%	0.82	1	500	400	80%	1.25	1	500	600	200	-7%
050_02	4th to MF Cherry	1	720	aspen	100%	0.00	1	700	0	80%	1.25	1	700	900	900	-20%
050_02	4th to MF Cherry	2	94	sage/grass	65%	2.19	1	90	200	30%	4.39	1	90	400	200	-35%
050_02	4th to MF Cherry	3	170	aspen	100%	0.00	1	200	0	80%	1.25	1	200	300	300	-20%
050_02	4th to MF Cherry	4	910	sage/grass	65%	2.19	1	900	2,000	40%	3.76	1	900	3,000	1,000	-25%
050_02	Crawford Canyon	1	1200	sage/grass	65%	2.19	1	1,000	2,000	60%	2.51	1	1,000	3,000	1,000	-5%
050_02	Crawford Canyon	2	260	sage/grass	65%	2.19	1	300	700	40%	3.76	1	300	1,000	300	-25%
050_02	Crawford Canyon	3	110	aspen	99%	0.06	2	200	10	90%	0.63	2	200	100	90	-9%
050_02	Crawford Canyon	4	540	aspen	99%	0.06	2	1,000	60	50%	3.14	2	1,000	3,000	3,000	-49%
050_02	Crawford Canyon	5	860	sage/grass	39%	3.82	2	2,000	8,000	40%	3.76	2	2,000	8,000	0	0%
050_02	trib to Crawford	1	460	sage/grass	65%	2.19	1	500	1,000	60%	2.51	1	500	1,000	0	-5%
050_02	trib to Crawford	2	350	aspen	100%	0.00	1	400	0	80%	1.25	1	400	500	500	-20%
050_02	trib to Crawford	3	420	sage/grass	65%	2.19	1	400	900	30%	4.39	1	400	2,000	1,000	-35%
050_02	trib to Crawford	4	200	aspen	100%	0.00	1	200	0	80%	1.25	1	200	300	300	-20%
050_02	trib to Crawford	5	450	sage/grass	65%	2.19	1	500	1,000	40%	3.76	1	500	2,000	1,000	-25%
050_02	trib to Crawford	6	300	sage/grass	39%	3.82	2	600	2,000	40%	3.76	2	600	2,000	0	0%
050_02	trib to Crawford	7	490	grass	31%	4.33	2	1,000	4,000	30%	4.39	2	1,000	4,000	0	-1%
050_02	Richardson Canyon	1	240	sage/grass	65%	2.19	1	200	400	60%	2.51	1	200	500	100	-5%
050_02	Richardson Canyon	2	620	Drummond willow	87%	0.82	1	600	500	80%	1.25	1	600	800	300	-7%
050_02	Richardson Canyon	3	730	Drummond willow	87%	0.82	1	700	600	50%	3.14	1	700	2,000	1,000	-37%
050_02	Richardson Canyon	4	170	sage/grass	65%	2.19	1	200	400	60%	2.51	1	200	500	100	-5%
050_02	Richardson Canyon	5	170	aspen	100%	0.00	1	200	0	70%	1.88	1	200	400	400	-30%
050_02	Richardson Canyon	6	650	sage/grass	65%	2.19	1	700	2,000	40%	3.76	1	700	3,000	1,000	-25%
050_02	Richardson Canyon	7	1200	aspen	99%	0.06	2	2,000	100	90%	0.63	2	2,000	1,000	900	-9%
050_02	Richardson Canyon	8	360	aspen	99%	0.06	2	700	40	50%	3.14	2	700	2,000	2,000	-49%
050_02	Richardson Canyon	9	300	sage/grass	39%	3.82	2	600	2,000	20%	5.02	2	600	3,000	1,000	-19%
050_02	Richardson Canyon	10	230	alder	86%	0.88	2	500	400	50%	3.14	2	500	2,000	2,000	-36%
050_02	Richardson Canyon	11	250	sage/grass	39%	3.82	2	500	2,000	30%	4.39	2	500	2,000	0	-9%
							Totals		98,000					140,000	37,000	

Table C-18. Existing and target solar loads for 4th-order Cherry Creek (ID17040218SK050_04).

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
050_04	MF Cherry Creek	1	220	alder	72%	1.76	3	700	1,000	60%	2.51	3	700	2,000	1,000	-12%
050_04	MF Cherry Creek	2	390	alder	72%	1.76	3	1,000	2,000	40%	3.76	3	1,000	4,000	2,000	-32%
050_04	MF Cherry Creek	3	410	alder	72%	1.76	3	1,000	2,000	60%	2.51	3	1,000	3,000	1,000	-12%
050_04	MF Cherry Creek	4	350	Geyer willow	64%	2.26	3	1,000	2,000	50%	3.14	3	1,000	3,000	1,000	-14%
050_04	MF Cherry Creek	5	300	beaver ponds	20%	5.02	3	900	5,000	20%	5.02	3	900	5,000	0	0%
050_04	MF Cherry Creek	6	690	Geyer willow	64%	2.26	3	2,000	5,000	40%	3.76	3	2,000	8,000	3,000	-24%
050_04	Cherry Creek	1	520	Geyer willow	64%	2.26	3	2,000	5,000	50%	3.14	5	3,000	9,000	4,000	-14%
050_04	Cherry Creek	2	640	Geyer willow	64%	2.26	3	2,000	5,000	70%	1.88	5	3,000	6,000	1,000	0%
050_04	Cherry Creek	3	510	Geyer willow	64%	2.26	3	2,000	5,000	60%	2.51	5	3,000	8,000	3,000	-4%
050_04	Cherry Creek	4	200	Geyer willow	64%	2.26	3	600	1,000	40%	3.76	5	1,000	4,000	3,000	-24%
050_04	Cherry Creek	5	670	Geyer willow	64%	2.26	3	2,000	5,000	60%	2.51	5	3,000	8,000	3,000	-4%
050_04	Cherry Creek	6	190	Geyer willow	53%	2.95	4	800	2,000	60%	2.51	6	1,000	3,000	1,000	0%
050_04	Cherry Creek	7	780	Geyer willow	53%	2.95	4	3,000	9,000	50%	3.14	6	5,000	20,000	10,000	-3%
050_04	Cherry Creek	8	180	beaver ponds	20%	5.02	4	700	4,000	20%	5.02	6	1,000	5,000	1,000	0%
050_04	Cherry Creek	9	410	Geyer willow	53%	2.95	4	2,000	6,000	40%	3.76	6	2,000	8,000	2,000	-13%
050_04	Cherry Creek	10	390	Geyer willow	53%	2.95	4	2,000	6,000	50%	3.14	6	2,000	6,000	0	-3%
050_04	Cherry Creek	11	92	Geyer willow	53%	2.95	4	400	1,000	20%	5.02	6	600	3,000	2,000	-33%
050_04	Cherry Creek	12	190	Geyer willow	53%	2.95	4	800	2,000	50%	3.14	6	1,000	3,000	1,000	-3%
050_04	Cherry Creek	13	480	Geyer willow	53%	2.95	4	2,000	6,000	50%	3.14	6	3,000	9,000	3,000	-3%
							Totals		74,000					120,000	42,000	

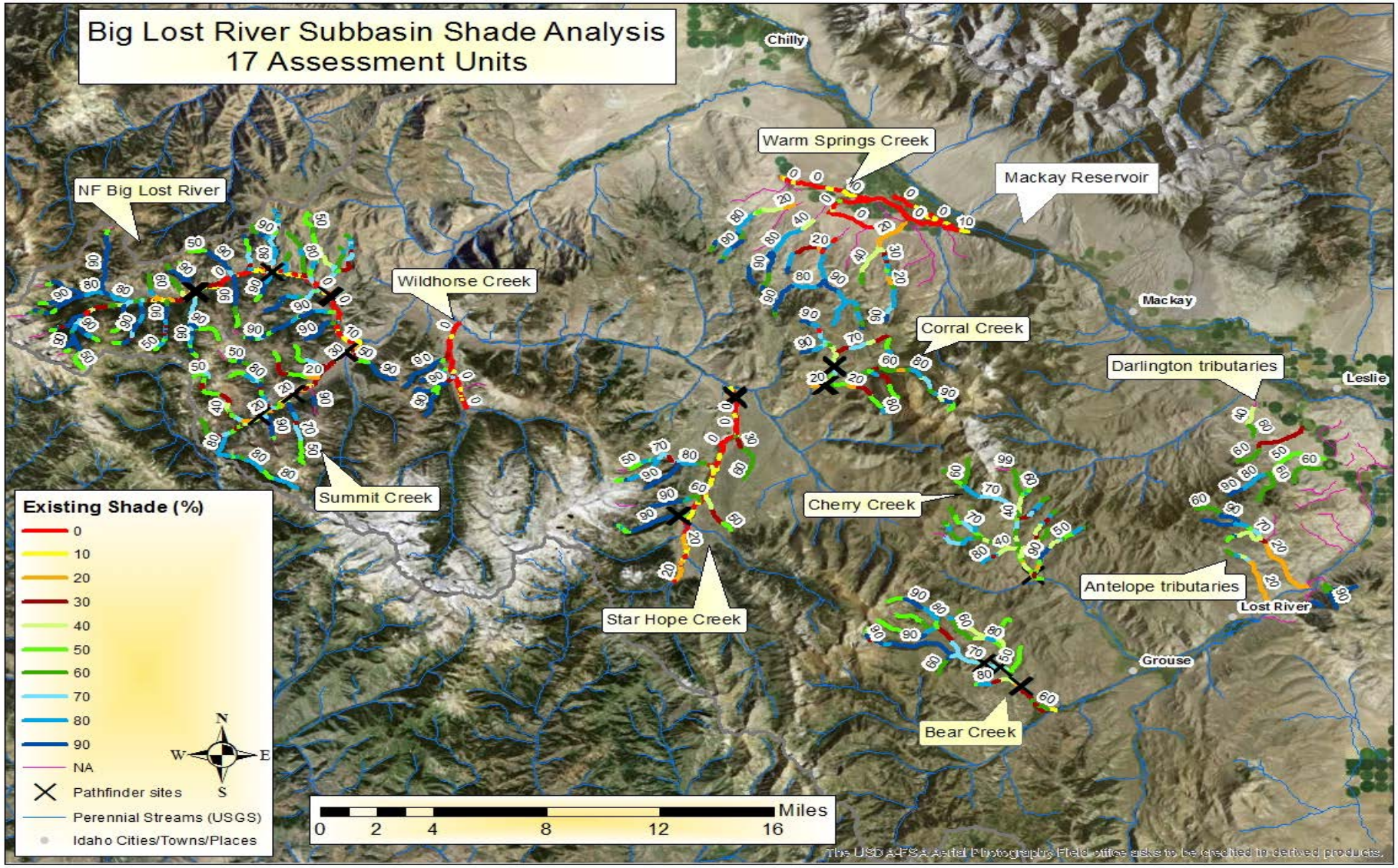

Figure C-1. Existing shade estimated for the 17 AUs of Big Lost River subbasin by aerial photo interpretation.

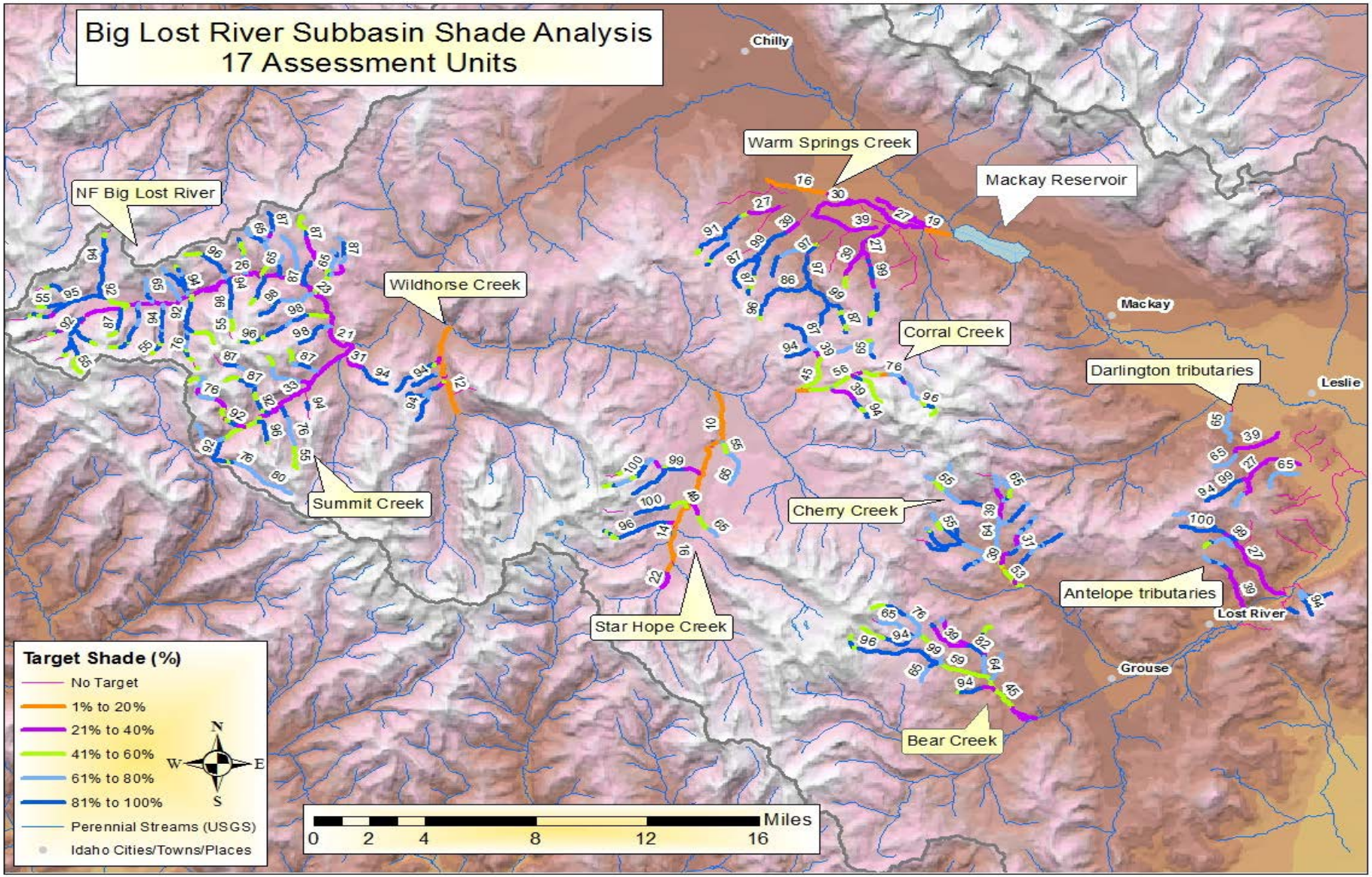

Figure C-2. Target shade for the 17 AUs of Big Lost River subbasin by aerial photo interpretation.

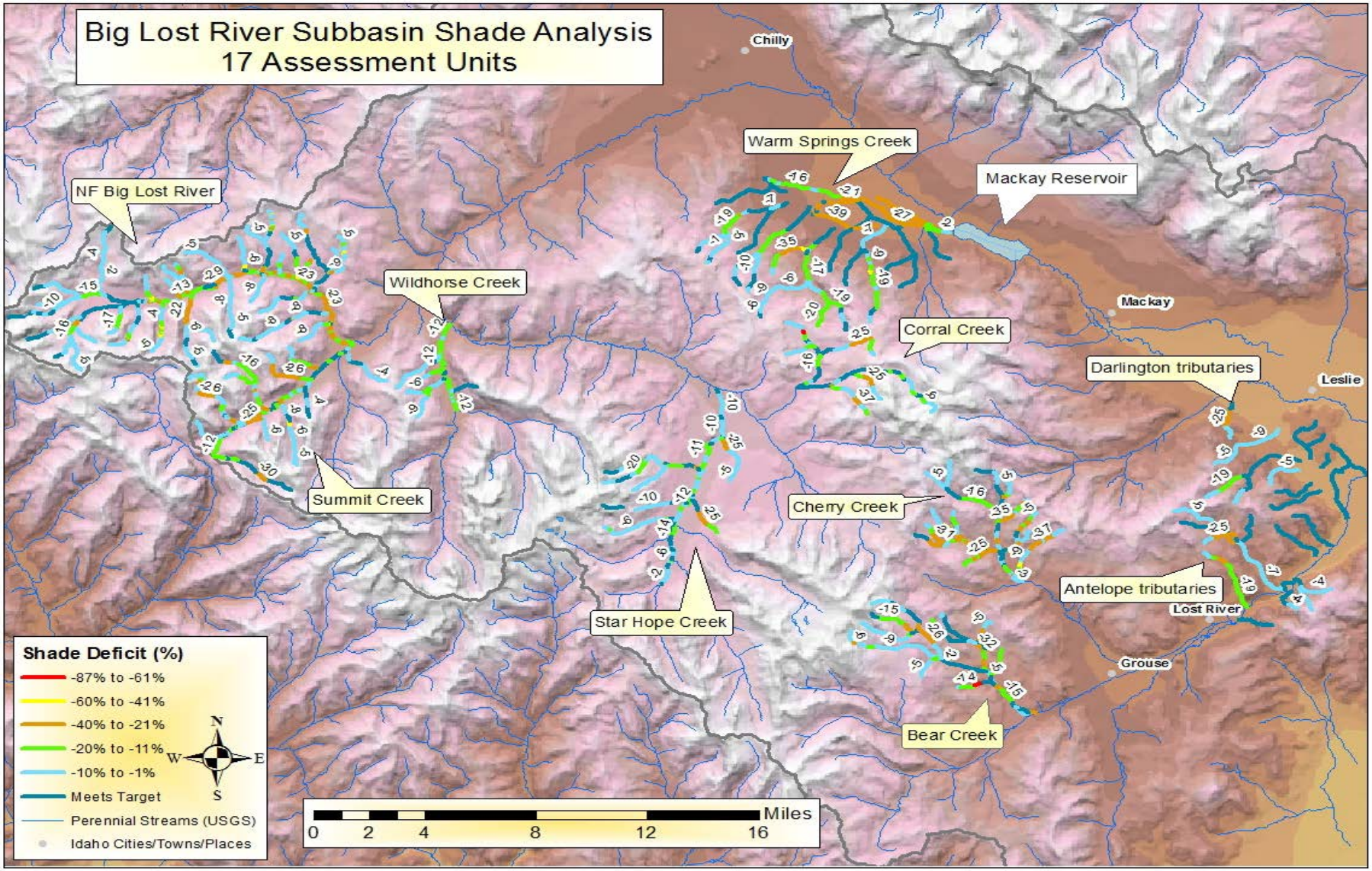

Figure C-3. Shade deficit (difference between existing and target) for the 17 AUs of Big Lost River subbasin by aerial photo interpretation.

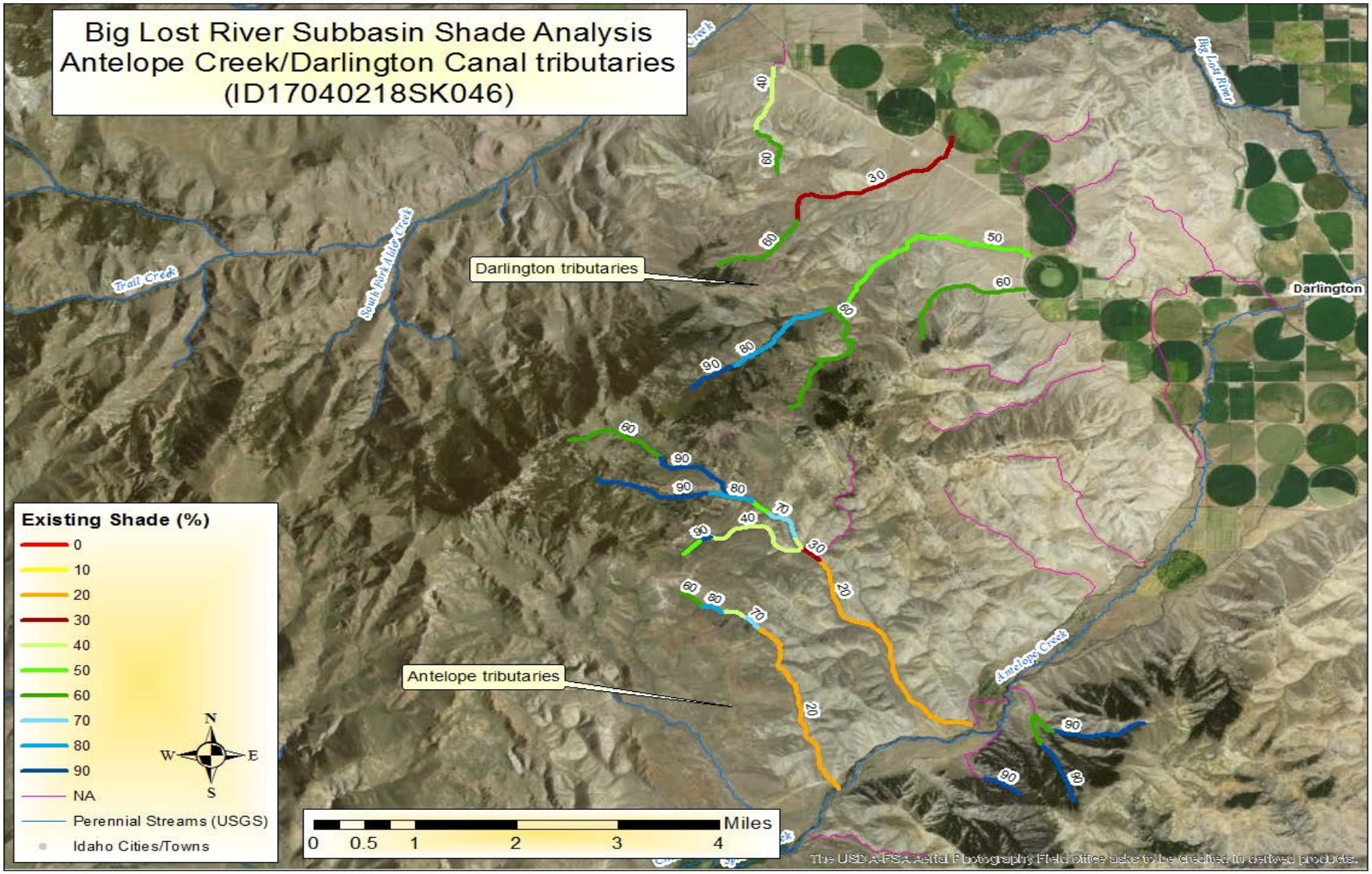

Figure C-4. Existing shade estimated for the Antelope Creek/Darlington canal tributaries by aerial photo interpretation.

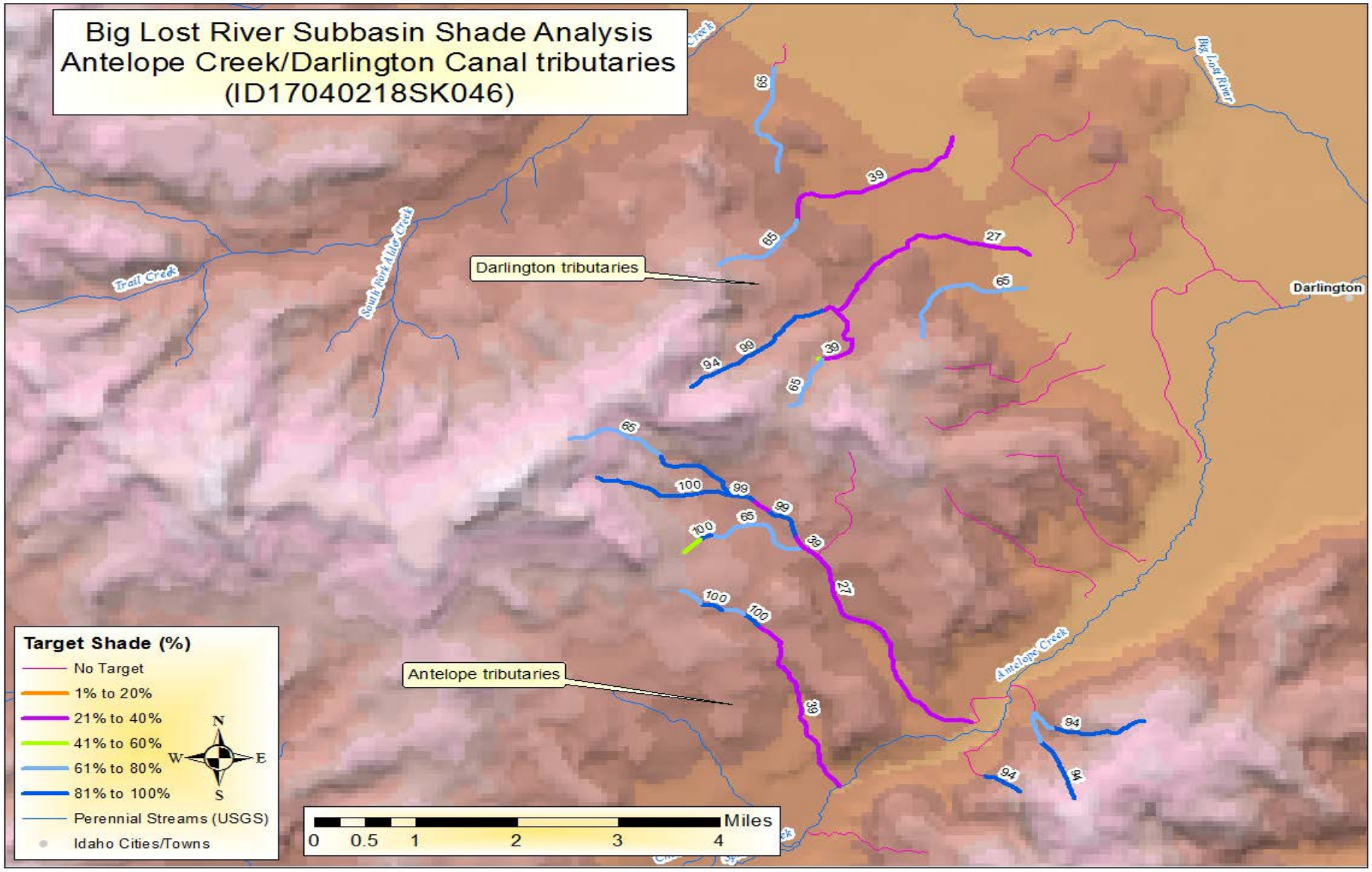

Figure C-5. Target shade for the Antelope Creek/Darlington canal tributaries.

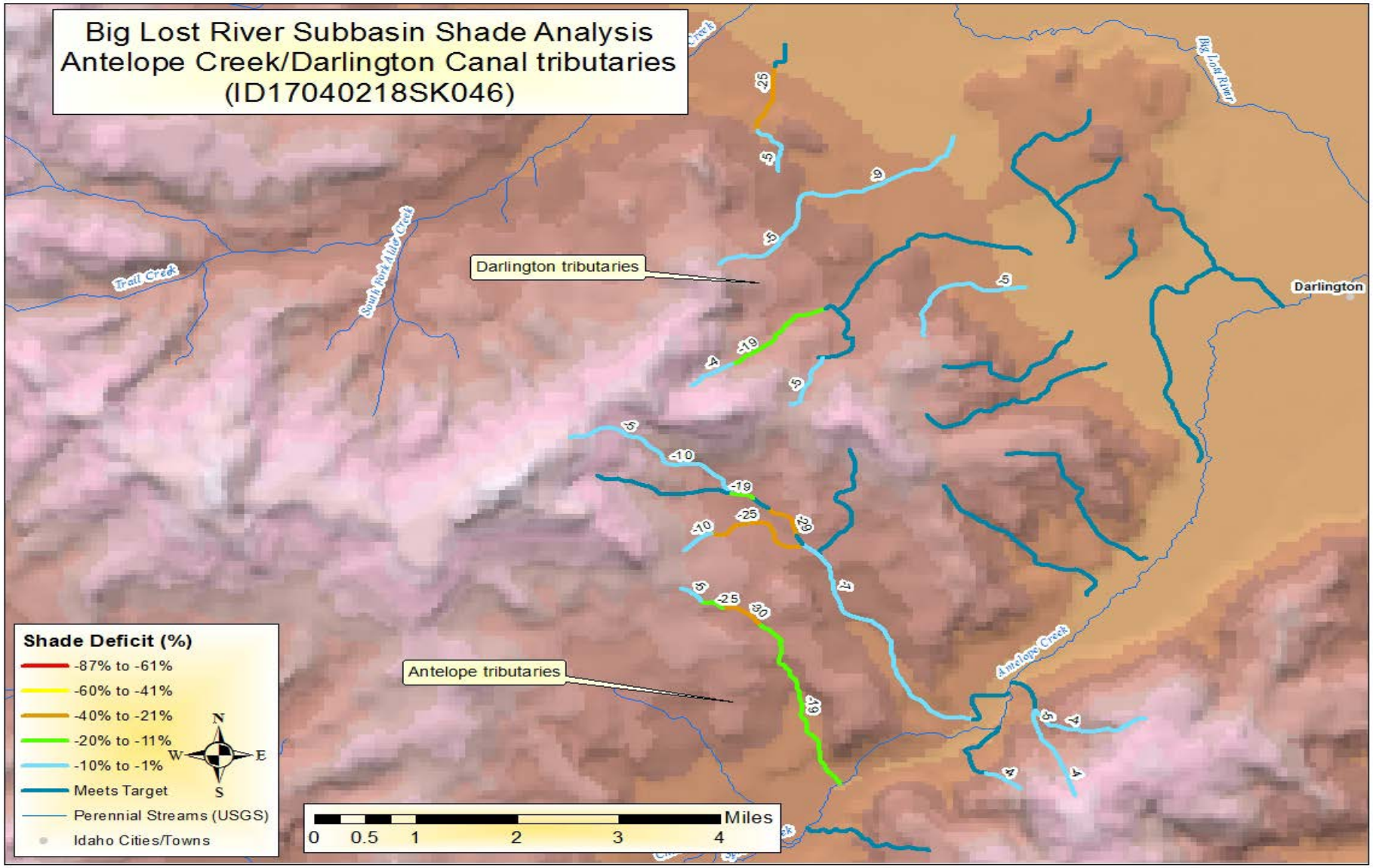

Figure C-6. Shade deficit (difference between existing and target) for the Antelope Creek/Darlington canal tributaries.

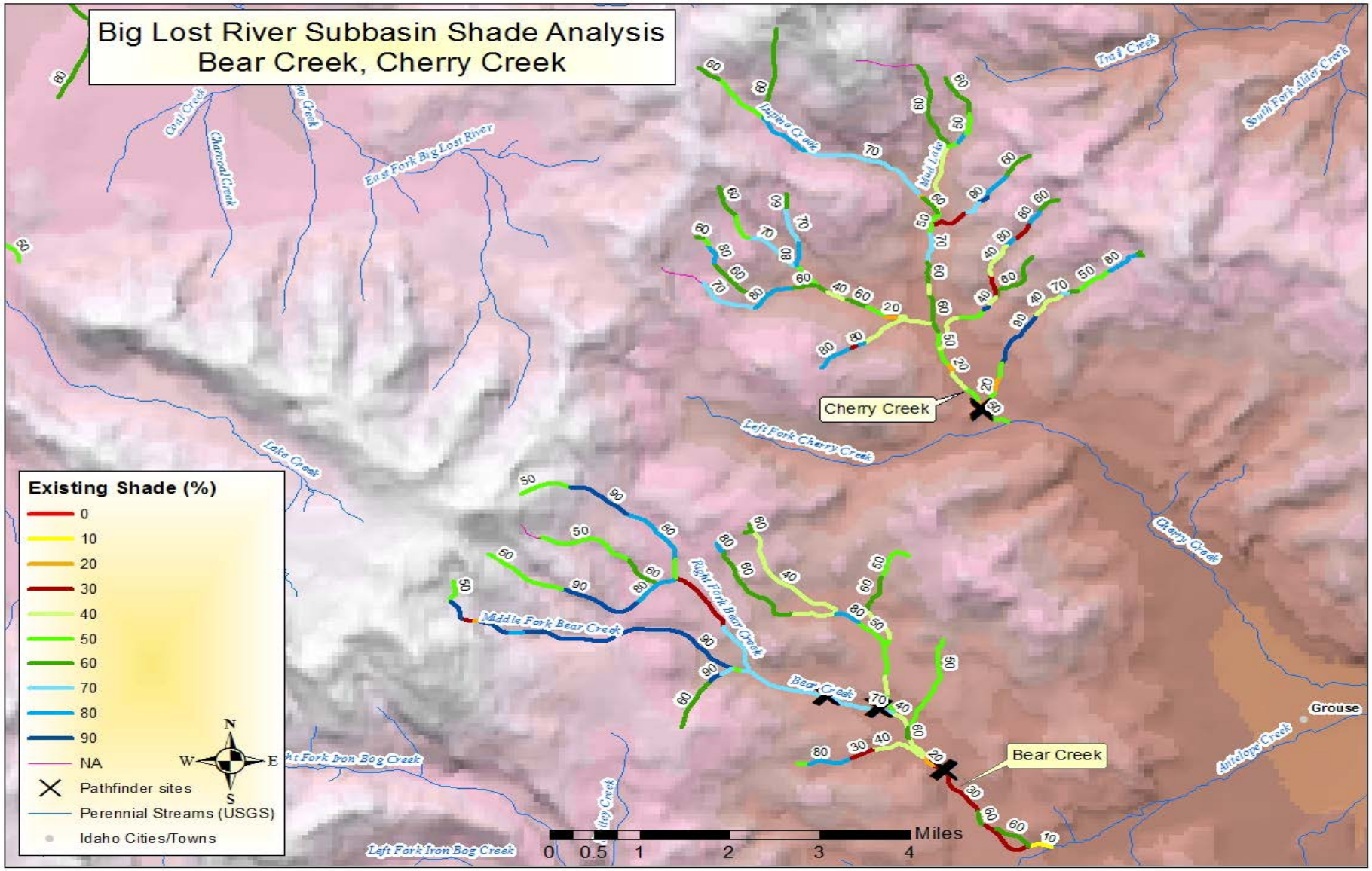

Figure C-7. Existing shade estimated for the Bear Creek and Cherry Creek watersheds by aerial photo interpretation.

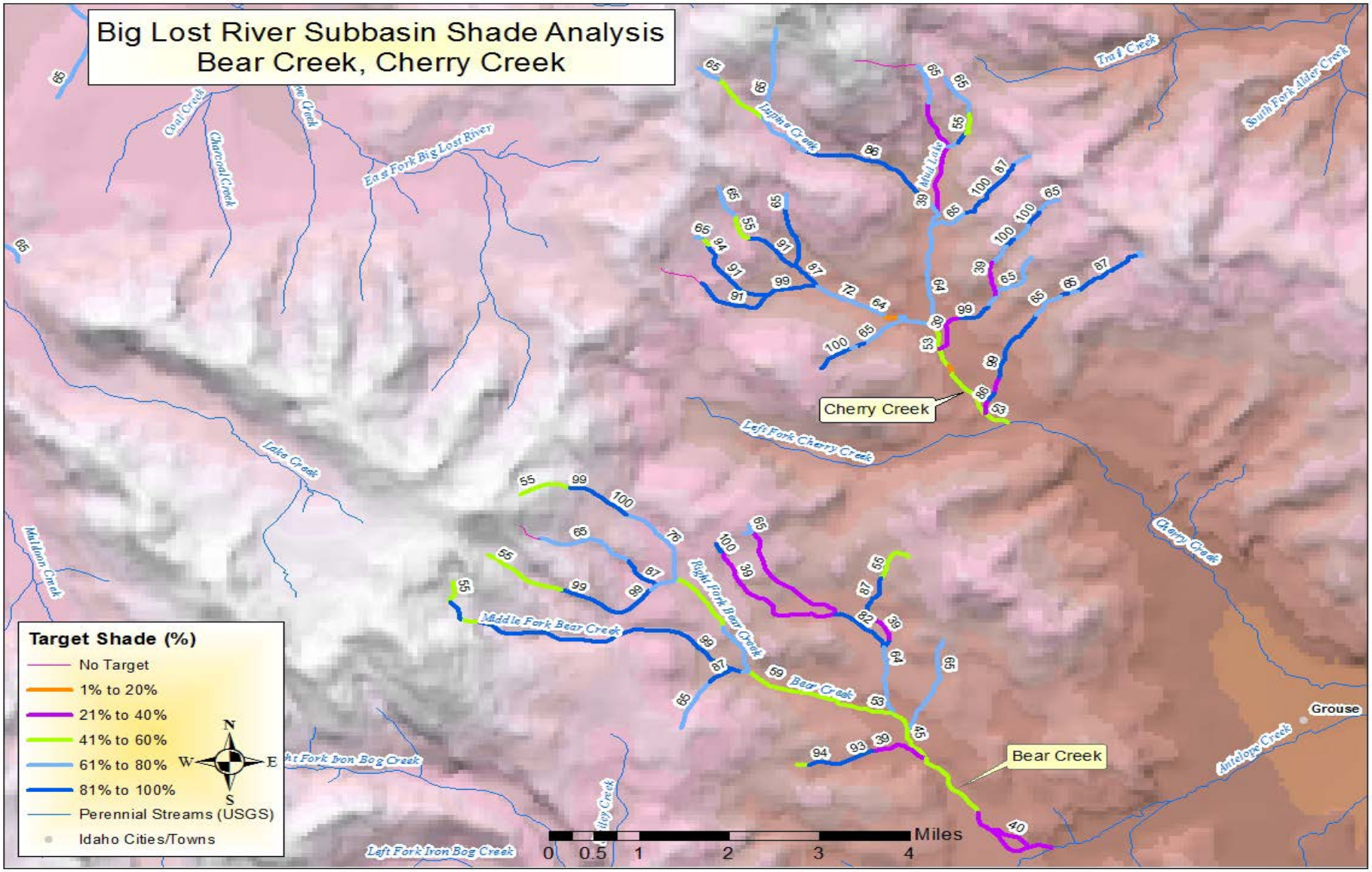

Figure C-8. Target shade for the Bear Creek and Cherry Creek watersheds.

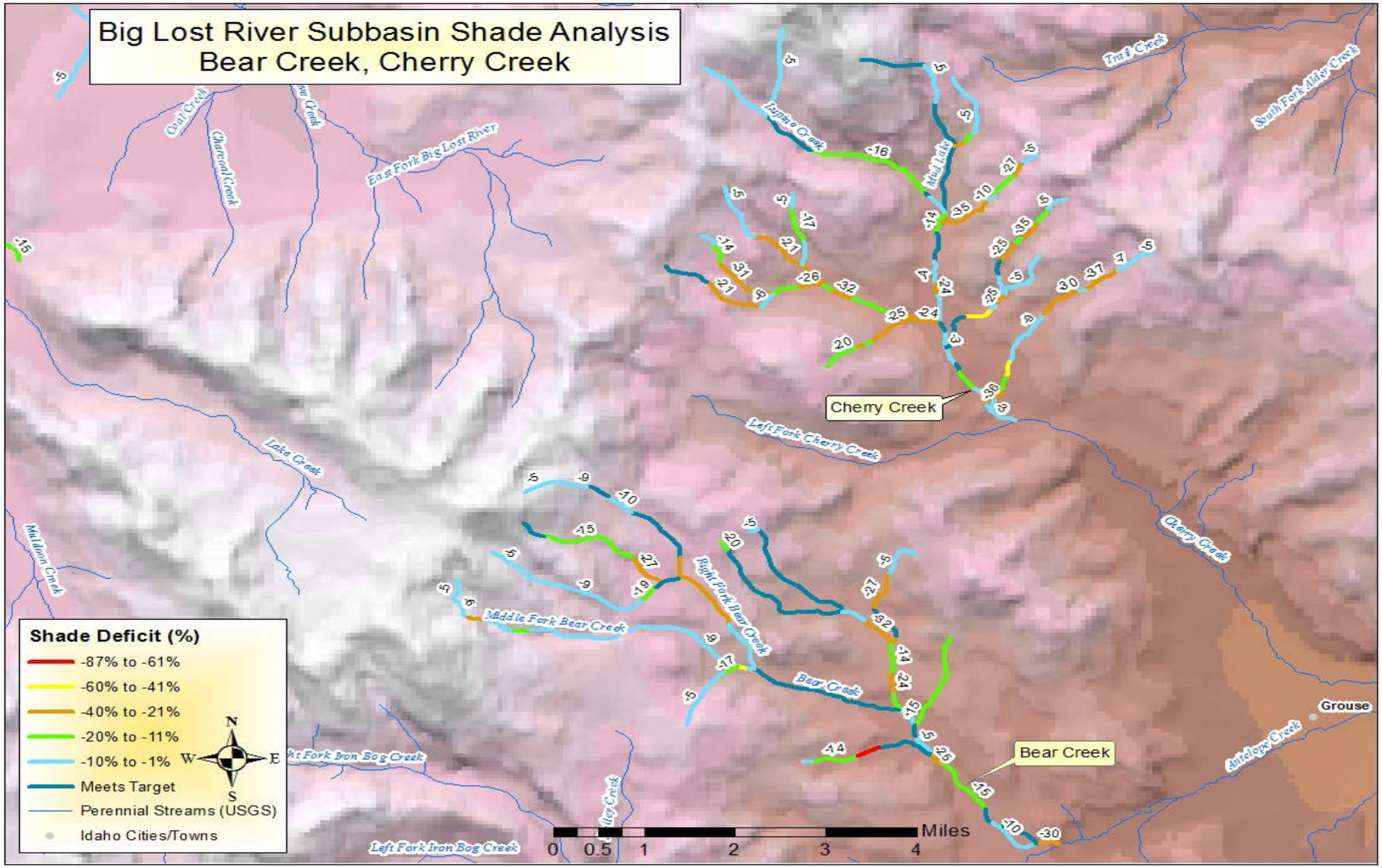

Figure C-9. Shade deficit (difference between existing and target) for the Bear Creek and Cherry Creek watersheds.

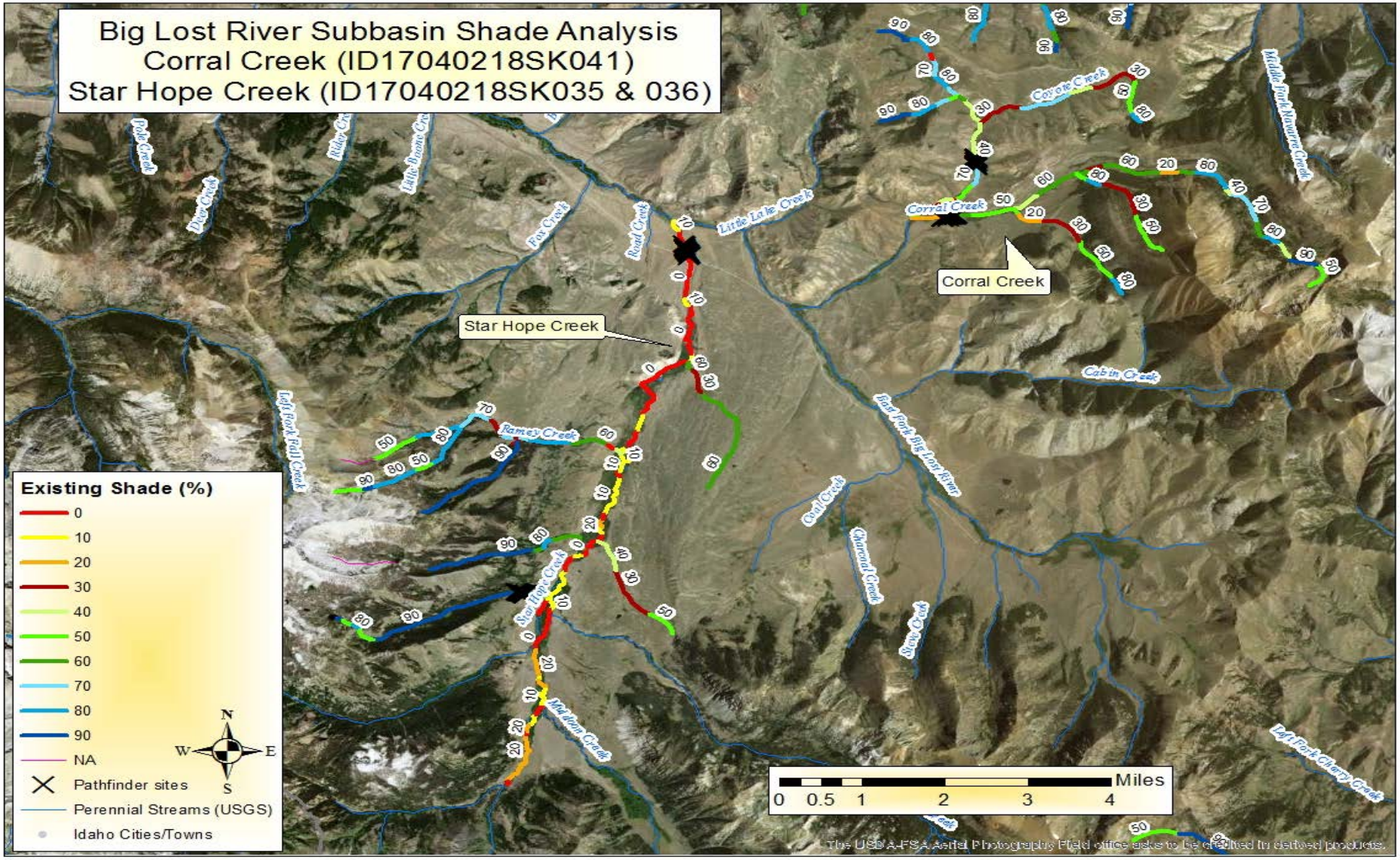

Figure C-10. Existing shade estimated for the Corral Creek and Star Hope Creek watersheds by aerial photo interpretation.

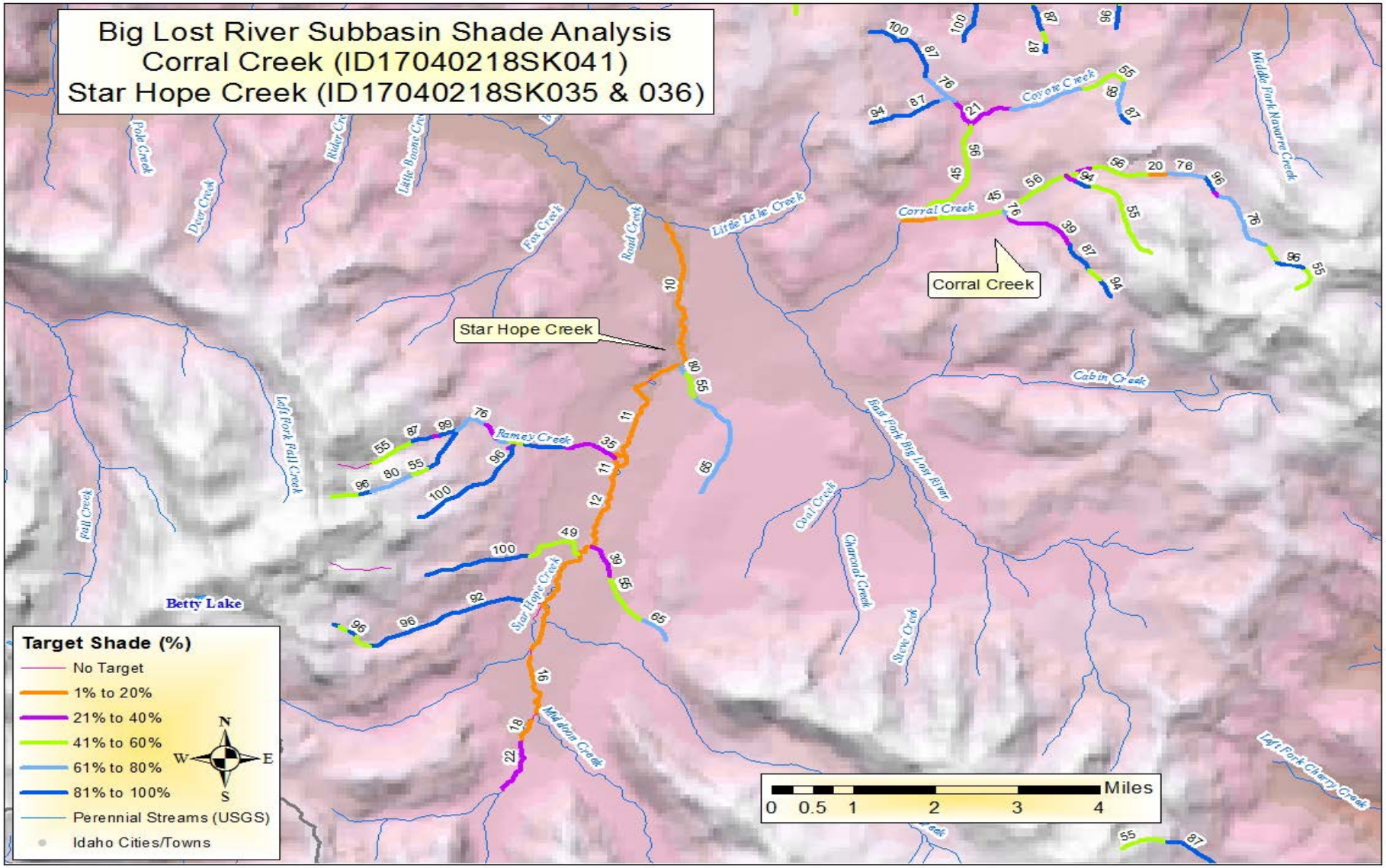

Figure C-11. Target shade for the Corral Creek and Star Hope Creek watersheds.

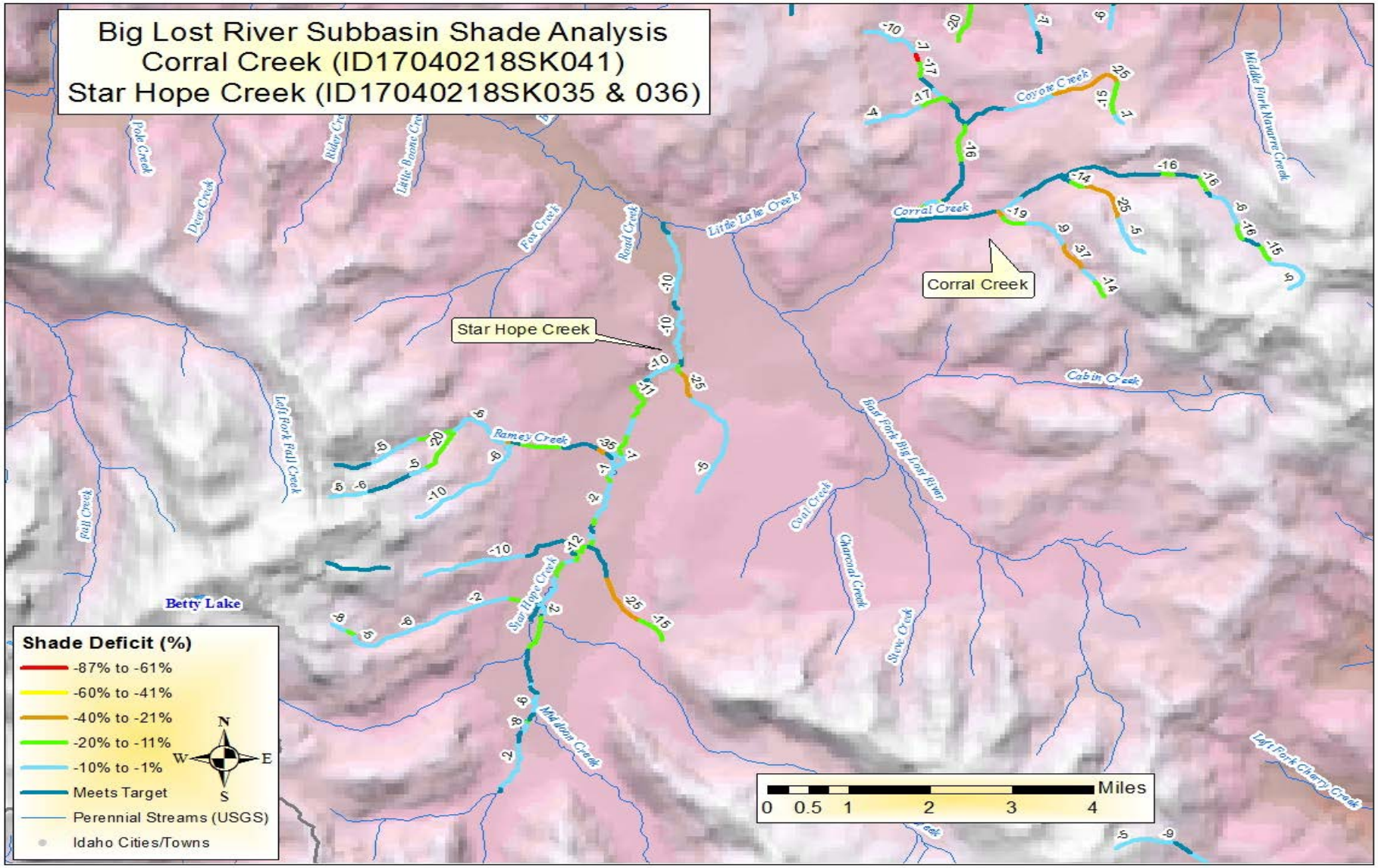

Figure C-12. Shade deficit (difference between existing and target) for the Corral Creek and Star Hope Creek watersheds.

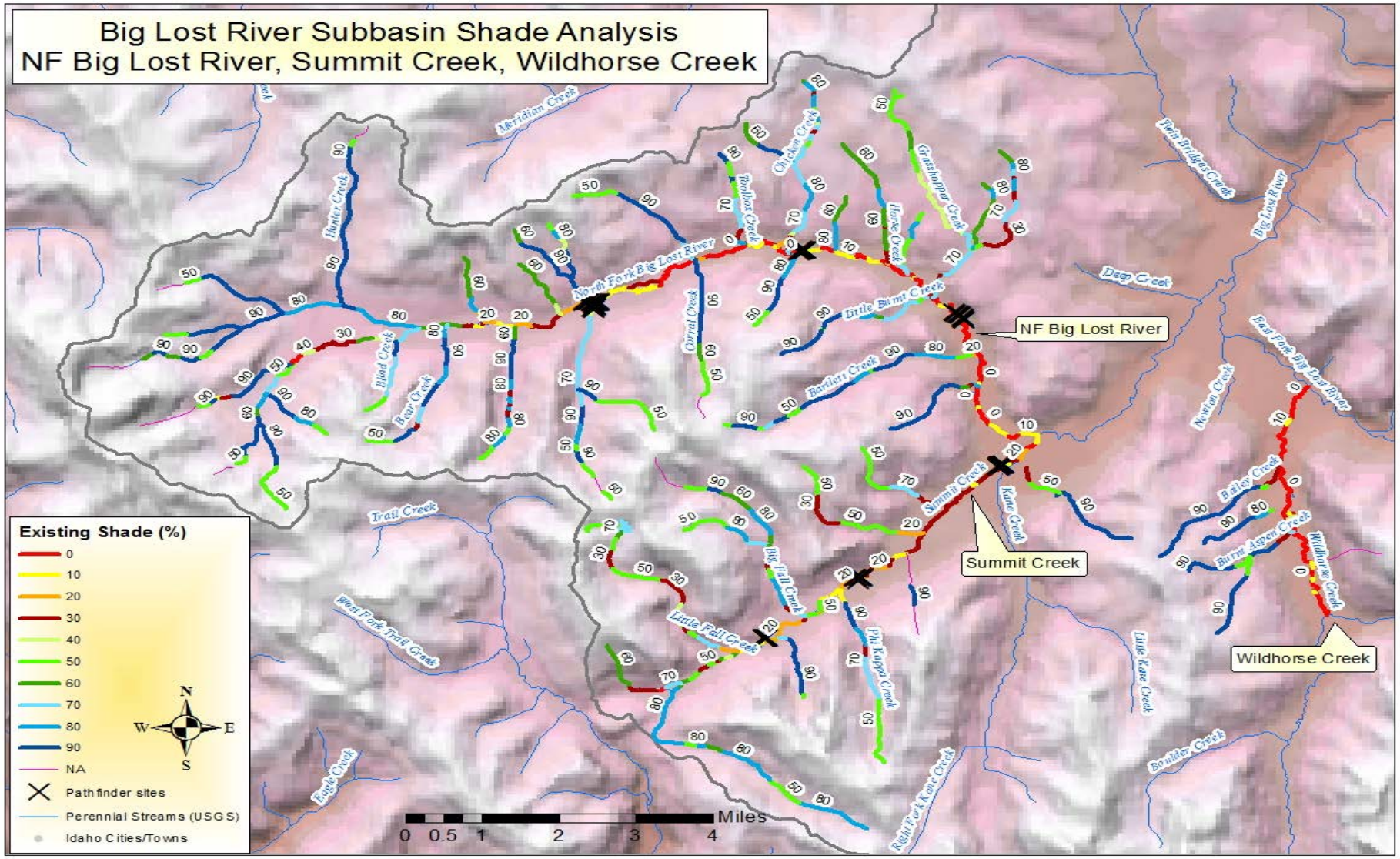

Figure C-13. Existing shade estimated for the North Fork Big Lost River, Summit Creek, and Wildhorse Creek watersheds by aerial photo interpretation.

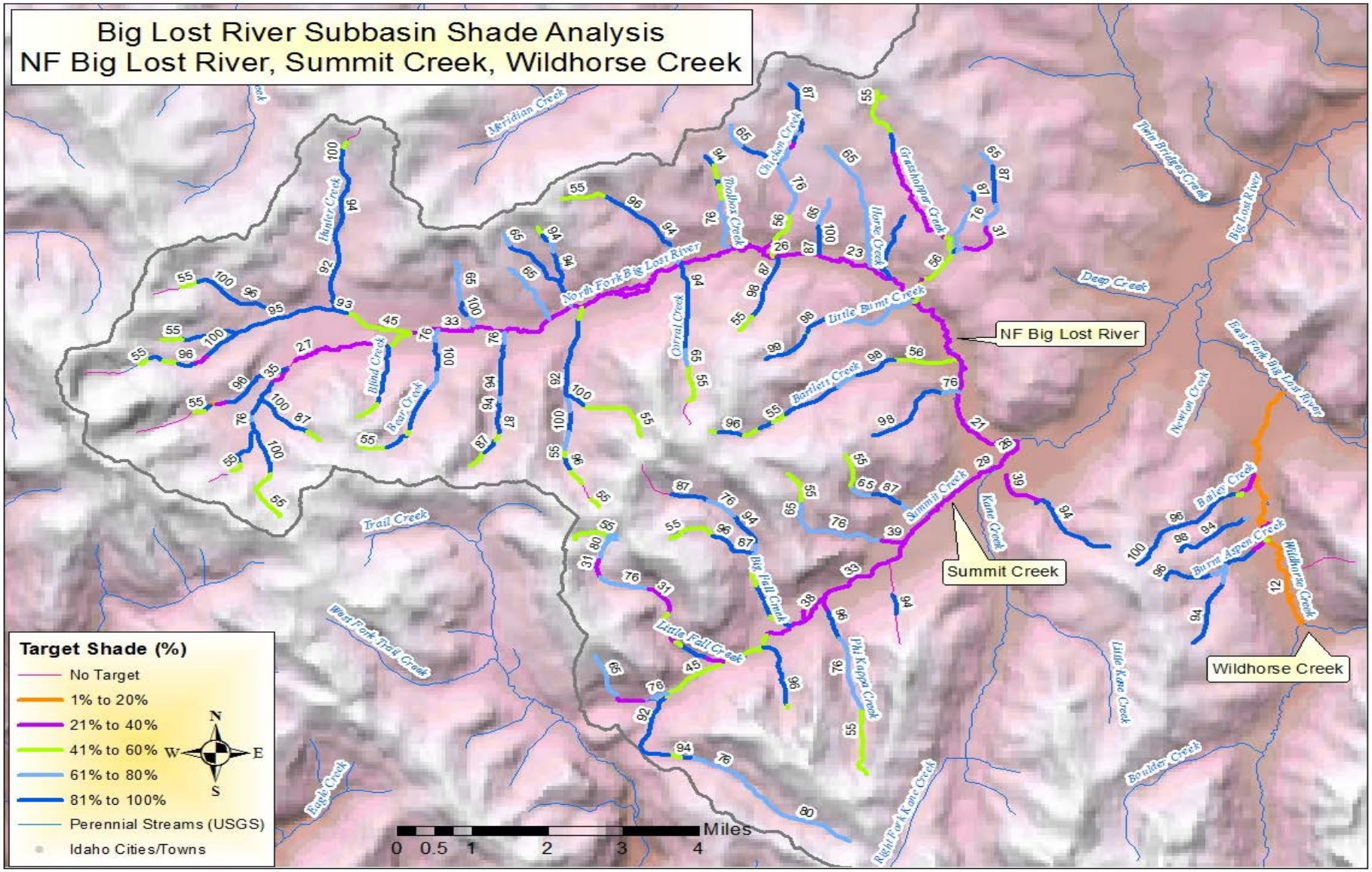

Figure C-14. Target shade for the North Fork Big Lost River, Summit Creek, and Wildhorse Creek watersheds.

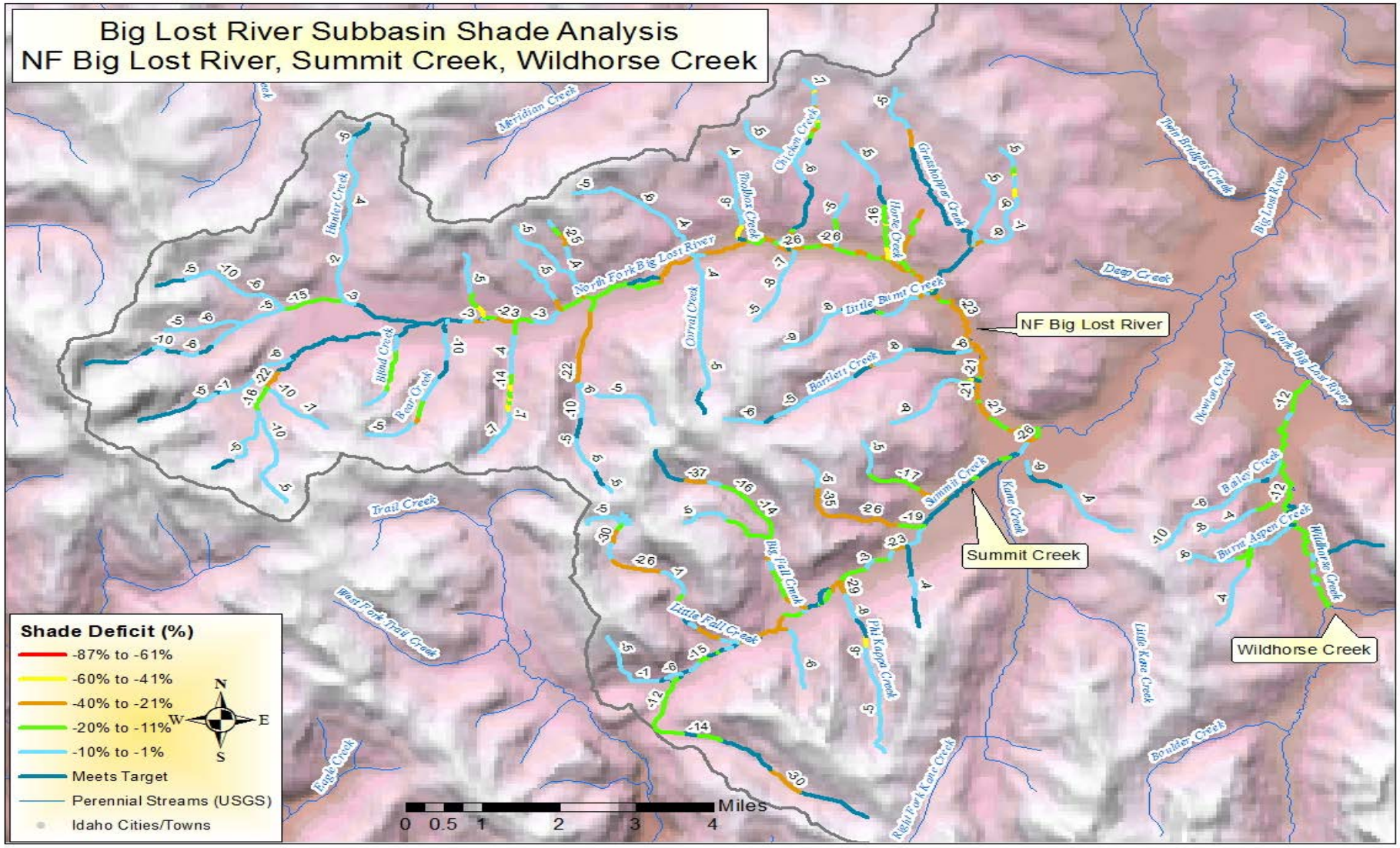

Figure C-15. Shade deficit (difference between existing and target) for the North Fork Big Lost River, Summit Creek, and Wildhorse Creek watersheds.

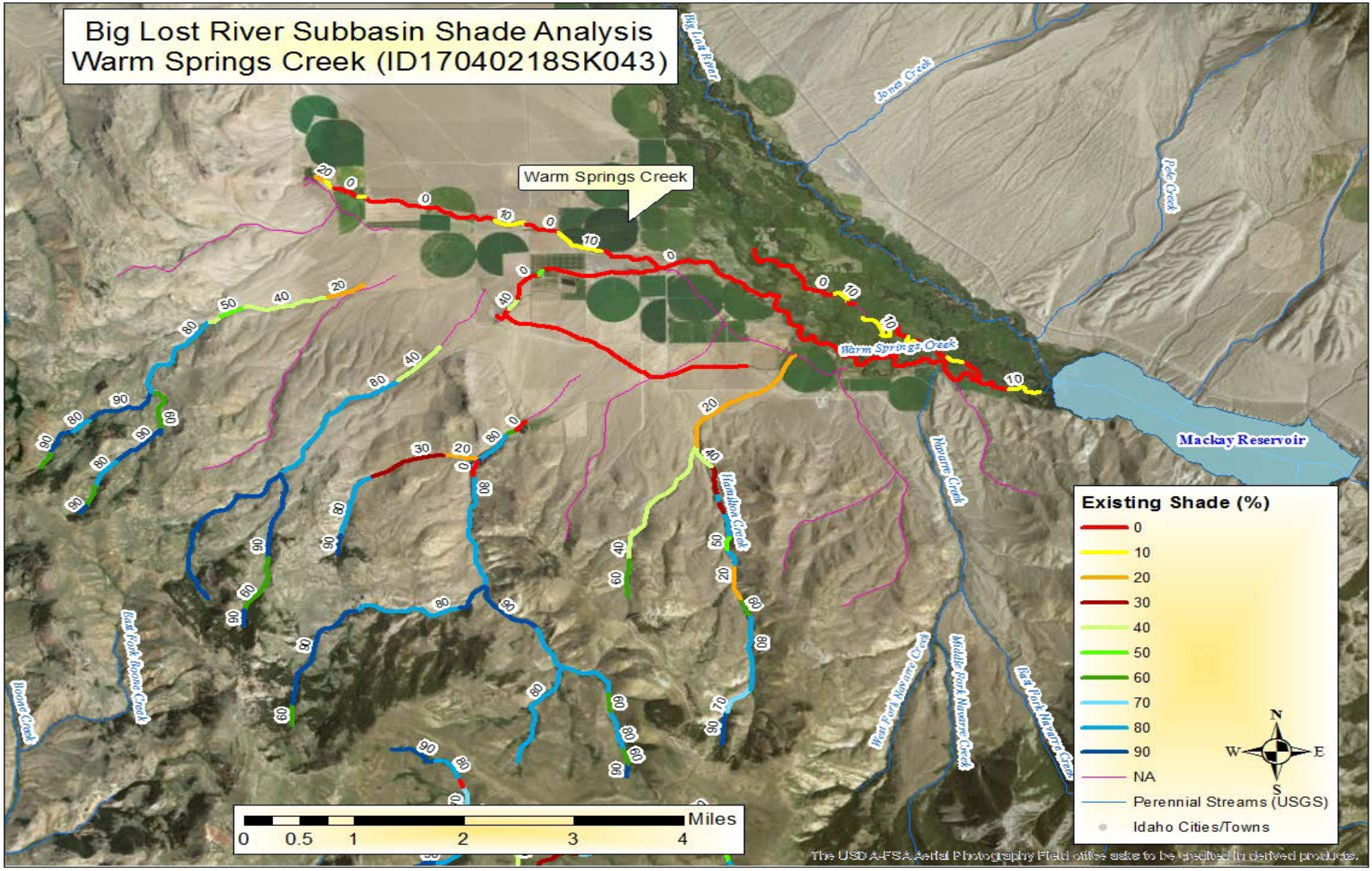

Figure C-16. Existing shade estimated for the Warm Springs Creek watershed by aerial photo interpretation.

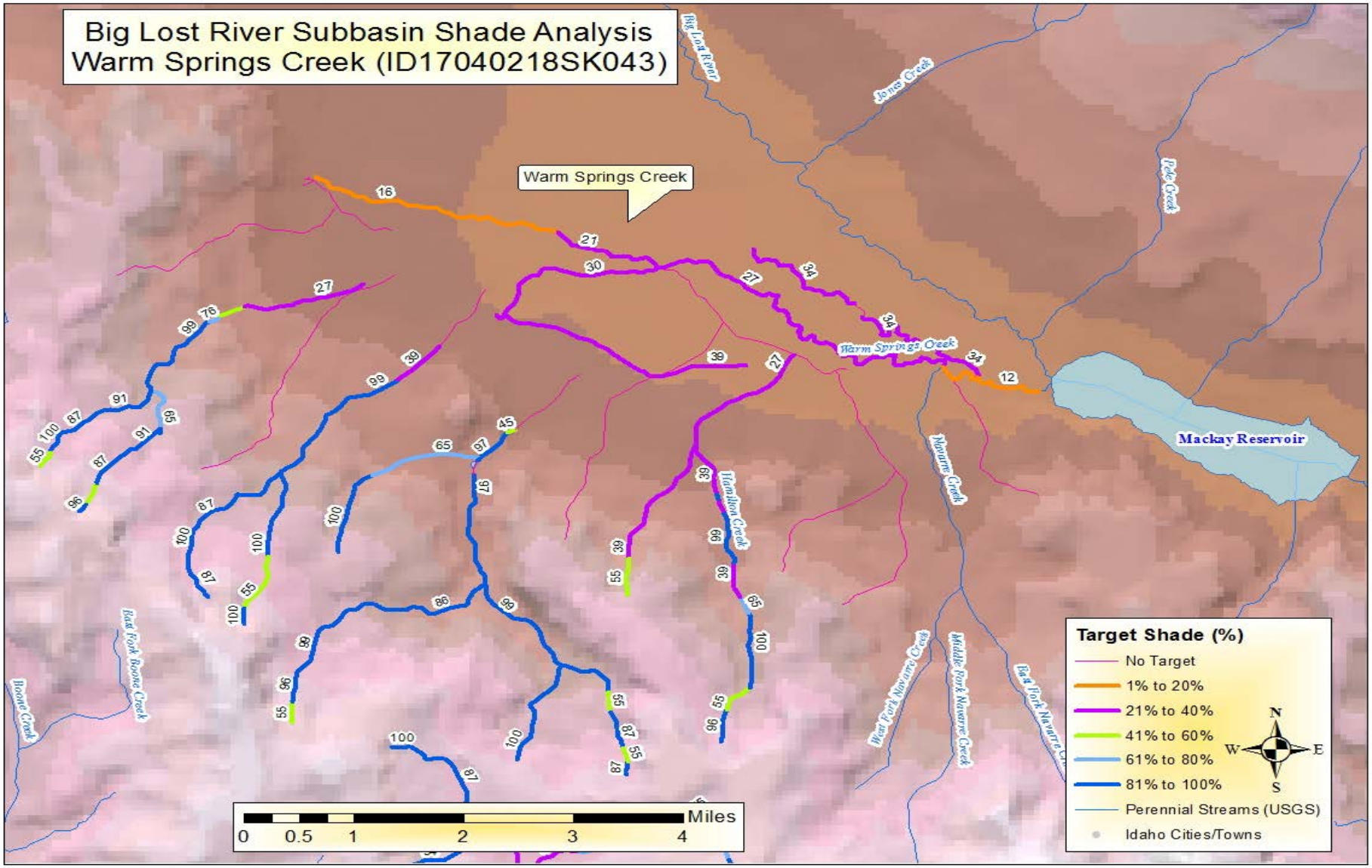

Figure C-17. Target shade for the Warm Springs Creek watershed.

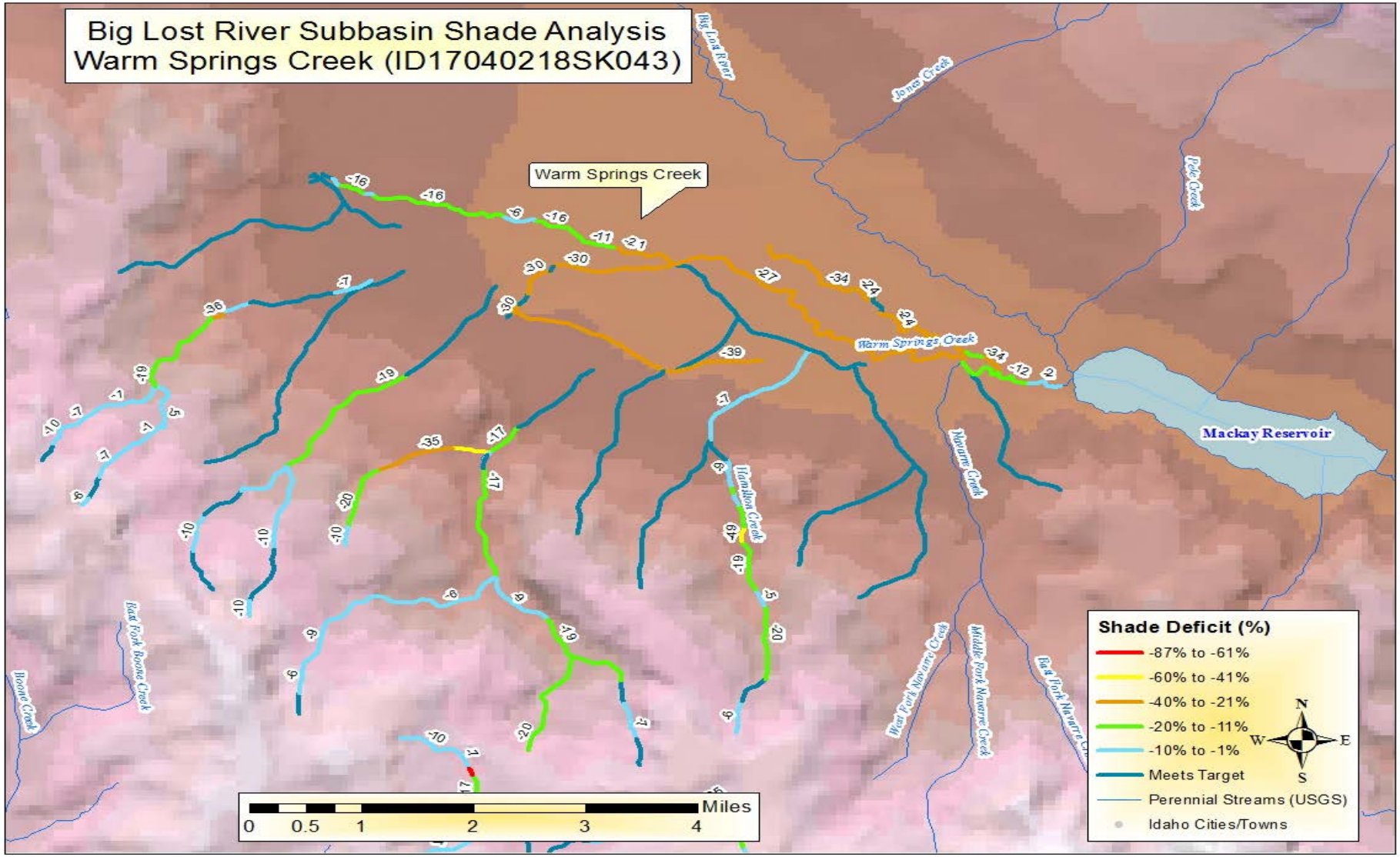

Figure C-18. Shade deficit (difference between existing and target) for the Warm Springs Creek watershed.

Appendix D. Idaho Department of Fish and Game Mackay Fish Hatchery and Clear Springs Foods, Inc. Lost River Hatchery Waste Load Allocation Modification (HUC 17040218)

Introduction

The 2004 Big Lost River subbasin assessment and total maximum daily loads (TMDLs) contained waste load allocations for the Idaho Department of Fish and Game (IDFG) Mackay Fish Hatchery and the Clear Springs Foods, Inc. Lost River hatchery. These wasteload allocations were based solely on Idaho's water quality standards for salmonid spawning and contained a 9 °C daily average during the salmonid spawning season, March 1 through June 30 and September 15 through November 15. After US Environmental Protection Agency (EPA) approval, the Idaho Department of Environmental Quality (DEQ) discovered the spring sources for both hatcheries used spring water that was at or above the 9 °C wasteload allocation, resulting in near continuous excursions of the wasteload allocation. Because this wasteload allocation was included in EPA's General Aquaculture National Pollutant Discharge Elimination System (NPDES) permit, the IDFG facility has not complied with the wasteload allocation, must report continual exceedances of temperature on monthly Discharge Monitoring Reports (DMRs), and has no mechanism to reduce spring temperatures to achieve compliance with the wasteload allocation. DEQ, in cooperation with IDFG and Clear Springs Foods collected temperature information to modify the wasteload allocation to accurately reflect the natural spring temperatures.

IDFG Mackay Fish Hatchery (Permit # IDG-130000)

IDFG maintains and operates the Mackay Fish Hatchery at the headwaters of Warm Springs Creek, in the Big Lost River watershed. The springs collectively produce 16 to 23 cubic feet per second (cfs) of water, depending on seasonality. The Mackay Fish Hatchery collects subsurface spring flows from sources within 150 feet of each other. Spring water is collected into underground pipes before it enters the hatchery. The springs' water temperatures are constant and range from 10 °C to 13 °C (50°F to 54ºF). The two most significant spring sources, the "Six Pack" and "Hole" sources have constant temperatures of 13.0 °C and 10.6 °C, respectively. The springs flow together and mix, with a resulting temperature of 11 ºC, which has remained constant since the 1983 Borah Peak earthquake. This 11 ºC water is piped underground to four potential locations: hatchery house, large raceways, small raceways, and hole raceways (Figure D-1). IDFG collected continuous data at these locations in an attempt to determine which individual sources added the most heat. Unused water flows directly to the outfall structure for discharge.

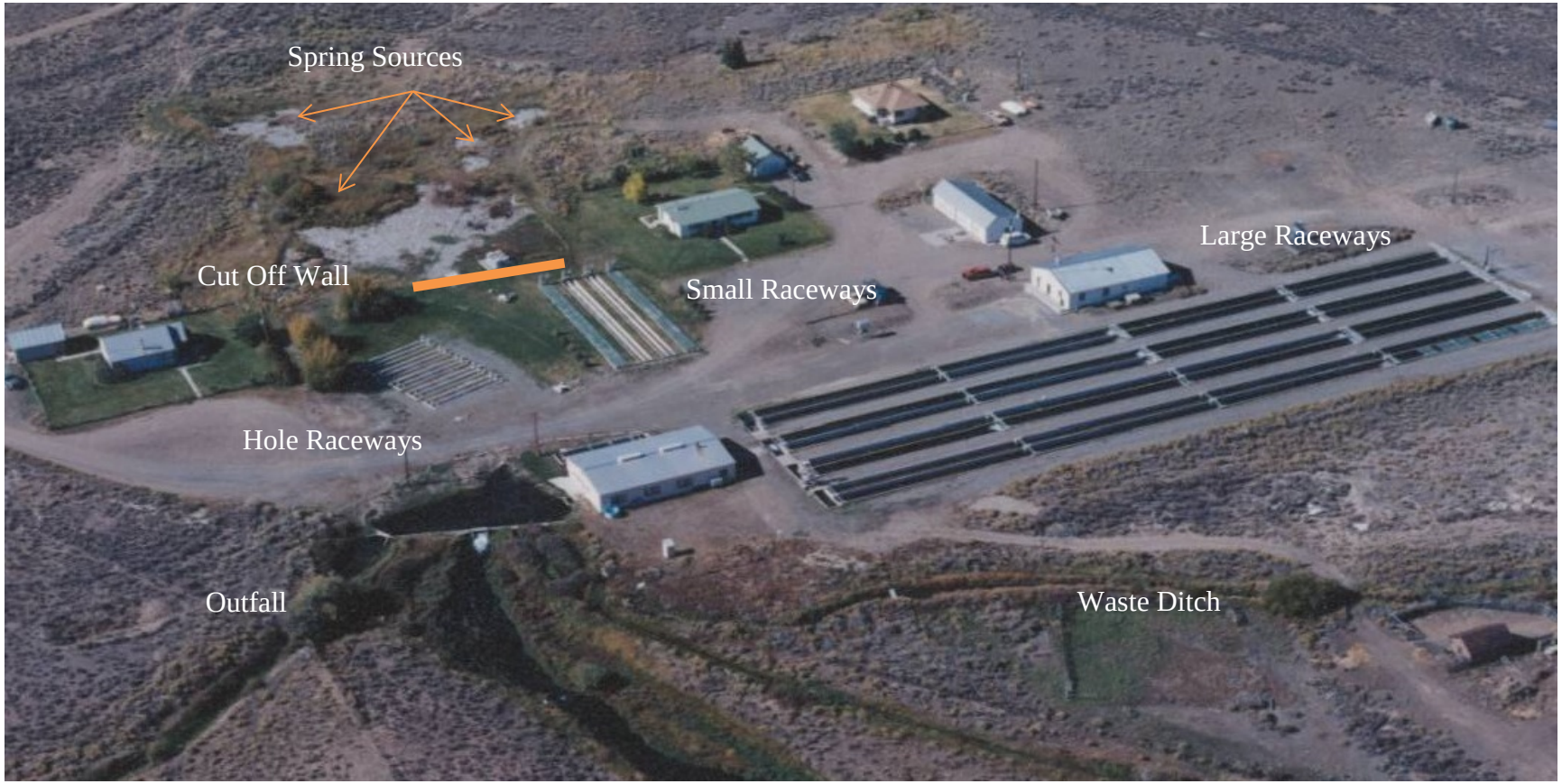

Figure D-1. Aerial view of the Mackay Fish Hatchery.

Temperature Records

The spring source was fully covered with large boulders and cobble in 1984 to protect the water from hatchery contamination. From 1984–1994, measured temperature at the inflow of water to the hatchery and the combined outfall were collected with a thermometer immersed in water until stabilized, then removed after recording. Shown in Table D-1, data are averages of these "dip" recordings as reported by IDFG. During 1984–1996, the monthly average hatchery effluent temperature was 11.9 ºC with a range from 11.1 °C to 12.6 °C (Figure D-2). IDFG staff continuously monitored temperatures at the spring sources and various locations by placing Onset Hobo model continuous thermistors around the facility in 2008 through February 2015 (Table D-1) In addition, spring temperatures are monitored monthly for DMR purposes. Figure D-3 displays the monthly average temperatures for the combined spring sources and the outfall. During the monitoring period (2008–2015), the annual average effluent temperature was 10.9 °C, slightly less than the combined spring's input. Each record contained at least 70,000 data points representing temperatures taken in 30-minute intervals. This data set represents 1,021 days of temperature information, spanning all of the salmonid spawning seasons for the area. Figure D-4 displays the 1,021 daily average temperatures for both the spring source and the outfall.

Table D-1. Measured temperature at the Mackay Fish Hatchery (2008–Feb 2015).

Location	Average Temperature (ºC)
Combined spring sources	11.1
Outfall (2008–Feb 2015 continuous loggers)	10.9

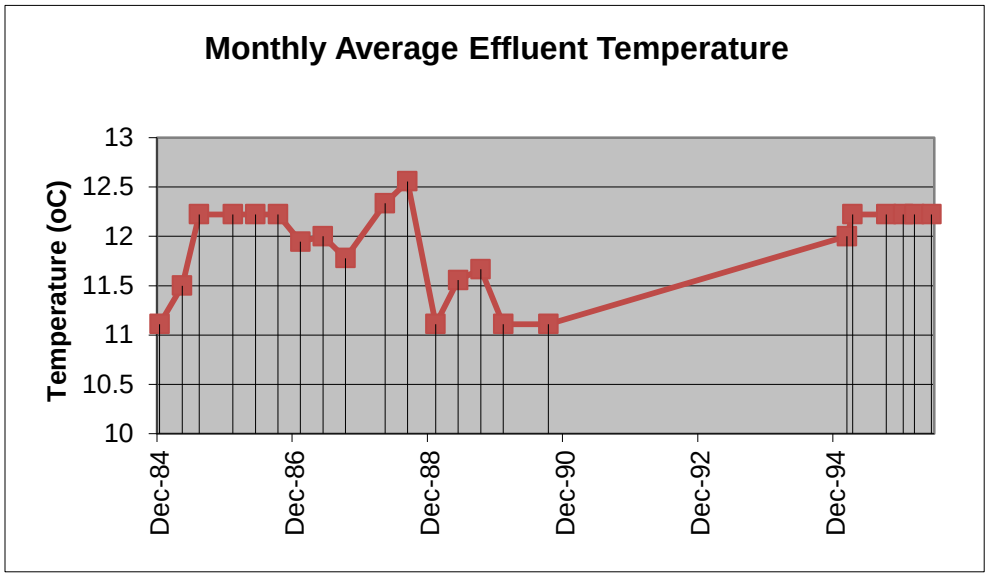

Figure D-2. Historic monthly effluent temperature 1984–1996.

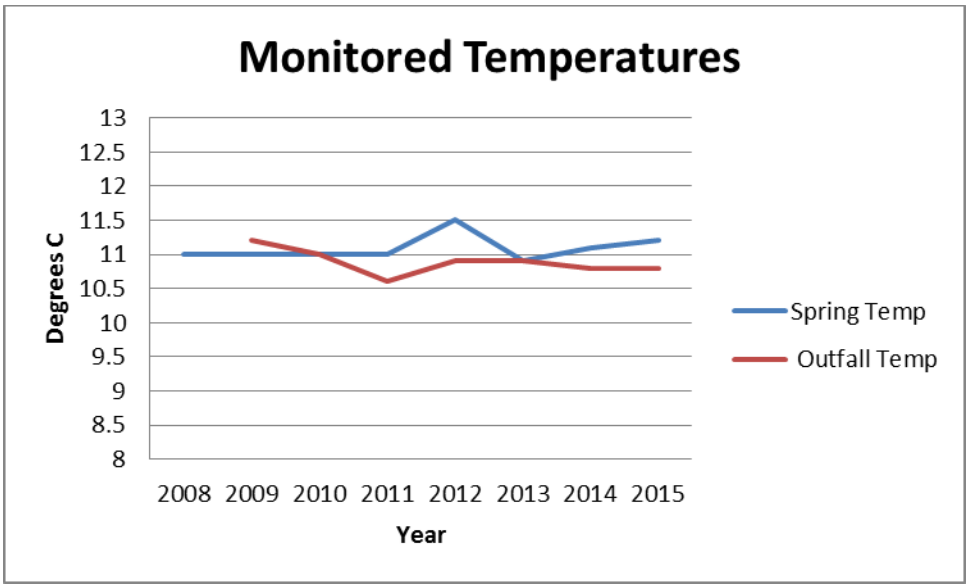

Figure D-3. Monitored spring and outfall temperature 2008–2015, monthly averages.

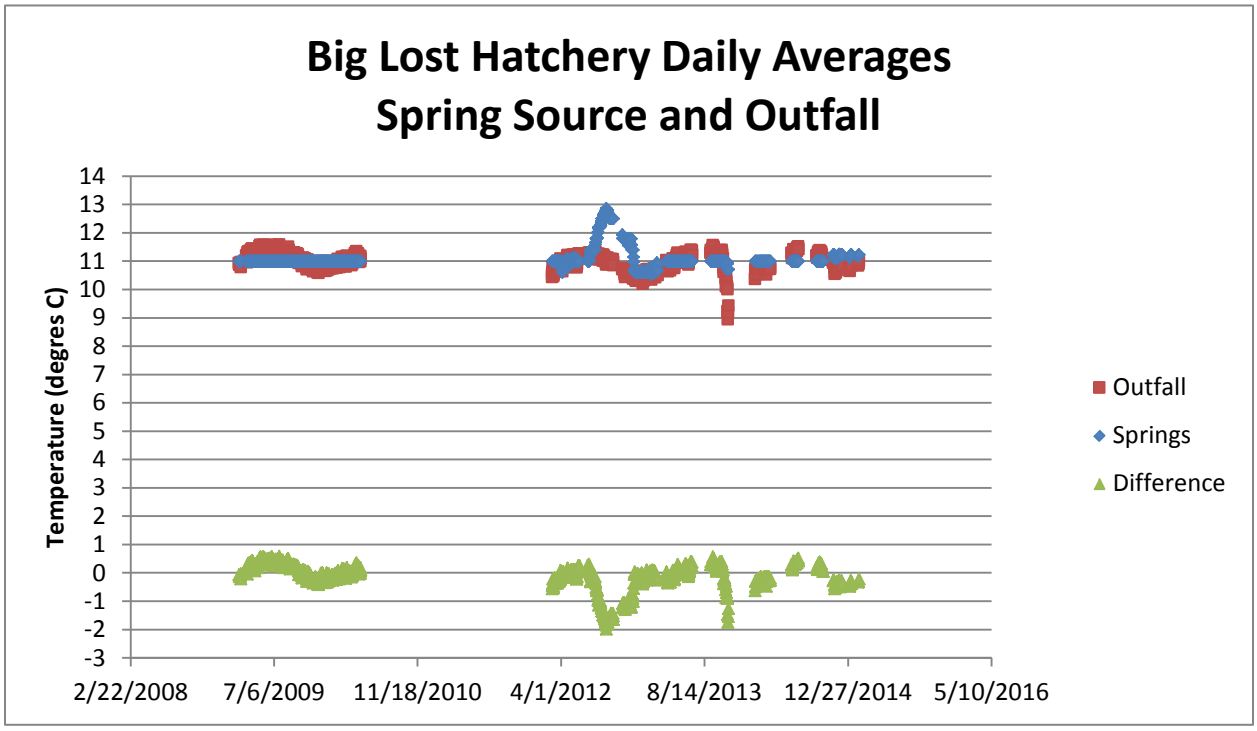

Figure D-4. Mackay Fish Hatchery daily averages spring source and outfall.

When the data are examined for daily averages and daily differences between the spring and outfall, 543 of 1,021 (53%) daily averages display a net water cooling between the spring source and outfall; 284 of 1,021 (28%) display temperature increases of less the 0.3 ºC, while 180 of 1,021 (18%) indicate temperature increases of more than 0.3 ºC. The daily differences are displayed in Figure D-5.

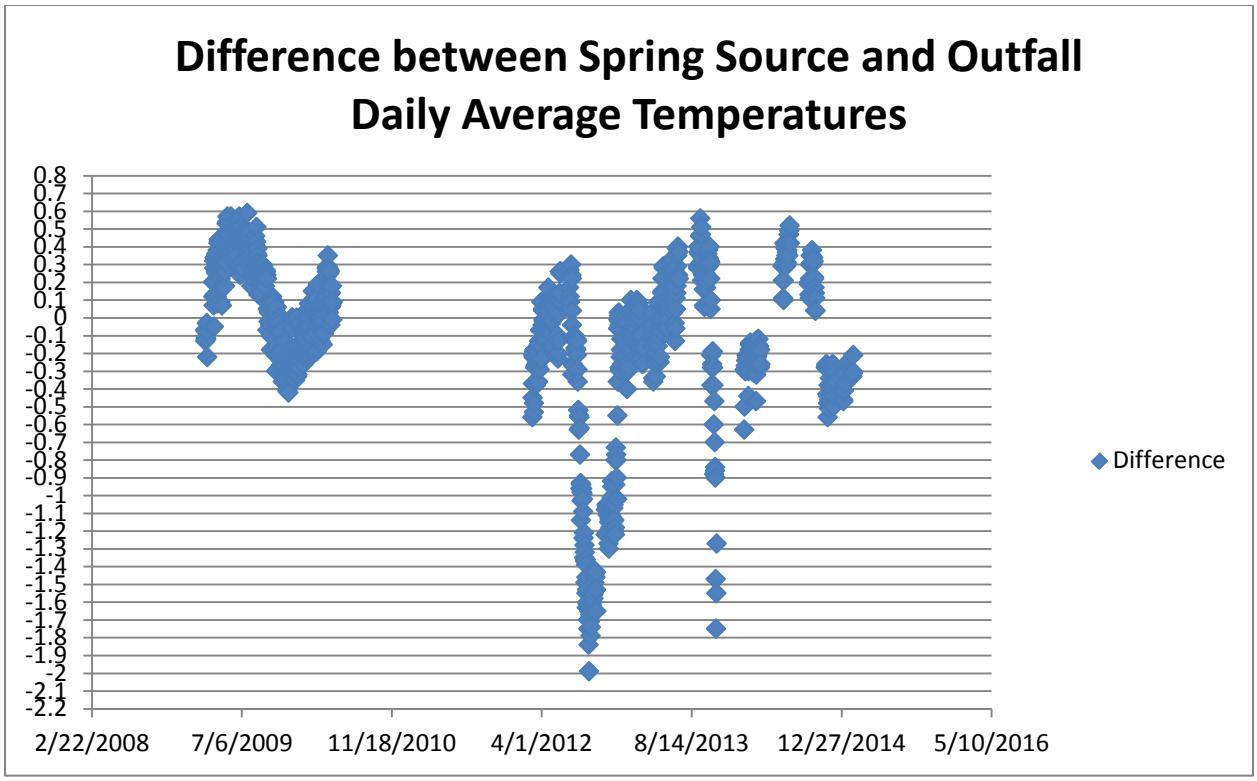

Figure D-5. Difference between spring source and outfall daily average temperatures.

Clear Springs Foods, Inc. Lost River Hatchery (Permit # IDG-130000)

The Lost River Hatchery is located on the northern headwaters tributary of Warm Springs Creek. Similar to the IDFG facility, the Lost River Hatchery collects water directly as it is expressed from the spring source and immediately uses the water in aquaculture activities. Currently, the facility is not in use. Purchased by Clear Springs Foods, Inc., the hatchery is undergoing significant upgrades and construction. All the old holding tanks and raceways were removed and new construction is planned for 2015.

Clear Springs Foods collected temperature information in 2012 and 2013. Figure D-6 and Figure D-7 display 2012/2013 data reflecting the old configuration of point of diversion and delivery to the old hatchery under previous ownership. All spring temperatures were below 9 °C. In 2013, Clear Springs added additional spring sites, identified as S1 and S2 where they emerge from the ground. Each site is protected by a roof-shingled spring box. Site P1 is a pool created by a cement dam that captures additional water for diversion into the fish farm. Site H1 represents the location where S1 may enter the new hatchery. The difference in temperature between S1 and H1 results from current exposure in stream channels. It appears the spring near the point of use may exceed 9 °C, creating the same compliance issues for the Lost River Hatchery that currently occur for the IDFG Mackay Fish Hatchery.

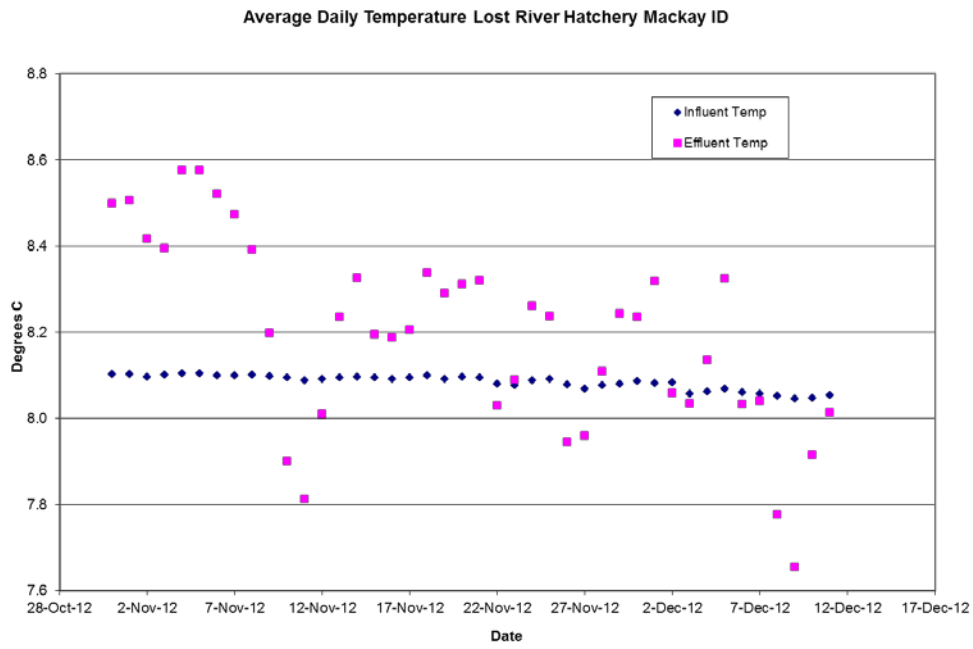

Figure D-6. Lost River Hatchery average spring and effluent temperatures.

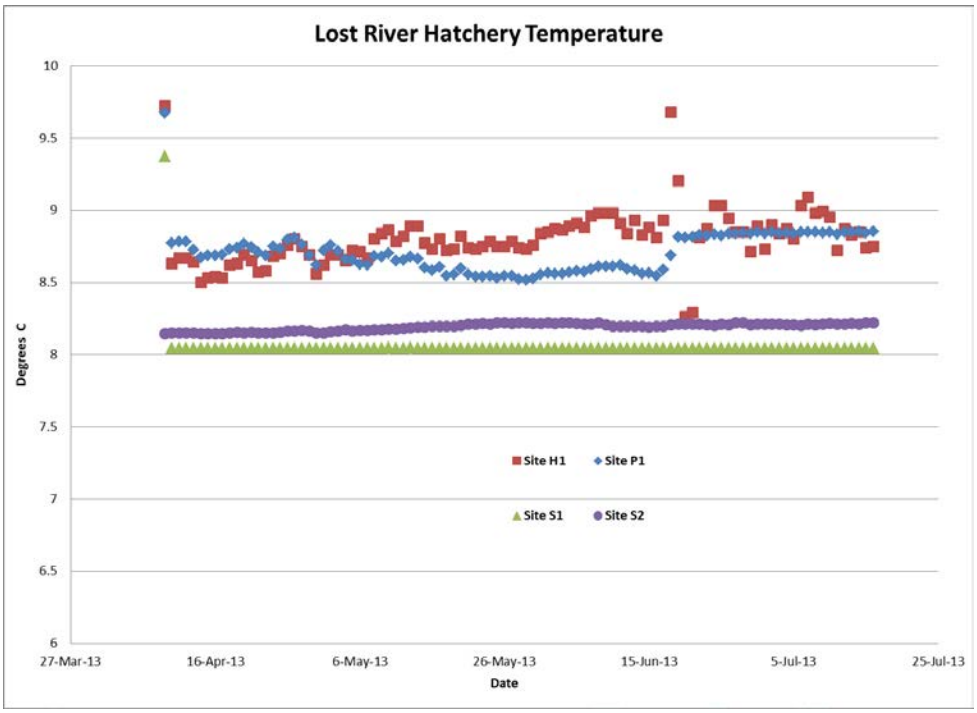

Figure D-7. Lost River Hatchery sources and potential points of use.

Continued Monitoring

DEQ will establish a period of temperature records in Warm Springs Creek below each facility and at a combined downstream location to assess the Warm Springs assessment unit's (AU's) beneficial use support status for salmonid spawning related to temperature. Figure D-8 displays approximate temperature monitoring locations.

Figure D-8. Proposed temperature monitoring network.

Modified Waste Load Allocation

Based on the collected data, the hatcheries do not continually increase the temperature of the spring sources before they are discharged from the present day outfall structure. The current wasteload allocation for both hatcheries is to meet the numeric state water quality standard including salmonid spawning temperatures during spring and fall months. Meeting the standard is not possible because the source water at the Mackay Fish Hatchery (11 °C) already exceeds the 9°C daily average for salmonid spawning. However, to protect salmonid spawning to the extent practicable, DEQ is modifying the current temperature wasteload allocation for the hatcheries to the inflow daily average temperature plus 0.15 ºC for each facility. This wasteload allocation is consistent with IDAPA 58.01.02.400.01(b), which allows for up to a 0.3 °C temperature increase above natural background. This 0.3 ºC increase must be divided between all the point sources found within the AU; specifically the Mackay Fish Hatchery and Lost River Hatchery. The wasteload allocation also reflects the actual natural background conditions for temperature. Each facility will need to measure continuous inflow temperature daily to determine compliance. Upon approval of this modification, the temperature wasteload allocations in the 2004 TMDL will no longer apply and the new wasteload allocations will become part of the next General Aquaculture Permit.

Reasonable Assurance

Providing reasonable assurance for the point sources to meet the wasteload allocation is a necessary requirement of this wasteload allocation modification. The reasonable assurance for each facility is outlined below.

Mackay Fish Hatchery

The Mackay Fish Hatchery facility does not appreciably impact Warm Springs Creek temperatures year round, and data suggest approximately 18% of the monitored daily averages will exceed the wasteload allocation. Four factors suggest the hatchery is currently implementing the most practicable best management practices (BMPs), presented below.

Retention Time

Water used by the hatchery does not have an extended period of time for heat addition when used by the hatchery. During full production, the large raceways have a retention time of 58 minutes, the small raceways keep water 22 minutes, and the hole raceways average 35 minutes. From September through March (7 months per year), the retention times are typically only half as long, due to the lower production levels.

Shade

During the summer months, IDFG covers the raceways with shade cloth, mounted on a frame. While designed to reduce sun burn on juvenile fish, heat stress is also reduced. The shade cloth also reduces solar insolation. Approximately 75% of the active hole and small raceways are covered during the summer months, and 10% of the large raceway is covered (Figure D-1).

Spring Sources

The spring sources are covered in coarse, durable rock over the entire wetland area where the springs once emerged (Figure C-9). Constructed in 1984, the original intention of the rock cover was to protect the springs from contamination, but the rock cover also provides substantial temperature buffering during the high-temperature summer months.

Temperatures

Inflow and outflow temperatures vary little from each other for many portions of the year.

Figure D-9. Covered spring sources location at the Mackay Fish Hatchery.

Lost River Hatchery

Because the facility is not operating but being rehabilitated, the Lost River Hatchery was designed and will be constructed in a manner reflecting the current state of BMPs for aquaculture facilities. Like the Mackay Fish Hatchery, the use of shade cloth over raceways, spring source protection and temperature monitoring will demonstrate compliance with the wasteload allocation.

Public Participation

The wasteload allocation modification for the two facilities was discussed with the Upper Snake basin advisory group on April 1, 2015. The wasteload allocation modification will go to public comment for 30 days and upon EPA approval, incorporated into the next General Aquaculture Permit and Clean Water Act §401 certified by DEQ as compliant with Idaho's water quality standards.

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Appendix E. Public Comments

[To be added following the public comment period.]

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Appendix F. Distribution List

[To be added following the public comment period.]

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