South Fork Salmon River Subbasin Temperature Total Maximum Daily Loads and Revised Sediment Targets:

Addendum to the SF Salmon River Subbasin Assessment and TMDL

Department of Environmental Quality

February 2012

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Acknowledgments

Cover photo of Johnson Creek taken by Mark Shumar on September 9, 2009.

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Abbreviations, Acronyms, and Symbols

§303(d) Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section

AU assessment unit

BMP best management practice

BURP Beneficial Use Reconnaissance Program

C Celsius

CWA Clean Water Act

DEQ Department of Environmental Quality

EPA United States Environmental Protection Agency

FPA Idaho Forest Practices Act

GIS Geographical Information Systems

HUC Hydrologic Unit Code

I.C. Idaho Code

IDAPA Refers to citations of Idaho administrative rules

IDFG Idaho Department of Fish and Game

IDWR Idaho Department of Water Resources

LA load allocation

LC load capacity

m meter

mi mile

mi^2 square miles

MOS margin of safety

MWMT maximum weekly maximum temperature

NA not assessed

NB natural background

nd no data (data not available)

PNV potential natural vegetation

SBA subbasin assessment

TMDL total maximum daily load

U.S. United States

U.S.C. United States Code

USDA United States Department of Agriculture

USFS United States Forest Service

WAG Watershed Advisory Group

WLA wasteload allocation

WQS water quality standard

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Executive Summary

The federal Clean Water Act (CWA) requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the CWA, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the CWA establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently this list must be published every two years. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards.

This document addresses 14 named streams comprising 28 assessment units (Figure 1) in the South Fork Salmon River Subbasin that were recommended for listing for temperature in the 1991 South Fork Salmon River TMDL. This document addresses the temperature TMDLs for these streams. For more information about these watersheds and the subbasin as a whole see the *South Fork Salmon River Subbasin Assessment* (DEQ, 2002) and the South Fork Salmon River TMDL Five Year Review (DEQ 2011). This document also revises the sediment targets from the 1991 TMDL.

This TMDL analysis has been developed to comply with Idaho's TMDL requirements. The TMDL analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition that meets water quality standards and supports beneficial uses.

Subbasin at a Glance

The South Fork Salmon River Subbasin (HUC ID17060208) is located in central Idaho east of the cities of McCall and Cascade. The 4th order assessment unit of Johnson Creek is listed on Idaho's 2010 section 303d list for temperature as is the 2nd order assessment unit of Secesh River tributaries that includes Grouse Creek. The 2nd order assessment unit (AU) of Johnson Creek is listed for combined biota/habitat bioassessments and it was determined the cause of impairment was temperature. The 2nd order of Johnson Creek also includes Sand and Trout Creeks. All other streams examined in this document are suspected to have temperature problems because US Forest Service temperature data showed exceedance of salmonid spawning temperature criteria and were recommended for 303d listing in the South Fork Salmon River Subbasin Assessment (DEQ 2002).

Major portions of this subbasin were burned in wildfires in recent years. Much of the lack of shade on individual streams results from vegetation being burned away. Although natural recovery from wildfire begins with the next season's growth, shade on streams in forested systems will take many years to recover.

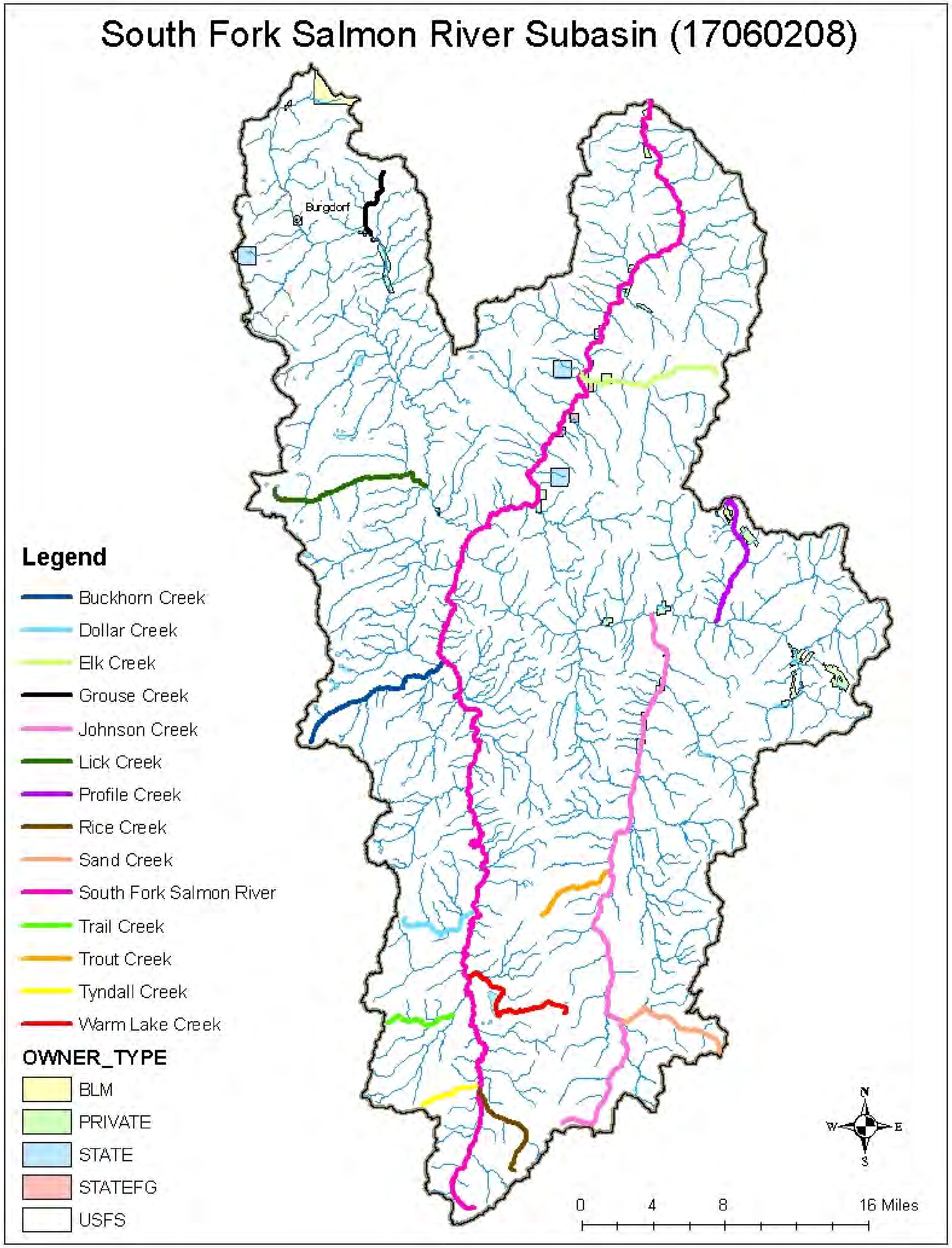

Figure 1.Subbasin at a glance.

Key Findings

DEQ analyzed 14 named streams covering 28 assessment units in the subbasin based on Forest Service temperature data and recommendations from the 2002 Subbasin Assessment (DEQ 2002) (Table 1).

Effective shade targets were established for 28 assessment units based on the concept of maximum shading under potential natural vegetation equals natural background temperature levels. TMDLs were established for 27 assessment units. Shade targets were actually derived from effective shade curves developed for similar vegetation types in Idaho. Existing shade was determined from aerial photo interpretation field verified with solar pathfinder data.

With the exception of Trail Creek and perhaps Profile Creek, all other streams in the analysis lack shade resulting in excess solar load. Many streams were further impacted by recent wildfire. Tributary streams in the Warm Lake area (Warm Lake Creek, Rice Creek, and Trout Creek) have been most affected, resulting in high excess solar loads. Elk Creek in the lower SF Salmon River area and Grouse Creek in the Secesh River Watershed also appeared to have been affected.

Some tributary streams were not as affected and have moderate levels of shade loss and excess solar loading. The lower canyon sections of the major rivers, the South Fork Salmon and Johnson Creek, are in relatively good condition with respect to shade primarily because they are wide with low shade targets to begin with, and are in a more sparsely vegetated dry forest zone. Meadow areas were similarly less impacted because of their lower shade targets.

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

In addition to developing temperature TMDLs, this TMDL addendum also provides a revision of the sediment targets used in the South Fork Salmon River (SFSR) TMDL to more closely reflect natural conditions in the watershed. These targets are based on the Payette and Boise National Forest Watershed Condition Indicators (WCI) for the SFSR watershed as shown in Table 2.

Table 1. Summary of temperature assessment outcomes.

Water Body Segment/ AU	Pollutant	TMDLs Completed	Recommended Changes to §303(d) List	Justification
Buckhorn Creek/ ID17060208SL012_02 ID17060208SL012_03 ID17060208SL012_04 ID17060208SL012_05	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; all AU's unlisted for temp but impaired
Dollar Creek/ ID17060208SL015_02 ID17060208SL015_03	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; SL015_03 unlisted for temp but impaired
Elk Creek/ ID17060208SL034_02 ID17060208SL034_03 ID17060208SL034_04	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; all AU's unlisted for temp but impaired

Water Body Segment/ AU	Pollutant	TMDLs Completed	Recommended Changes to §303(d) List	Justification
Grouse Creek/Secesh River Tribs ID17060208SL005_02	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade
Grouse Creek/Secesh River Tribs ID17060208SL005_03	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; unlisted for temp but impaired
Johnson Creek/Sand Creek/Trout Creek ID17060208SL025_02	Temperature	Yes	Move to Category 4A; de-list for combined biota/habitat bioassessments;	Excess Solar Load from Lack of Shade; temp found to be causal pollutant
Johnson Creek/ ID17060208SL025_03	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; unlisted for temp but impaired
Johnson Creek/ ID17060208SL025_04	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade
Lick Creek/ ID17060208SL009_02 ID17060208SL009_03	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; unlisted for temp but impaired
Profile Creek/ ID17060208SL031_02 ID17060208SL031_03	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; unlisted for temp but impaired
Rice Creek/ ID17060208SL018_02	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; unlisted for temp but impaired
Trail Creek/ ID17060208SL017_02	Temperature	No	None	No Excess Solar Load
South Fork Salmon River/Tyndall Creek ID17060208SL010_02 ID17060208SL010_03 ID17060208SL010_04 ID17060208SL010_05 ID17060208SL001_06	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade;unlisted for temp but impaired
Warm Lake Creek/ ID17060208SL019_02 ID17060208SL019_03 ID17060208SL020_02	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; unlisted for temp but impaired

Table 2. Proposed SFSR TMDL Sediment Monitoring Targets.

Sediment Target	Sediment Target
Interstitial Sediment Deposition (tributary SFSR target)	Any single mean free matrix count over 27% OR a five-year mean free matrix count of 17% or more.
Intragravel Quality (mainstem SFSR target)	5-year mean fines < 6.3 mm concentrations at depth of 28% or less with no more than two years between 28% and 36%.

1. Subbasin Assessment – Water Quality Concerns and Beneficial Use Status

The South Fork Salmon River TMDL Five Year Review (DEQ 2011) summarized more recent water quality data for the watershed. Data related to temperature is summarized here.

The Assessment Units (AUs) shown in Table 3 were determined not to meet federal bull trout spawning criteria in the 1991 TMDL based on U.S. Forest Service (USFS) data and are addressed in this temperature TMDL. Many of these streams were suggested for listing in the original TMDL due to the presence of roads in Riparian Habitat Conservation Areas (RHCAs). Current management practices that minimize riparian disturbance have likely improved riparian shading.

However, for all streams that did not meet the bull trout temperature criteria, PNV investigations were done to see if natural background conditions were met. SS TEMP modeling was done in the 2002 Subbasin Assessment, but, in the past five years, DEQ has adopted the PNV approach to more accurately assess natural background conditions. (Table 4 shows more recent data for those streams.)

Table 3. Streams that do not meet Bull Trout Spawning Criteria based on Forest Service temperature Data.

Water Body Segment/ AU	Pollutant	Justification
South Fork Salmon River/Tyndall Creek/SL010_02 SL010_03,SL010_04, SL010_05, SL001_06	Temperature	Federal bull trout temp criteria exceeded
Johnson Creek/Trout Creek/Sand Creek/SL025_02, SL025_03, SL025_04	Temperature	Federal bull trout temp criteria exceeded
Rice Creek/SL018_02	Temperature	Federal bull trout temp criteria exceeded
Dollar Creek/SL015_02	Temperature	Federal bull trout temp criteria exceeded
Trail Creek/SL017_02	Temperature	Federal bull trout temp criteria exceeded
Warm Lake Creek/SL019_02, SL019_03, SL020_02	Temperature	Federal bull trout temp criteria exceeded
Profile Creek/SL031_02, SL031_03	Temperature	Federal bull trout temp criteria exceeded
Buckhorn Creek/SL012_02, SL012_03, SL012_04, SL012_05	Temperature	Federal bull trout temp criteria exceeded
Lick Creek/SL009_02, SL009_03	Temperature	Federal bull trout temp criteria exceeded
Grouse Creek/Secesh River Tribs/SL005_02, SL005_03	Temperature	Federal bull trout temp criteria exceeded
Elk Creek/SL034_02, SL034_03, SL034_04	Temperature	Federal bull trout temp criteria exceeded

1.1 Temperature Monitoring

Currently, the bull trout temperature criterion effective for CWA purposes is the federally promulgated temperature criterion of 10ºC (7-day average of maximum daily temperatures) for waters specified in 40CFR 131.33 during the months of June, July, August and September. Table 4 shows the most recent criterion exceedance data for the streams previously recommended for 303d listing and/or temperature TMDL development in the South Fork Salmon Subbasin Assessment. These analysis were the basis in part for developing the PNV temperature TMDLs included in this document.

Table 4. Exceedances of federal bull trout criteria (June-September monitoring) USFS Data.

Stream	Year	MWMT (C)
Grouse Creek	2008	15.81
W. Fk Buckhorn Ck	2004	16.89
Elk Creek	2009	17.33
Little Buckhorn Ck	2001	14.23
Profile Creek (mouth)	2009	13.42
SFSR upstream of Mormon Creek	2008	12.4
SFSR upstream of Rice Creek	2009	15.41
SFSR below IDFG rearing ponds	2008	18.8
SFSR at Glory Hole	2003	21.96
SFSR at Poverty Flat	2004	21.6
SFSR at Indian Point	2009	20.48
SFSR at Badley Bridge	2001	22.23
Sand Creek	2008	16.39
Dollar Creek	2005	14.10
Buckhorn	2003	17.56
Lick Creek	2007	18.19
Tyndall Creek	2009	11.4
Rice Creek	2009	14.13
Trout Creek	2009	11.26

The Nez Perce Tribe monitored sites on Johnson Creek in 2007 (Figure 2). Based on water temperature monitoring data from 2007, seven-day, in-stream maximums occurred at most sites during the months of July and August (Figure 3). The highest average 7-day maximum temperature was recorded in late July at the Ice Hole monitoring location. On average, stream temperatures were consistently the highest at the Rock Creek location and consistently the lowest at the Burnt Log location.

For Chinook salmon, optimal water temperatures range from 12.0º to 14.0 ºC. Exposure to water temperatures greater than 21.0 ºC for more than 1 week usually is fatal to adult Chinook salmon, while the upper incipient lethal temperature for Chinook salmon is 26.2 ºC. Temperatures recorded within key rearing and spawning areas in 2007 were generally within the range of preferred temperatures for summer Chinook salmon and none were determined to inhibit spawning, migration, or rearing.

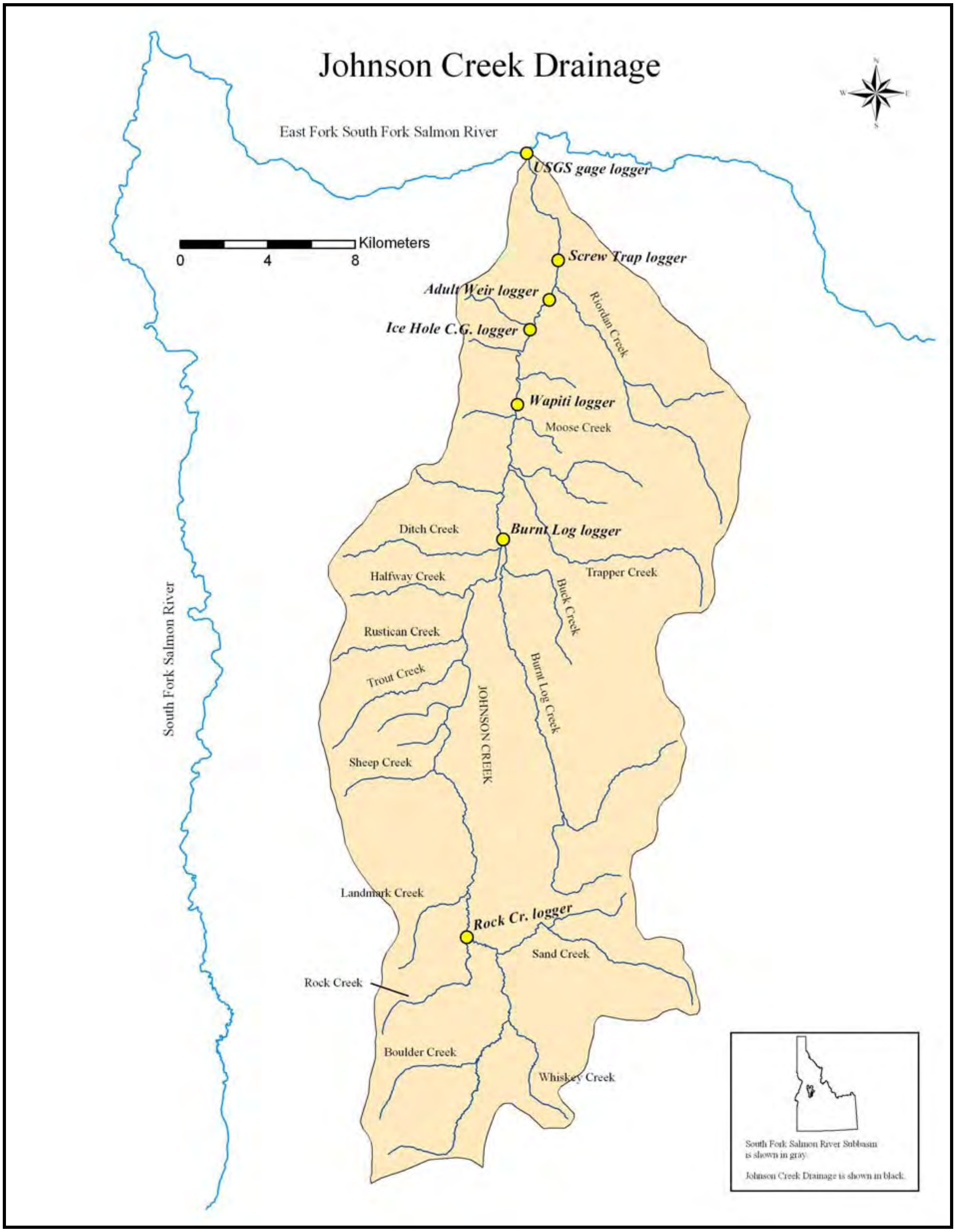

Figure 2. Johnson Creek Temperature Monitoring Sites.

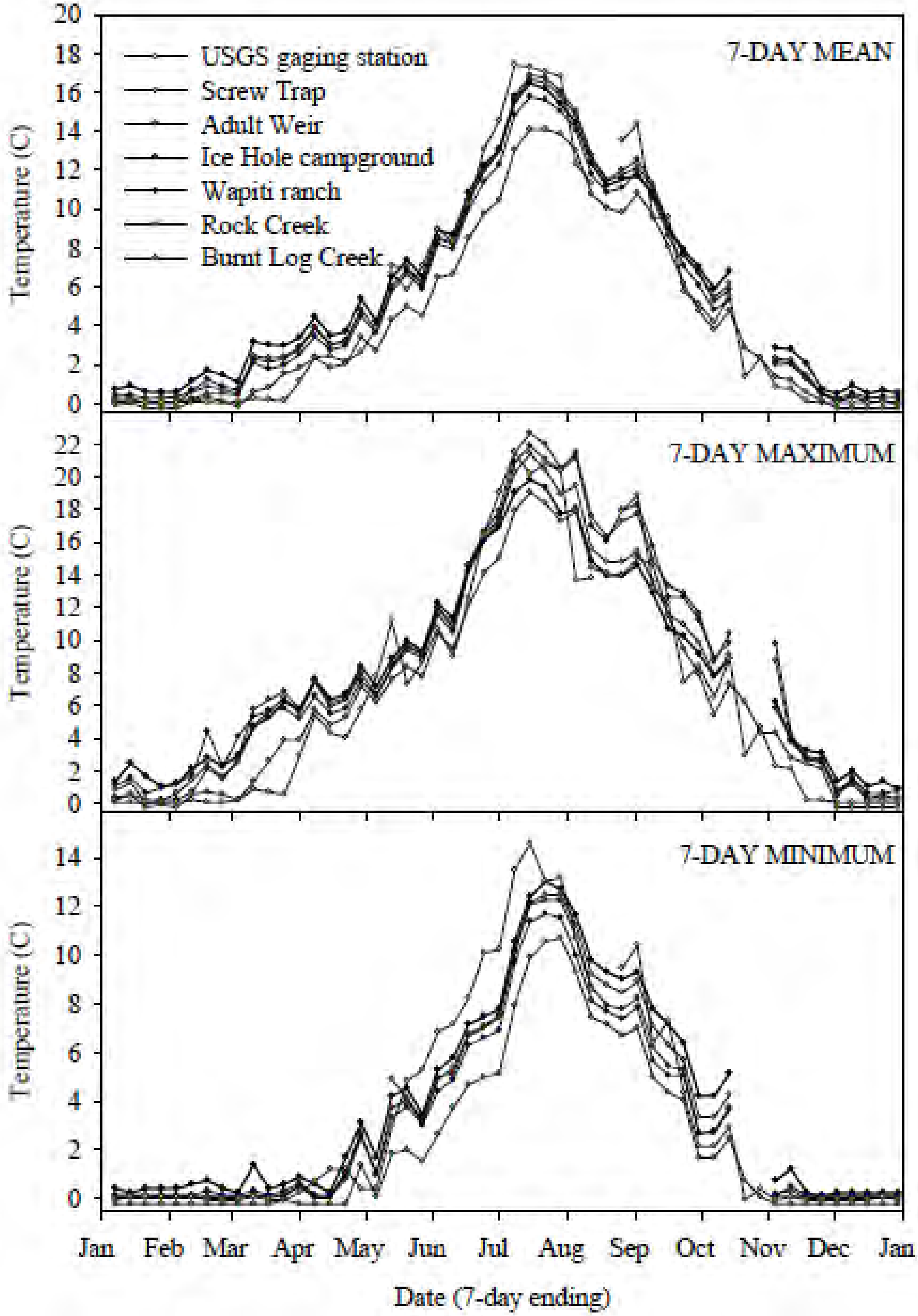

Figure 3. Seven-day mean, maximum and minimum instream temperatures summarized from six thermographs in Johnson Creek and one thermograph located in Burnt Log Creek during 2007.

Currently, the bull trout temperature criterion effective for CWA purposes is the federally promulgated temperature criterion of 10ºC (7-day average of maximum daily temperatures) for waters specified in 40CFR 131.33 during the months of June, July, August, and September. As shown, Johnson Creek exceeds the bull trout spawning criteria. TMDLs are recommended for AUs SL025_02, SL025_03 and SL025_04.

An assessment of AU SL025_02 was done by DEQ based upon eleven BURP sites, mostly sampled in 2008. This is a very large assessment unit, and is comprised of many small first and second order streams. Some of these sites were burned in recent fires. Eleven sites is more than adequate to characterize the assessment unit. The high number is partly because of the presence of a reference/trend site that is visited every year. Every site scored 3 out of 3 for the macroinvertebrate index, except one site that scored 2. These scores indicate that Cold Water Aquatic Life is fully supported. However, two of the sites had a poor fish assemblage, and Boise National Forest temperature data indicate that the Bull Trout temperature standard is violated. The habitat scores for these two sites were 2 out of 3 and 3 out of 3. The sites had stable banks and low percent wetted width fines, indicating that sediment is not likely impacting habitat. For that reason, this Assessment Unit is determined to fully support CWAL, and not fully support SS. Temperature appears to be the causal factor in impairing beneficial uses.

1.2 Sediment Monitoring Targets

The targets established for the 1991 TMDL are shown in Table 5. The proposed revised targets based on the Watershed Condition Indicators used in the SFSR watershed by the USFS are shown in Table 6 for moderate quality of gravel and interstitial sediments. The Southwest Idaho Land and Resource Management Plan (LRMP) revision effort, National Marine Fisheries Service (NMFS) biological opinion Term and Condition 3.B.1.required the Payette National Forest (PNF) and Boise National Forest (BNF) to revise the default sediment watershed condition indicator (WCI) values to something more appropriate for the South Fork Salmon River (SFSR).

Table 5. Applicable SFSR TMDLs.

Waterbody	Pollutant	Target
ID17060208SL001_06 ID17060208SL010_03 ID17060208SL010_04 ID17060208SL010_05	Sediment Sediment Sediment Sediment	Five year depth fines mean of 27% or less with no individual year > 29% Cobble Embeddedness five year mean of 32% with no single year over 37% or Acceptable improved trends in other monitored water quality parameters directly related to salmonid spawning and coldwater aquatic life

Table 6. Proposed SFSR TMDL Sediment Monitoring Targets.

Sediment Target	Sediment Target
Interstitial Sediment Deposition (tributary SFSR target)	Any single mean free matrix count over 27% OR A five-year mean free matrix count of 17% or more.
Intragravel Quality (mainstem SFSR target)	5-year mean fines < 6.3 mm concentrations at depth of 28% or less with no more than two years between 28% and 36%.

Revised Target Selection

The original SF Salmon River TMDL monitoring targets were not reflective of natural conditions. These targets are being replaced with the WCI Payette Forest Indicators for moderate quality intragravel and interstitial conditions. The rationale for these targets can be found in "*Developing Appropriate Sediment Related Watershed Condition Indicators For National Environmental Policy Act Analyses and Biological Assessments in the South Fork Salmon River Basin*" (USFS 2005). These sediment targets were adopted from this document, which used the South Fork Salmon sediment monitoring database to develop site specific targets in conjunction with the Chamberlain Basin as a reference site. These targets were developed as part of requirements by NOAA Fisheries Service in the biological opinion pursuant to the ESA listing of Chinook salmon.

The following section describes and summarizes the USFS 2005 report.

The USFS has moved from cobble embeddedness sampling towards routinely doing free matrix, so the interstitial targets are focused on free matrix criteria; free matrix criteria are tributary targets whereas core sampling (depth fines) are mainstem targets.

Intensive sediment monitoring began in the SFSR following the flooding that occurred in the winter of 1964-65, but an established program with a well-defined protocol for monitoring sediment levels in the river did not begin until 1974. This program was established by the Boise National Forest (BNF), but the SFSR crosses the BNF and the PNF, and this monitoring has been pursued as a cooperative effort between the two Forests in coordination with the Forest Service research station in Boise, Idaho. Because little objective information about sediment conditions in spawning gravels existed prior to the 1964-65 events, the Payette National Forest established a program of monitoring intragravel conditions in two spawning areas in Chamberlain Basin in the Frank Church River Of No Return Wilderness to establish an understanding of inherent spawning area conditions in granitic watersheds. An additional four spawning areas in the Secesh River watershed, a developed watershed tributary to the SFSR that was less severely affected by the 1964-65 events, were also sampled. Table F-1 in Appendix F lists the reference sites used in indicator development.

Most of the sites used to determine reference conditions are in undeveloped watersheds; however, a few identified in that report as "partially" developed were used where the effects of Forest development is likely to be unimportant with respect to natural conditions (*e.g.*, in Lick Creek); these sites were thought to be sufficiently undisturbed to illustrate reference conditions and were important for providing an adequate sampling of certain Forest areas. Overall, this collection of sites provides a broad sample of sediment conditions that can be expected to reflect natural conditions, a necessary first step in determining constraints for Forest management.

Core sampling (depth fines) is an established standard for evaluating sediment conditions and trends in streambed sediments and provides the most complete assessment of substrate composition. In practice, however, the McNeil method is highly labor-intensive and not well suited to many of the smaller streams on the Forest. Measurements of free matrix , an index that indicates interstitial space in streambed cobbles available to small fish and macroinvertebrates is used for more remote settings and smaller streams and tributaries.

Core sampling is probably the best method for determining the ability of streambeds in primary Chinook and steelhead spawning areas to provide suitable conditions for spawning and embryo development. These areas also provide a location that integrates the effects of disturbances distributed throughout relatively large watershed areas

For a period of time prior to 1999, most interstitial monitoring sites had both embeddedness and free matrix sampling, and double sampling showed that embeddedness could actually be predicted from free matrix counts despite differences in sampling design (embeddedness is measured in a much more restricted stratum of instream locations than free matrix, which evaluates conditions over a short reach of stream irrespective of habitat type). Consequently, cobble embeddedness measurement has been restricted to a subset of the interstitial sites in order to avoid duplicated effort while still providing for double sampling, which allows estimates of embeddedness from free matrix counts and data quality assurance.

These revised targets for high quality intragravel conditions are based on frequency distributions of sediment results from reference watersheds in conjunction with fish biology, specifically salmonid production information related to sediment. The third quartile or 75th percentile was used as a boundary for acceptable values of each water quality indicator in conjunction with knowledge of fish biology to set the actual index values.

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

The South Fork Salmon River TMDL Five Year Review (DEQ 2011) summarizes the most current TMDL and other water quality implementation efforts in the watershed. Current implementation efforts have focused on riparian protection as well as improving fish passage (http://www.deq.idaho.gov/media/455312-salmon_river_sf_five_year_review_0311.pdf).

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3. Total Maximum Daily Loads

A TMDL prescribes an upper limit on discharge of a pollutant from all sources so as to assure water quality standards are met. It further allocates this load capacity (LC) among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation (WLA); and nonpoint sources, each of which receives a load allocation (LA). Natural background (NB), when present, is considered part of the LA, but is often broken out on its own because it represents a part of the load not subject to control. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (Water quality planning and management, 40 CFR Part 130) require a margin of safety (MOS) be a part of the TMDL.

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

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

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

3.1 In-stream Water Quality Targets

For the SF Salmon River Subbasin Temperature TMDLs, DEQ utilized a potential natural vegetation (PNV) approach. The Idaho water quality standards include a provision (IDAPA 58.01.02.200.09) which establishes that if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered to be a violation of water quality standards. In these situations, natural conditions essentially become the water quality standard, and the natural level of shade and channel width become the target of the TMDL. The instream temperature which results from attainment of these conditions is consistent with the water quality standards, even though it may exceed numeric temperature criteria. See Appendix B for further discussion of water quality standards and background provisions. The PNV approach is described below. Additionally, the procedures and methodologies to develop PNV target shade levels and to estimate existing shade levels are described in Shumar and De Varona (2009). For a more complete discussion of shade and its affects on stream water temperature, the reader is referred to the *South Fork Clearwater Subbasin Assessment and TMDL* (DEQ, 2004) and *The Potential Natural Vegetation (PNV) Temperature Total Maximum Daily Load (TMDL) Procedures Manual* (Shumar and De Varona, 2009).

3.1.1 Potential Natural Vegetation for Temperature TMDLs

There are several important contributors of heat to a stream including ground water temperature, air temperature and direct solar radiation (Poole and Berman 2001). Of these, direct solar radiation is the source of heat that is most likely to be controlled or manipulated. The parameters that affect or control 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 affects how closely riparian vegetation grows together and water storage in the alluvial aquifer. Streamside vegetation and channel morphology are factors influencing shade, which are most likely to have been influenced by anthropogenic activities, and which can be most readily corrected and addressed by a TMDL.

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

Potential natural vegetation (PNV) along a stream is that riparian plant community that could grow to an overall mature state, although some level of natural disturbance is usually included in our development and use of shade targets. The PNV can be removed by disturbance either naturally (wildfire, disease/old age, wind-blown, wildlife grazing) or anthropogenically (domestic livestock grazing, vegetation removal, erosion). The idea behind PNV as targets for temperature TMDLs is that PNV provides a natural level of solar loading to the stream without any anthropogenic removal of shade producing vegetation. Anything less than PNV (with the exception of natural levels of disturbance and age distribution) results in the stream heating up from anthropogenically created additional solar inputs. We can estimate PNV from models of plant community structure (shade curves for specific riparian plant communities), and we can measure existing vegetative cover or shade. Comparing the two will tell us how much excess solar load the stream is receiving, and what potential there is to decrease solar gain. Streams disturbed by wildfire, flood or some other natural disturbance will be at less than PNV and require their own time to recover. Streams that have been disturbed by human activity may require additional restoration above and beyond natural recovery.

Existing shade was estimated for 14 water bodies from visual observations of aerial photos. These estimates were field verified by measuring shade with a solar pathfinder at systematically located points along the streams (see below for methodology). PNV targets were determined from an analysis of probable vegetation at the streams and comparing that to shade curves developed for similar vegetation communities. A shade curve shows the relationship between effective shade and stream width. As a stream gets wider, the shade decreases as the 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. Existing and PNV shade was converted to solar load from data collected on flat plate collectors at the nearest National Renewable Energy Laboratory (NREL) weather stations collecting these data. In this case, the Boise, ID station was used. The difference between existing and potential solar load, assuming existing load is higher, is the load reduction necessary to bring the stream back into compliance with water quality standards (see Appendix B). PNV shade and loads are assumed to be the natural condition, thus stream temperatures under PNV conditions are assumed to be natural (so long as there are no point sources or any other anthropogenic sources of heat in the watershed), and are thus considered to be consistent with the Idaho water quality standards, even though they may exceed numeric criteria by more than 0.3°C.

3.1.2 Pathfinder Methodology

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

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

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

3.1.3 Aerial Photo Interpretation

Expectations of shade based on plant type and density are provided for natural breaks in vegetation density, marked out on a 1:100K or 1:250K hydrography. Each interval is assigned a single value representing the bottom of a 10%-shade class as described below (*adapted from the CWE process, IDL, 2000)*. For example, if we estimate that shade for a particular stretch of stream is somewhere between 50% and 59%, we assign the value of 50% to that section of stream. The estimate is based on a general intuitive observation about the kind of vegetation present, its density, and the width of the stream. Streams where the banks and water are clearly visible usually are in low shade classes (10 to 30%). Streams with dense forest or heavy brush where no portion of the stream is visible usually are in high shade classes (70 to 90%). More open canopies, where portions of the stream may be visible, usually fall into moderate class intervals (40 to 60%).

It is important to note that the visual estimates made from the aerial photos are strongly influenced by canopy cover. It is not always possible to visualize or anticipate shade characteristics resulting from topography and landform. We assume that canopy coverage and shade are similar based on research conducted by Oregon DEQ. The visual estimates of ‘shade’ in this TMDL should be field verified with a solar pathfinder. The pathfinder measures effective shade and is taking into consideration other physical features that block the sun from hitting the stream surface (e.g. hillsides, canyon walls, terraces, man-made structures). The estimate of ‘shade’ made visually from an aerial photo does not always take into account topography or any shading that may occur from physical features other than vegetation. However, research has shown that shade and cover measurements are remarkably similar (OWEB, 2001), reinforcing the idea that riparian vegetation and objects proximal to the stream provide the most shade.

3.1.4 Stream Morphology

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

This width factor (i.e., NSDZ or Bankfull Width) may not be discernable from the aerial photo work described previously. Accordingly, this parameter must be estimated from available information. We use regional curves for the major basins in Idaho, data compiled by Diane Hopster of Idaho Department of Lands (Figure 4), to estimate natural bankfull width.

For each stream evaluated in the loading analysis, natural bankfull width is estimated based on drainage area of the Salmon Basin regional curve. Although estimates from other curves were examined (i.e. Upper Snake, Payette/Weiser), the Salmon Basin curve was ultimately chosen because of its proximity to the watershed in question. Additionally, existing width data should be evaluated and compared to these curve estimates if such data are available. However, for the SF Salmon Subbasin, only a few BURP sites exist and bankfull width data from those sites represents only spot data (three measured widths in a reach only several hundred meters long) that are not always representative of the stream as a whole.

In general, we found BURP bankfull width data to agree with bankfull width estimates from the Salmon Basin curve and chose not to make natural and existing widths any smaller than these regional curve estimates. The loading tables will 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 7. Occasionally, segments of streams were found to have existing measurements much wider than predicted. In such cases, the existing data was used to represent existing widths in loading tables.

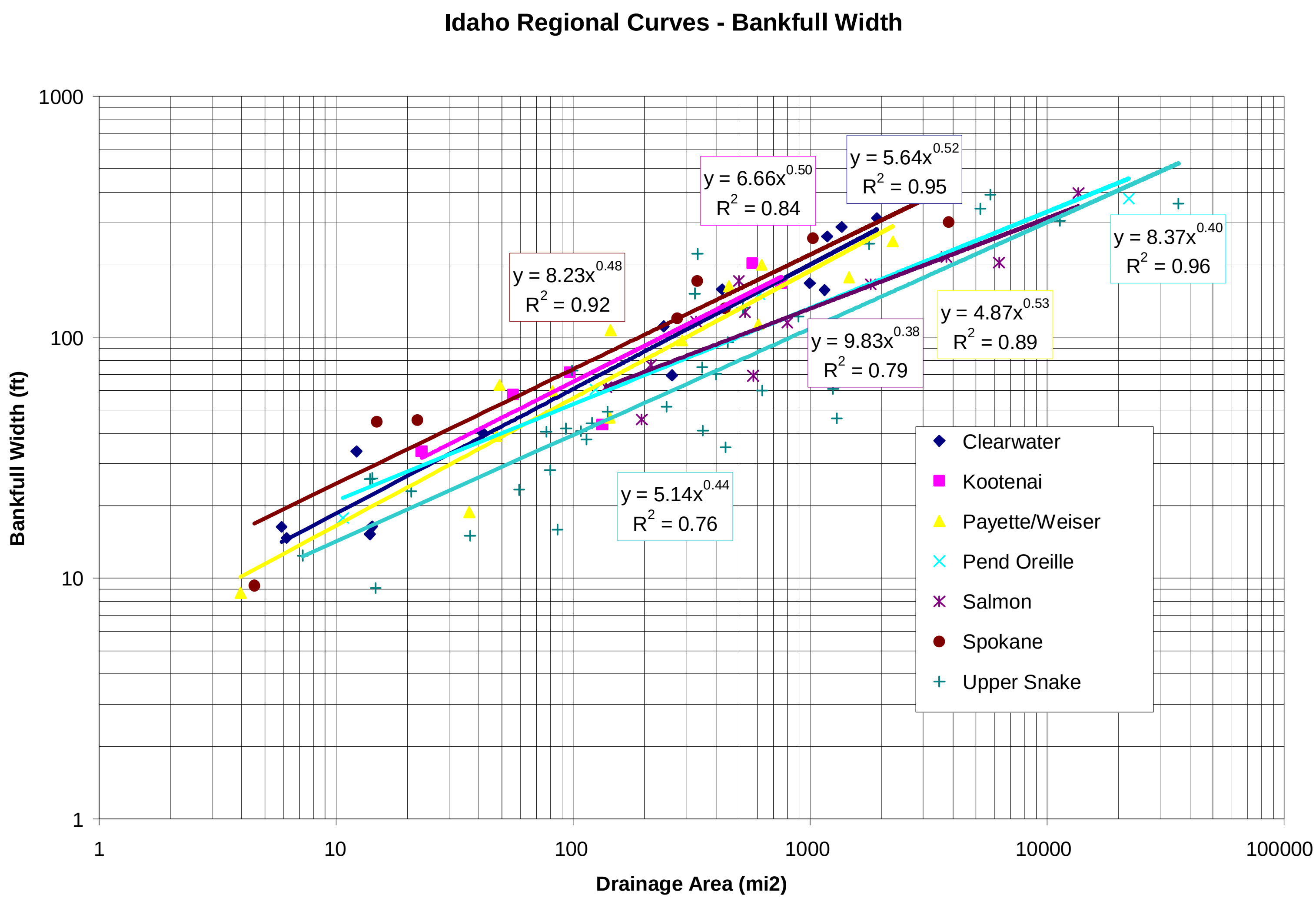

Figure 4. Bankfull Width as a Function of Drainage Area

Table 7. Bankfull Width Drainage Area Estimates.

Location	area (sq mi)	Salmon (m)	BURP data (m)
Sand Creek @ mouth	12.8	8	13.5, 7
Sand Creek ab NF Sand	8	7	5.4
Sand Creek ab SF Sand	4.6	5	3
Sand Creek ab 2nd trib.	1.5	3	2
Johnson Creek @ mouth	217.9	23	25
Johnson Creek ab Riordan Cr	186.2	22	23
Johnson Creek bl Burntlog Cr	141.8	20	20
Johnson Creek ab Burntlog Cr	102.8	17	19.5
Johnson Creek ab Halfway Cr	90.1	17	15.3
Johnson Creek ab Trout Cr	77.2	16	12.6
Johnson Creek ab Landmark Cr	47.1	13	27.8
Johnson Creek ab Sand Cr	24	10	7
Johnson Creek bl Whiskey Cr	20.1	9	10
Johnson Creek ab Whiskey Cr	13.7	8	8.1
Johnson Creek ab Boulder Cr	7.5	6	
Johnson Creek ab Tyndall Meadow	1.8	4	3
Trout Creek @ mouth	5.7	6	4.5, 5
Trout Creek ab meadow @ 6480ft	3.3	5	
Profile Creek @ mouth	19.5	9	8.8, 9.4
Profile Creek ab Camp Cr	14.5	8	
Profile Creek ab Missouri Cr	7.7	7	4.6, 6.7
Profile Creek ab Ellison Cr	1.63	4	
Rice Creek @ mouth	10.1	7	6.7, 6.1
Rice Creek ab Cupp Creek	7.9	7	
Rice Creek ab 1st tributary	2.7	4	5.6, 2.9
Tyndall Creek @ mouth	3.45	5	3.3
Tyndall Creek @ 5800ft	1.85	4	
Trail Creek @ mouth	10.8	7	6.3
Trail Creek @ tributary rd xing	4.1	5	
Trail Creek @ 6050ft	1.59	4	3.8
Buckhorn Creek @ mouth	48.5	13	10.6
Buckhorn Creek ab WF Buckhorn	25.5	10	10.9
Buckhorn Creek ab Little Buckhorn	18.9	9	
Buckhorn Creek ab SF Buckhorn	9.1	7	
Dollar Creek @ mouth	16.5	9	7.3, 8.4
Dollar Creek ab NF Dollar Cr	9.9	7	5.4, 9.7
Dollar Creek @ 5300ft	8.1	7	
Dollar Creek ab 1st tributary	2.62	4	
Elk Creek @ mouth	43.6	13	8.2
Elk Creek ab SF Elk Creek	14.4	8	5
Elk Creek ab MF Elk Creek	7	6	
Grouse Creek @ mouth	11.7	8	5.1
Grouse Creek ab 2nd tributary	8	7	6.4
Grouse Creek ab 3rd tributary	6.4	6	4
Grouse Creek ab Sand Cr	1.69	4	
Warm Lake Creek @ mouth	23.8	10	7, 6.4
Warm Lake Creek ab Cabin Cr	10.5	7	6
Warm Lake Creek bl Warm Lake	9.2	7	5
Warm Lake Creek ab Warm Lake	6.1	6	
Warm Lake Creek @ 5600ft	2.22	4	2.7, 3.5
Lick Creek @ mouth	34.1	11	
Lick Creek ab NF Lick Creek	23.6	10	10, 14, 8.8
Lick Creek ab Prince Creek	14.2	8	10
Lick Creek ab Hum Creek	5.4	6	6
SF Salmon River @ mouth	1309.7	46	59
SF Salmon River ab Grouse Cr	1197.6	44	
SF Salmon River ab Elk Cr	1121.5	43	
SF Salmon River bl Secesh R	1032.5	42	54
SF Salmon River bl EFSF Salmon	783.9	38	35
SF Salmon River ab EFSF Salmon	362.3	28	30
SF Salmon River bl Buckhorn Cr	316	27	25
SF Salmon River ab Buckhorn Cr	267.5	25	28
SF Salmon River ab Dollar Cr	138.8	20	21
SF Salmon River bl Warm Lake Cr	116.3	18	
SF Salmon River bl Curtis Cr	91.5	17	18
SF Salmon River ab Curtis Cr	64.2	15	
SF Salmon River bl Tyndall Cr	37	12	12
SF Salmon River ab Rice Cr	22.8	10	
SF Salmon River bl Mormon Cr	13.7	8	9.9
SF Salmon River ab Mormon Cr	8.7	7	
SF Salmon River ab Back Cr	5.3	6	
SF Salmon River ab 1st tributary	2.57	4	

3.1.5 Design Conditions

The SF Salmon River Subbasin occurs in the Idaho Batholith Level 3 Ecoregion of McGrath et al. (2001). This Ecoregion is known for its deeply dissected mountainous terrain of granitic rocks. Soils are droughty, highly erodible and with limited fertility. Grand fir, Douglas fir and western larch occur at higher elevations, while Ponderosa pine, shrubs and grasses inhabit deep canyons. Engelmann spruce and subalpine fir also occur, especially along stream margins at higher elevations. Pacific trees (western hemlock, western red cedar) are limited or absent from this Ecoregion.

Most of the subbasin is within the Southern Forested Mountains Level 4 Ecoregion, while the lower SF Salmon River canyon itself is in the Hot Dry Canyons Level 4 Ecoregion (McGrath et al., 2001). The Southern Forested Mountains are known for their droughty soils from granitic rocks. Open Douglas fir forests are common, with grand fir and subalpine fir at higher elevations. Ponderosa pine grows lower in the canyons. The Hot Dry Canyon portion is deeply dissected and warmer and drier with increasing depth. Ponderosa pine, sagebrush and grasses are widespread. Douglas fir can occur but is less common, and often only on north-facing slopes. South-facing slopes in general are drier and less wooded.

The upper portion of the subbasin contains numerous low gradient meadows of low shrubs and/or grasses. These low shrub meadows are tentatively identified as a Wolf's willow (*Salix wolfii*) community type. Their locations were interpreted through examination of stream gradient and aerial photos.

3.1.6 Target Selection

To determine potential natural vegetation shade targets for streams in the SF Salmon Subbasin, effective shade curves for the Southwest Idaho Ecogroup (Boise, Payette, Sawtooth National Forests) were examined (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.

As a stream becomes wider, a given vegetation type loses its ability to shade wider and wider streams. For each water body, an overlay of potential vegetation groups (PVGs) from either the Boise National Forest or the Payette National Forest was examined. A PVG shade curve (from Shumar and De Varona, 2009) for the most common vegetation type was selected for shade target determination on each reach (see Figures C-1 through C-9 in Appendix C for selected vegetation types).

Meadow areas, often identified on the PVG overlay as non-forest were placed into either the Wolf's willow community type (above 6000ft elevation) or a grass meadow type (below 6000ft elevation). We determined these meadow areas from the PVG overlay, aerial photo interpretation and examination of stream gradient (Figure 5). Riparian areas clearly without forest vegetation and with gradients generally less than 3% were placed into one of the two meadow categories. These meadows are predominantly found in the Sand Creek, Tyndall Meadows (upper Johnson Creek) and Stolle Meadows (upper SF Salmon River) areas. The Wolf's willow type had an overall average canopy cover of 90% and an average height of 1m from a combination of willow, shrubby cinquefoil and graminoids (grasses/ grass-like plants) based on information provided by Chris Murphy of IDFG Conservation Data Center. The grass meadow type had 100% canopy cover with an average height of 0.7m from graminoid species.

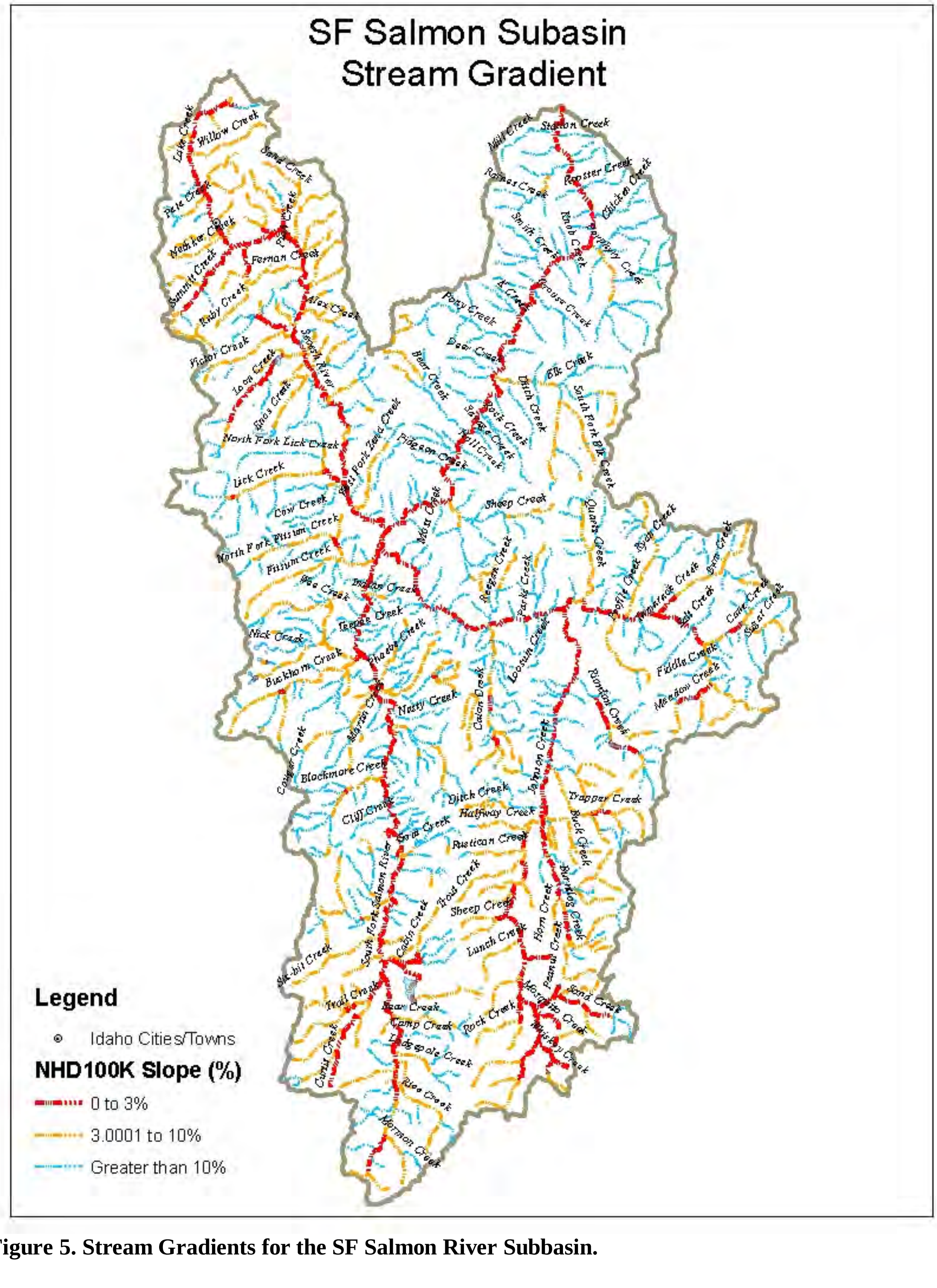

Figure 5. Stream Gradients for the SF Salmon River Subbasin.

Additionally, there were numerous areas in the upper watershed where narrow meadow corridors existed within forested settings. Tree margins were clearly set back away from streams and grass dominated meadows occupied near-stream riparian areas. These narrow meadows, although included within a particular PVG forest type, would not be expected to attain forest level shade targets. Again, these areas were most often within stream gradients less than 3%. We developed new shade curves for these narrow meadow corridors by using the graminoid plant community (100% canopy cover, 0.7m height) in the first two zones of the buffer width (~10m width) and the corresponding PVG forest type values (for canopy cover and height) in the remaining seven zones of the buffer width in the shade model. We developed three such shade curves (presented in Figures C-10, C-11 and C-12 of Appendix C), one for each of PVG 6 (*moist grand fir*), PVG 9 (*hydric subalpine fir*), and PVG 10 (*persistent lodgepole pine*).

We used a different approach with avalanche paths and deep canyon areas that are dry and barren on south-facing slopes. Avalanche paths crossing streams would typically remove half or more of the forest vegetation along the stream. These paths were only seen in upper Buckhorn Creek (Table 8). The dry, deep canyon of the lower part of the SF Salmon River (Table 21, Table 22, and Table 23) would be rock barren and completely lack vegetation on the south- and east-facing sides of the river. In these situations, we used half of the corresponding shade curve value to represent the lack of vegetation on one side of the stream. For example, if the stream reach was within PVG 2 (*warm, dry Douglas fir*) on one side of the river canyon and barren rock on the other side of the river, we used half of the corresponding PVG 2 shade value based on stream width. A 30m wide river under PVG 2 would have a shade target of 16%. Half that value, or 8%, would be used for the shade target in these barren rock areas.

3.1.7 Monitoring Points

The accuracy of the aerial photo interpretations were field verified with a solar pathfinder at 16 sites within the subbasin. The results of these field investigations can be seen in Appendix C. The original aerial photo interpretation was conducted using 2004 National Agriculture Imagery Program (NAIP) imagery, however, since that time the watershed has extensively burned in recent wildfires and we have acquired the latest high resolution imagery (2009 NAIP). Therefore, the solar pathfinder field work was used to calibrate our eyes as we re-examined the aerial photo interpretation using the newer 2009 imagery. Estimates of existing shade within this document are based on this corrected interpretation.

Effective shade monitoring can take place on any reach throughout the subbasin and compared to estimates of existing shade seen on Figure 7, Figure 10, Figure 13, Figure 16, Figure 19, Figure 22, Figure 25, Figure 28, Figure 31 and described in Table 8 through Table 28. Those areas with the largest disparity between existing shade estimates and shade targets should be monitored with solar pathfinders to verify the existing shade levels and to determine progress towards meeting shade targets. It is important to note that many existing shade estimates have not been field verified, and may require adjustment during the implementation process. Stream segments for each change in existing shade vary in length depending on land use or landscape that has affected that shade level. It is appropriate to monitor within a given existing shade segment to see if that segment has increased its existing shade towards target levels. Ten equally spaced solar pathfinder measurements within that segment averaged together should suffice to determine new shade levels in the future.

3.2 Load Capacity

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

We obtained solar load data for flat plate collectors from National Renewable Energy Laboratory (NREL) weather stations nearby. In this case, data from the Boise, ID station was used. The solar loads used in this TMDL are spring/summer averages, thus, we use an average load for the six month period from April through September. These months coincide with time of year that stream temperatures are increasing, when deciduous vegetation is in leaf, and extend into early fall spawning time. Table 8 through Table 28 show the PNV shade targets (identified as Target or Potential Shade) and their corresponding potential summer load (in kWh/m^2/day and kWh/day) that serve as the loading capacities for the streams.

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

3.3 Estimates of Existing Pollutant Loads

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

Existing loads in this temperature TMDL come from estimates of existing shade as determined from aerial photo interpretations. Like target shade, existing shade was converted to a solar load by multiplying the fraction of open stream by the solar radiation measured on a flat plate collector at the NREL weather stations. Existing shade data are presented in Table 8 through Table 28. Like loading capacities (potential loads), existing loads are presented on an area basis (kWh/m^2/day) and as a total load (kWh/day).

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

Table 8. Existing and Potential Solar Loads for Buckhorn Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Buckhorn Creek**
AU# ID17060208SL012_02														
1800	0.9	0.638	0.97	0.1914	-0.45	1	1	1800	1148.4	1800	344.52	-803.88	-7	PVG 9
110	0.4	3.828	0.49	3.2538	-0.57	2	2	220	842.16	220	715.836	-126.324	-9	AV path
1160	0.9	0.638	0.96	0.2552	-0.38	3	3	3480	2220.24	3480	888.096	-1332.144	-6	
140	0.7	1.914	0.47	3.3814	1.47	4	4	560	1071.84	560	1893.584	821.744	0	AV path
320	0.8	1.276	0.94	0.3828	-0.89	4	4	1280	1633.28	1280	489.984	-1143.296	-14	
240	0.4	3.828	0.47	3.3814	-0.45	4	4	960	3674.88	960	3246.144	-428.736	-7	AV path
160	0.8	1.276	0.94	0.3828	-0.89	4	4	640	816.64	640	244.992	-571.648	-14	
180	0.4	3.828	0.94	0.3828	-3.45	4	4	720	2756.16	720	275.616	-2480.544	-54	
520	0.7	1.914	0.92	0.5104	-1.40	5	5	2600	4976.4	2600	1327.04	-3649.36	-22	
180	0.8	1.276	0.84	1.0208	-0.26	5	5	900	1148.4	900	918.72	-229.68	-4	PVG 6
310	0.2	5.104	0.13	5.5506	0.45	5	5	1550	7911.2	1550	8603.43	692.23	0	meadow
800	0.8	1.276	0.78	1.4036	0.13	6	6	4800	6124.8	4800	6737.28	612.48	0	PVG 6
540	0.7	1.914	0.72	1.7864	-0.13	7	7	3780	7234.92	3780	6752.592	-482.328	-2	
AU# ID17060208SL012_03														
730	0.7	1.914	0.72	1.7864	-0.13	7	7	5110	9780.54	5110	9128.504	-652.036	-2	
1200	0.6	2.552	0.68	2.0416	-0.51	8	8	9600	24499.2	9600	19599.36	-4899.84	-8	
140	0.5	3.19	0.68	2.0416	-1.15	8	8	1120	3572.8	1120	2286.592	-1286.208	-18	
410	0.3	4.466	0.68	2.0416	-2.42	8	8	3280	14648.48	3280	6696.448	-7952.032	-38	
770	0.7	1.914	0.68	2.0416	0.13	8	8	6160	11790.24	6160	12576.256	786.016	0	
120	0.5	3.19	0.68	2.0416	-1.15	8	8	960	3062.4	960	1959.936	-1102.464	-18	
500	0.6	2.552	0.68	2.0416	-0.51	8	8	4000	10208	4000	8166.4	-2041.6	-8	
390	0.5	3.19	0.68	2.0416	-1.15	8	8	3120	9952.8	3120	6369.792	-3583.008	-18	
200	0.6	2.552	0.68	2.0416	-0.51	8	8	1600	4083.2	1600	3266.56	-816.64	-8	
410	0.4	3.828	0.63	2.3606	-1.47	9	9	3690	14125.32	3690	8710.614	-5414.706	-23	
1080	0.6	2.552	0.63	2.3606	-0.19	9	9	9720	24805.44	9720	22945.032	-1860.408	-3	
810	0.3	4.466	0.56	2.8072	-1.66	9	9	7290	32557.14	7290	20464.488	-12092.652	-26	PVG 5
890	0.2	5.104	0.56	2.8072	-2.30	9	9	8010	40883.04	8010	22485.672	-18397.368	-36	
630	0.5	3.19	0.63	2.3606	-0.83	9	9	5670	18087.3	5670	13384.602	-4702.698	-13	PVG 6
250	0.7	1.914	0.63	2.3606	0.45	9	9	2250	4306.5	2250	5311.35	1004.85	0	
AU# ID17060208SL012_04														
720	0.3	4.466	0.59	2.6158	-1.85	10	10	7200	32155.2	7200	18833.76	-13321.44	-29	
200	0.7	1.914	0.59	2.6158	0.70	10	10	2000	3828	2000	5231.6	1403.6	0	
AU# ID17060208SL012_05														
400	0.7	1.914	0.49	3.2538	1.34	13	13	5200	9952.8	5200	16919.76	6966.96	0	
400	0.5	3.19	0.49	3.2538	0.06	13	13	5200	16588	5200	16919.76	331.76	0	
							Total	**114,470**	**330,446**	**114,470**	**253,694**	**-76,751**	**-12**	

Table 9. Existing and Potential Solar Loads for Dollar Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Dollar Creek**
AU# ID17060208SL015_02														
1060	0.8	1.276	0.96	0.2552	-1.02	1	1	1060	1352.56	1060	270.512	-1082.048	-16	PVG 10
610	0.5	3.19	0.42	3.7004	0.51	2	2	1220	3891.8	1220	4514.488	622.688	0	meadow 10
350	0.8	1.276	0.95	0.319	-0.96	2	2	700	893.2	700	223.3	-669.9	-15	PVG 4
830	0.5	3.19	0.94	0.3828	-2.81	3	3	2490	7943.1	2490	953.172	-6989.928	-44	
120	0.9	0.638	0.92	0.5104	-0.13	4	4	480	306.24	480	244.992	-61.248	-2	
370	0.7	1.914	0.92	0.5104	-1.40	4	4	1480	2832.72	1480	755.392	-2077.328	-22	
470	0.7	1.914	0.86	0.8932	-1.02	5	5	2350	4497.9	2350	2099.02	-2398.88	-16	
340	0.3	4.466	0.86	0.8932	-3.57	5	5	1700	7592.2	1700	1518.44	-6073.76	-56	
130	0.7	1.914	0.8	1.276	-0.64	6	6	780	1492.92	780	995.28	-497.64	-10	
670	0.7	1.914	0.78	1.4036	-0.51	6	6	4020	7694.28	4020	5642.472	-2051.808	-8	PVG 6
910	0.7	1.914	0.72	1.7864	-0.13	7	7	6370	12192.18	6370	11379.368	-812.812	-2	
260	0.4	3.828	0.72	1.7864	-2.04	7	7	1820	6966.96	1820	3251.248	-3715.712	-32	
390	0.8	1.276	0.72	1.7864	0.51	7	7	2730	3483.48	2730	4876.872	1393.392	0	
490	0.8	1.276	0.65	2.233	0.96	7	7	3430	4376.68	3430	7659.19	3282.51	0	PVG 5
540	0.8	1.276	0.72	1.7864	0.51	7	7	3780	4823.28	3780	6752.592	1929.312	0	PVG 6
410	0.7	1.914	0.46	3.4452	1.53	7	7	2870	5493.18	2870	9887.724	4394.544	0	PVG 2
310	0.7	1.914	0.72	1.7864	-0.13	7	7	2170	4153.38	2170	3876.488	-276.892	-2	PVG 6
AU# ID17060208SL015_03														
350	0.7	1.914	0.63	2.3606	0.45	9	9	3150	6029.1	3150	7435.89	1406.79	0	
1100	0.4	3.828	0.63	2.3606	-1.47	9	9	9900	37897.2	9900	23369.94	-14527.26	-23	
110	0.7	1.914	0.63	2.3606	0.45	9	9	990	1894.86	990	2336.994	442.134	0	
							Total	**53,490**	**125,807**	**53,490**	**98,043**	**-27,764**	**-12**	

Table 10. Existing and Potential Solar Loads for Elk Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Elk Creek**
AU# ID17060208SL034_02														
200	0.4	3.828	0.96	0.2552	-3.57	1	1	200	765.6	200	51.04	-714.56	-56	PVG 11
270	0.7	1.914	0.96	0.2552	-1.66	1	1	270	516.78	270	68.904	-447.876	-26	
210	0.9	0.638	0.96	0.2552	-0.38	1	1	210	133.98	210	53.592	-80.388	-6	
1840	0.9	0.638	0.97	0.1914	-0.45	2	2	3680	2347.84	3680	704.352	-1643.488	-7	PVG 9
560	0.8	1.276	0.97	0.1914	-1.08	2	2	1120	1429.12	1120	214.368	-1214.752	-17	
180	0.7	1.914	0.97	0.1914	-1.72	2	2	360	689.04	360	68.904	-620.136	-27	
230	0.8	1.276	0.97	0.1914	-1.08	2	2	460	586.96	460	88.044	-498.916	-17	
210	0.2	5.104	0.31	4.4022	-0.70	2	2	420	2143.68	420	1848.924	-294.756	-11	meadow
110	0.7	1.914	0.96	0.2552	-1.66	3	3	330	631.62	330	84.216	-547.404	-26	PVG 9
620	0.8	1.276	0.96	0.2552	-1.02	3	3	1860	2373.36	1860	474.672	-1898.688	-16	
430	0.9	0.638	0.96	0.2552	-0.38	3	3	1290	823.02	1290	329.208	-493.812	-6	
310	0.7	1.914	0.96	0.2552	-1.66	3	3	930	1780.02	930	237.336	-1542.684	-26	
330	0.2	5.104	0.96	0.2552	-4.85	3	3	990	5052.96	990	252.648	-4800.312	-76	
480	0.7	1.914	0.94	0.3828	-1.53	4	4	1920	3674.88	1920	734.976	-2939.904	-24	
460	0.6	2.552	0.91	0.5742	-1.98	4	4	1840	4695.68	1840	1056.528	-3639.152	-31	PVG 6
260	0.8	1.276	0.91	0.5742	-0.70	4	4	1040	1327.04	1040	597.168	-729.872	-11	
500	0.8	1.276	0.84	1.0208	-0.26	4	4	2000	2552	2000	2041.6	-510.4	-4	PVG 5
AU# ID17060208SL034_03														
450	0.9	0.638	0.76	1.5312	0.89	5	5	2250	1435.5	2250	3445.2	2009.7	0	
AU# ID17060208SL034_04														
360	0.1	5.742	0.7	1.914	-3.83	6	6	2160	12402.72	2160	4134.24	-8268.48	-60	
990	0	6.38	0.7	1.914	-4.47	6	6	5940	37897.2	5940	11369.16	-26528.04	-70	
710	0.1	5.742	0.7	1.914	-3.83	6	6	4260	24460.92	4260	8153.64	-16307.28	-60	
770	0	6.38	0.65	2.233	-4.15	7	7	5390	34388.2	5390	12035.87	-22352.33	-65	
240	0.1	5.742	0.65	2.233	-3.51	7	7	1680	9646.56	1680	3751.44	-5895.12	-55	
1100	0	6.38	0.65	2.233	-4.15	7	7	7700	49126	7700	17194.1	-31931.9	-65	
740	0.1	5.742	0.6	2.552	-3.19	8	8	5920	33992.64	5920	15107.84	-18884.8	-50	
240	0	6.38	0.39	3.8918	-2.49	8	8	1920	12249.6	1920	7472.256	-4777.344	-39	PVG 1
200	0.2	5.104	0.43	3.6366	-1.47	8	8	1600	8166.4	1600	5818.56	-2347.84	-23	PVG 2
660	0	6.38	0.6	2.552	-3.83	8	8	5280	33686.4	5280	13474.56	-20211.84	-60	PVG 5
280	0	6.38	0.43	3.6366	-2.74	8	8	2240	14291.2	2240	8145.984	-6145.216	-43	PVG 2
200	0.1	5.742	0.43	3.6366	-2.11	8	8	1600	9187.2	1600	5818.56	-3368.64	-33	
180	0	6.38	0.08	5.8696	-0.51	8	8	1440	9187.2	1440	8452.224	-734.976	-8	meadow
							Total	**68,300**	**321,641**	**68,300**	**133,280**	**-188,361**	**-33**	

Table 11. Existing and Potential Solar Loads for Grouse Creek (Secesh Watershed).

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Grouse Creek**
AU# ID17060208SL005_02														
330	0.5	3.19	0.55	2.871	-0.32	1	1	330	1052.7	330	947.43	-105.27	-5	meadow
300	0	6.38	0.97	0.1914	-6.19	2	2	600	3828	600	114.84	-3713.16	-97	PVG 9
320	0.2	5.104	0.96	0.2552	-4.85	3	3	960	4899.84	960	244.992	-4654.848	-76	
440	0.1	5.742	0.94	0.3828	-5.36	4	4	1760	10105.92	1760	673.728	-9432.192	-84	
170	0.2	5.104	0.94	0.3828	-4.72	4	4	680	3470.72	680	260.304	-3210.416	-74	
550	0	6.38	0.94	0.3828	-6.00	4	4	2200	14036	2200	842.16	-13193.84	-94	
260	0.1	5.742	0.94	0.3828	-5.36	4	4	1040	5971.68	1040	398.112	-5573.568	-84	
1400	0.1	5.742	0.94	0.3828	-5.36	4	4	5600	32155.2	5600	2143.68	-30011.52	-84	
870	0.1	5.742	0.88	0.7656	-4.98	5	5	4350	24977.7	4350	3330.36	-21647.34	-78	PVG 10
150	0.3	4.466	0.88	0.7656	-3.70	5	5	750	3349.5	750	574.2	-2775.3	-58	
80	0	6.38	0.88	0.7656	-5.61	5	5	400	2552	400	306.24	-2245.76	-88	
180	0.2	5.104	0.92	0.5104	-4.59	5	5	900	4593.6	900	459.36	-4134.24	-72	PVG 9
560	0.1	5.742	0.89	0.7018	-5.04	6	6	3360	19293.12	3360	2358.048	-16935.072	-79	
440	0	6.38	0.11	5.6782	-0.70	6	6	2640	16843.2	2640	14990.448	-1852.752	-11	meadow
140	0.1	5.742	0.29	4.5298	-1.21	6	6	840	4823.28	840	3805.032	-1018.248	-19	PVG 9 meadow
230	0	6.38	0.11	5.6782	-0.70	6	6	1380	8804.4	1380	7835.916	-968.484	-11	meadow
130	0.1	5.742	0.16	5.3592	-0.38	6	6	780	4478.76	780	4180.176	-298.584	-6	PVG 5 meadow
40	0	6.38	0.16	5.3592	-1.02	6	6	240	1531.2	240	1286.208	-244.992	-16	
AU# ID17060208SL005_03														
280	0.5	3.19	0.82	1.1484	-2.04	6	6	1680	5359.2	1680	1929.312	-3429.888	-32	PVG 10
300	0	6.38	0.11	5.6782	-0.70	6	6	1800	11484	1800	10220.76	-1263.24	-11	meadow
340	0.2	5.104	0.25	4.785	-0.32	6	6	2040	10412.16	2040	9761.4	-650.76	-5	PVG 10 meadow
							Total	**34,330**	**194,022**	**34,330**	**66,663**	**-127,359**	**-52**	

Table 12. Existing and Potential Solar Loads for upper Johnson Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load ($kWh/m^2/day$)	Potential Shade (fraction)	Potential Summer Load ($kWh/m^2/day$)	Potential Load minus Existing load ($kWh/m^2/day$)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Upper Johnson Creek**
AU# ID17060208SL025_02														
1310	0.7	1.914	0.96	0.2552	-1.66	1	1	1310	2507.34	1310	334.312	-2173.028	-26	PVG 10
90	0.2	5.104	0.96	0.2552	-4.85	2	2	180	918.72	180	45.936	-872.784	-76	
140	0.8	1.276	0.96	0.2552	-1.02	2	2	280	357.28	280	71.456	-285.824	-16	
190	0.2	5.104	0.96	0.2552	-4.85	2	2	380	1939.52	380	96.976	-1842.544	-76	
310	0.5	3.19	0.96	0.2552	-2.93	2	2	620	1977.8	620	158.224	-1819.576	-46	
810	0.3	4.466	0.94	0.3828	-4.08	3	3	2430	10852.38	2430	930.204	-9922.176	-64	PVG 7
200	0.1	5.742	0.29	4.5298	-1.21	3	3	600	3445.2	600	2717.88	-727.32	-19	wolf's willow
4700	0	6.38	0.18	5.2316	-1.15	5	5	23500	149930	23500	122942.6	-26987.4	-18	
310	0.1	5.742	0.15	5.423	-0.32	6	6	1860	10680.12	1860	10086.78	-593.34	-5	
90	0.3	4.466	0.89	0.7018	-3.76	6	6	540	2411.64	540	378.972	-2032.668	-59	PVG 9
160	0.5	3.19	0.89	0.7018	-2.49	6	6	960	3062.4	960	673.728	-2388.672	-39	
160	0.1	5.742	0.15	5.423	-0.32	6	6	960	5512.32	960	5206.08	-306.24	-5	wolf's willow
2070	0	6.38	0.13	5.5506	-0.83	7	7	14490	92446.2	14490	80428.194	-12018.006	-13	
220	0.6	2.552	0.79	1.3398	-1.21	8	8	1760	4491.52	1760	2358.048	-2133.472	-19	PVG 9
430	0.2	5.104	0.26	4.7212	-0.38	8	8	3440	17557.76	3440	16240.928	-1316.832	-6	PVG 9 meadow
420	0.1	5.742	0.26	4.7212	-1.02	8	8	3360	19293.12	3360	15863.232	-3429.888	-16	PVG 9 meadow
							Total	**56,670**	**327,383**	**56,670**	**258,534**	**-68,850**	**-31**	

Table 13. Existing and Potential Solar Loads for middle Johnson Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Middle Johnson Creek**
AU# ID17060208SL025_03														
160	0	6.38	0.1	5.742	-0.64	9	9	1440	9187.2	1440	8268.48	-918.72	-10	wolf's willow
130	0.1	5.742	0.1	5.742	0.00	9	9	1170	6718.14	1170	6718.14	0	0	
120	0	6.38	0.1	5.742	-0.64	9	9	1080	6890.4	1080	6201.36	-689.04	-10	
590	0.1	5.742	0.1	5.742	0.00	9	9	5310	30490.02	5310	30490.02	0	0	
240	0.2	5.104	0.1	5.742	0.64	9	9	2160	11024.64	2160	12402.72	1378.08	0	
930	0	6.38	0.1	5.742	-0.64	9	9	8370	53400.6	8370	48060.54	-5340.06	-10	
120	0.1	5.742	0.09	5.8058	0.06	10	10	1200	6890.4	1200	6966.96	76.56	0	
390	0.2	5.104	0.09	5.8058	0.70	10	10	3900	19905.6	3900	22642.62	2737.02	0	
370	0.4	3.828	0.69	1.9778	-1.85	10	10	3700	14163.6	3700	7317.86	-6845.74	-29	PVG 9
280	0.3	4.466	0.23	4.9126	0.45	10	10	2800	12504.8	2800	13755.28	1250.48	0	PVG 9 meadow
550	0.1	5.742	0.09	5.8058	0.06	10	10	5500	31581	5500	31931.9	350.9	0	wolf's willow
140	0	6.38	0.08	5.8696	-0.51	11	11	1540	9825.2	1540	9039.184	-786.016	-8	
80	0.1	5.742	0.08	5.8696	0.13	11	11	880	5052.96	880	5165.248	112.288	0	
4190	0	6.38	0.07	5.9334	-0.45	27	13	113130	721769.4	54470	323192.298	-398577.102	-7	
130	0.1	5.742	0.07	5.9334	0.19	20	13	2600	14929.2	1690	10027.446	-4901.754	0	
770	0	6.38	0.07	5.9334	-0.45	20	14	15400	98252	10780	63962.052	-34289.948	-7	
480	0.1	5.742	0.55	2.871	-2.87	14	14	6720	38586.24	6720	19293.12	-19293.12	-45	PVG 9
130	0.3	4.466	0.55	2.871	-1.60	14	14	1820	8128.12	1820	5225.22	-2902.9	-25	
240	0.1	5.742	0.49	3.2538	-2.49	14	14	3360	19293.12	3360	10932.768	-8360.352	-39	PVG 10
150	0.3	4.466	0.49	3.2538	-1.21	14	14	2100	9378.6	2100	6832.98	-2545.62	-19	
2290	0.1	5.742	0.49	3.2538	-2.49	14	14	32060	184088.52	32060	104316.828	-79771.692	-39	
280	0.2	5.104	0.49	3.2538	-1.85	14	14	3920	20007.68	3920	12754.896	-7252.784	-29	
1200	0.1	5.742	0.49	3.2538	-2.49	14	14	16800	96465.6	16800	54663.84	-41801.76	-39	
740	0.2	5.104	0.46	3.4452	-1.66	15	15	11100	56654.4	11100	38241.72	-18412.68	-26	
1370	0.1	5.742	0.46	3.4452	-2.30	15	15	20550	117998.1	20550	70798.86	-47199.24	-36	
3030	0.3	4.466	0.46	3.4452	-1.02	15	15	45450	202979.7	45450	156584.34	-46395.36	-16	
210	0.3	4.466	0.45	3.509	-0.96	15	15	3150	14067.9	3150	11053.35	-3014.55	-15	PVG 4
340	0.2	5.104	0.45	3.509	-1.60	15	15	5100	26030.4	5100	17895.9	-8134.5	-25	
450	0.3	4.466	0.43	3.6366	-0.83	16	16	7200	32155.2	7200	26183.52	-5971.68	-13	
1400	0.4	3.828	0.43	3.6366	-0.19	16	16	22400	85747.2	22400	81459.84	-4287.36	-3	
520	0.2	5.104	0.43	3.6366	-1.47	16	16	8320	42465.28	8320	30256.512	-12208.768	-23	
3240	0.3	4.466	0.42	3.7004	-0.77	17	17	55080	245987.28	55080	203818.032	-42169.248	-12	
550	0.1	5.742	0.42	3.7004	-2.04	17	17	9350	53687.7	9350	34598.74	-19088.96	-32	
770	0.2	5.104	0.42	3.7004	-1.40	17	17	13090	66811.36	13090	48438.236	-18373.124	-22	
250	0.1	5.742	0.42	3.7004	-2.04	17	17	4250	24403.5	4250	15726.7	-8676.8	-32	
520	0.3	4.466	0.42	3.7004	-0.77	17	17	8840	39479.44	8840	32711.536	-6767.904	-12	
1400	0.2	5.104	0.42	3.7004	-1.40	17	17	23800	121475.2	23800	88069.52	-33405.68	-22	PVG 10
460	0.3	4.466	0.48	3.3176	-1.15	17	17	7820	34924.12	7820	25943.632	-8980.488	-18	PVG 9
							Total	**482,460**	**2,593,400**	**418,270**	**1,701,942**	**-891,458**	**-16**	

Table 14. Existing and Potential Solar Loads for lower Johnson Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Lower Johnson Creek**
AU# ID17060208SL025_04														
1700	0.3	4.466	0.22	4.9764	0.51	20	20	34000	151844	34000	169197.6	17353.6	0	PVG 2
1910	0.2	5.104	0.22	4.9764	-0.13	20	20	38200	194972.8	38200	190098.48	-4874.32	-2	
250	0.3	4.466	0.22	4.9764	0.51	20	20	5000	22330	5000	24882	2552	0	
2360	0.2	5.104	0.22	4.9764	-0.13	20	20	47200	240908.8	47200	234886.08	-6022.72	-2	
1030	0.1	5.742	0.21	5.0402	-0.70	21	21	21630	124199.46	21630	109019.526	-15179.934	-11	
710	0	6.38	0.21	5.0402	-1.34	21	21	14910	95125.8	14910	75149.382	-19976.418	-21	
540	0.1	5.742	0.21	5.0402	-0.70	21	21	11340	65114.28	11340	57155.868	-7958.412	-11	
3020	0	6.38	0.21	5.0402	-1.34	21	21	63420	404619.6	63420	319649.484	-84970.116	-21	
2300	0.2	5.104	0.2	5.104	0.00	22	22	50600	258262.4	50600	258262.4	0	0	
540	0.1	5.742	0.2	5.104	-0.64	22	22	11880	68214.96	11880	60635.52	-7579.44	-10	
1800	0.2	5.104	0.2	5.104	0.00	22	22	39600	202118.4	39600	202118.4	0	0	
190	0.1	5.742	0.2	5.104	-0.64	23	23	4370	25092.54	4370	22304.48	-2788.06	-10	
4570	0.2	5.104	0.2	5.104	0.00	23	23	105110	536481.44	105110	536481.44	0	0	
170	0.1	5.742	0.2	5.104	-0.64	23	23	3910	22451.22	3910	19956.64	-2494.58	-10	
							Total	**451,170**	**2,411,736**	**451,170**	**2,279,797**	**-131,938**	**-7**	

Table 15. Existing and Potential Solar Loads for Lick Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Lick Creek**
AU# ID17060208SL009_02														
510	0.7	1.914	0.97	0.1914	-1.72	1	1	510	976.14	510	97.614	-878.526	-27	PVG 9
640	0.5	3.19	0.97	0.1914	-3.00	2	2	1280	4083.2	1280	244.992	-3838.208	-47	
200	0.7	1.914	0.96	0.2552	-1.66	3	3	600	1148.4	600	153.12	-995.28	-26	
80	0.5	3.19	0.96	0.2552	-2.93	3	3	240	765.6	240	61.248	-704.352	-46	
340	0.6	2.552	0.96	0.2552	-2.30	3	3	1020	2603.04	1020	260.304	-2342.736	-36	
350	0	6.38	0.16	5.3592	-1.02	4	4	1400	8932	1400	7502.88	-1429.12	-16	meadow
550	0.6	2.552	0.94	0.3828	-2.17	4	4	2200	5614.4	2200	842.16	-4772.24	-34	PVG 9
140	0.3	4.466	0.31	4.4022	-0.06	5	5	700	3126.2	700	3081.54	-44.66	-1	meadow 9
310	0.5	3.19	0.92	0.5104	-2.68	5	5	1550	4944.5	1550	791.12	-4153.38	-42	PVG 9
360	0.6	2.552	0.89	0.7018	-1.85	6	6	2160	5512.32	2160	1515.888	-3996.432	-29	
790	0.6	2.552	0.7	1.914	-0.64	6	6	4740	12096.48	4740	9072.36	-3024.12	-10	PVG 5
490	0.7	1.914	0.65	2.233	0.32	7	7	3430	6565.02	3430	7659.19	1094.17	0	
550	0.6	2.552	0.72	1.7864	-0.77	7	7	3850	9825.2	3850	6877.64	-2947.56	-12	PVG 6
430	0.5	3.19	0.68	2.0416	-1.15	8	8	3440	10973.6	3440	7023.104	-3950.496	-18	
100	0.2	5.104	0.68	2.0416	-3.06	8	8	800	4083.2	800	1633.28	-2449.92	-48	
230	0.6	2.552	0.68	2.0416	-0.51	8	8	1840	4695.68	1840	3756.544	-939.136	-8	
200	0.4	3.828	0.68	2.0416	-1.79	8	8	1600	6124.8	1600	3266.56	-2858.24	-28	
40	0.2	5.104	0.08	5.8696	0.77	8	8	320	1633.28	320	1878.272	244.992	0	meadow
AU# ID17060208SL009_03														
90	0.2	5.104	0.07	5.9334	0.83	9	9	810	4134.24	810	4806.054	671.814	0	
180	0.4	3.828	0.2	5.104	1.28	9	9	1620	6201.36	1620	8268.48	2067.12	0	meadow 6
200	0.7	1.914	0.63	2.3606	0.45	9	9	1800	3445.2	1800	4249.08	803.88	0	PVG 6
470	0.3	4.466	0.2	5.104	0.64	9	9	4230	18891.18	4230	21589.92	2698.74	0	meadow 6
150	0	6.38	0.07	5.9334	-0.45	9	9	1350	8613	1350	8010.09	-602.91	-7	meadow
210	0.6	2.552	0.56	2.8072	0.26	9	9	1890	4823.28	1890	5305.608	482.328	0	PVG 5
520	0	6.38	0.07	5.9334	-0.45	9	9	4680	29858.4	4680	27768.312	-2090.088	-7	meadow
380	0.3	4.466	0.56	2.8072	-1.66	9	9	3420	15273.72	3420	9600.624	-5673.096	-26	PVG 5
330	0.6	2.552	0.56	2.8072	0.26	9	9	2970	7579.44	2970	8337.384	757.944	0	
210	0.5	3.19	0.56	2.8072	-0.38	9	9	1890	6029.1	1890	5305.608	-723.492	-6	
860	0.6	2.552	0.56	2.8072	0.26	9	9	7740	19752.48	7740	21727.728	1975.248	0	
2140	0.5	3.19	0.53	2.9986	-0.19	10	10	21400	68266	21400	64170.04	-4095.96	-3	
670	0.5	3.19	0.59	2.6158	-0.57	10	10	6700	21373	6700	17525.86	-3847.14	-9	PVG 6
1100	0.4	3.828	0.37	4.0194	0.19	10	10	11000	42108	11000	44213.4	2105.4	0	PVG 2
440	0.5	3.19	0.55	2.871	-0.32	11	11	4840	15439.6	4840	13895.64	-1543.96	-5	PVG 6
1010	0.4	3.828	0.35	4.147	0.32	11	11	11110	42529.08	11110	46073.17	3544.09	0	PVG 2
810	0.4	3.828	0.55	2.871	-0.96	11	11	8910	34107.48	8910	25580.61	-8526.87	-15	PVG 6
290	0.2	5.104	0.55	2.871	-2.23	11	11	3190	16281.76	3190	9158.49	-7123.27	-35	
							Total	**131,230**	**458,409**	**131,230**	**401,304**	**-57,105**	**-15**	

Table 16. Existing and Potential Solar Loads for Profile Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Profile Creek**
AU# ID17060208SL031_02														
830	0.8	1.276	0.96	0.2552	-1.02	1	1	830	1059.08	830	211.816	-847.264	-16	PVG 7
1600	0.9	0.638	0.94	0.3828	-0.26	3	3	4800	3062.4	4800	1837.44	-1224.96	-4	
420	0.8	1.276	0.91	0.5742	-0.70	4	4	1680	2143.68	1680	964.656	-1179.024	-11	
210	0.7	1.914	0.91	0.5742	-1.34	4	4	840	1607.76	840	482.328	-1125.432	-21	
2080	0.9	0.638	0.84	1.0208	0.38	5	5	10400	6635.2	10400	10616.32	3981.12	0	
340	0.8	1.276	0.8	1.276	0.00	6	6	2040	2603.04	2040	2603.04	0	0	PVG 4
1100	0.8	1.276	0.74	1.6588	0.38	7	7	7700	9825.2	7700	12772.76	2947.56	0	
100	0.7	1.914	0.74	1.6588	-0.26	7	7	700	1339.8	700	1161.16	-178.64	-4	
AU# ID17060208SL031_03														
400	0.6	2.552	0.7	1.914	-0.64	8	8	3200	8166.4	3200	6124.8	-2041.6	-10	
1730	0.8	1.276	0.7	1.914	0.64	8	8	13840	17659.84	13840	26489.76	8829.92	0	
620	0.7	1.914	0.7	1.914	0.00	8	8	4960	9493.44	4960	9493.44	0	0	
2200	0.6	2.552	0.65	2.233	-0.32	9	9	19800	50529.6	19800	44213.4	-6316.2	-5	
210	0.7	1.914	0.65	2.233	0.32	9	9	1890	3617.46	1890	4220.37	602.91	0	
430	0.5	3.19	0.65	2.233	-0.96	9	9	3870	12345.3	3870	8641.71	-3703.59	-15	
1000	0.6	2.552	0.65	2.233	-0.32	9	9	9000	22968	9000	20097	-2871	-5	
							Total	**85,550**	**153,056**	**85,550**	**149,930**	**-3,126**	**-6**	

Table 17. Existing and Potential Solar Loads for Rice Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Rice Creek**
AU# ID17060208SL018_02														
200	0.5	3.19	0.96	0.2552	-2.93	1	1	200	638	200	51.04	-586.96	-46	PVG 11
180	0.8	1.276	0.96	0.2552	-1.02	1	1	180	229.68	180	45.936	-183.744	-16	PVG 10
390	0.7	1.914	0.96	0.2552	-1.66	1	1	390	746.46	390	99.528	-646.932	-26	PVG 7
240	0.8	1.276	0.96	0.2552	-1.02	2	2	480	612.48	480	122.496	-489.984	-16	PVG 10
520	0.6	2.552	0.96	0.2552	-2.30	2	2	1040	2654.08	1040	265.408	-2388.672	-36	
1500	0.7	1.914	0.94	0.3828	-1.53	3	3	4500	8613	4500	1722.6	-6890.4	-24	PVG 7
160	0.5	3.19	0.92	0.5104	-2.68	4	4	640	2041.6	640	326.656	-1714.944	-42	PVG 10
490	0.7	1.914	0.91	0.5742	-1.34	4	4	1960	3751.44	1960	1125.432	-2626.008	-21	PVG 7
490	0.9	0.638	0.86	0.8932	0.26	5	5	2450	1563.1	2450	2188.34	625.24	0	PVG 4
240	0.5	3.19	0.86	0.8932	-2.30	5	5	1200	3828	1200	1071.84	-2756.16	-36	
250	0.8	1.276	0.86	0.8932	-0.38	5	5	1250	1595	1250	1116.5	-478.5	-6	
150	0.4	3.828	0.86	0.8932	-2.93	5	5	750	2871	750	669.9	-2201.1	-46	
270	0.7	1.914	0.8	1.276	-0.64	6	6	1620	3100.68	1620	2067.12	-1033.56	-10	
930	0.4	3.828	0.8	1.276	-2.55	6	6	5580	21360.24	5580	7120.08	-14240.16	-40	
870	0.6	2.552	0.74	1.6588	-0.89	7	7	6090	15541.68	6090	10102.092	-5439.588	-14	
740	0.4	3.828	0.74	1.6588	-2.17	7	7	5180	19829.04	5180	8592.584	-11236.456	-34	
920	0.7	1.914	0.74	1.6588	-0.26	7	7	6440	12326.16	6440	10682.672	-1643.488	-4	
200	0.8	1.276	0.76	1.5312	0.26	7	7	1400	1786.4	1400	2143.68	357.28	0	PVG 10
290	0.5	3.19	0.76	1.5312	-1.66	7	7	2030	6475.7	2030	3108.336	-3367.364	-26	
130	0.7	1.914	0.76	1.5312	-0.38	7	7	910	1741.74	910	1393.392	-348.348	-6	
530	0.6	2.552	0.76	1.5312	-1.02	7	7	3710	9467.92	3710	5680.752	-3787.168	-16	
210	0.5	3.19	0.76	1.5312	-1.66	7	7	1470	4689.3	1470	2250.864	-2438.436	-26	
320	0.4	3.828	0.76	1.5312	-2.30	7	7	2240	8574.72	2240	3429.888	-5144.832	-36	
							Total	**51,710**	**134,037**	**51,710**	**65,377**	**-68,660**	**-23**	

Table 18. Existing and Potential Solar Loads for Sand Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Sand Creek**
AU# ID17060208SL025_02														
200	0.3	4.466	0.96	0.2552	-4.21	1	1	200	893.2	200	51.04	-842.16	-66	PVG 7
220	0.9	0.638	0.96	0.2552	-0.38	1	1	220	140.36	220	56.144	-84.216	-6	
380	0.6	2.552	0.96	0.2552	-2.30	1	1	380	969.76	380	96.976	-872.784	-36	PVG 10
1540	0.3	4.466	0.42	3.7004	-0.77	2	2	3080	13755.28	3080	11397.232	-2358.048	-12	wolf's willow
1060	0.2	5.104	0.42	3.7004	-1.40	2	2	2120	10820.48	2120	7844.848	-2975.632	-22	
120	0.5	3.19	0.38	3.9556	0.77	3	3	360	1148.4	360	1424.016	275.616	0	PVG 9 meadow
260	0.2	5.104	0.29	4.5298	-0.57	3	3	780	3981.12	780	3533.244	-447.876	-9	wolf's willow
930	0.7	1.914	0.94	0.3828	-1.53	3	3	2790	5340.06	2790	1068.012	-4272.048	-24	PVG 10
170	0.2	5.104	0.29	4.5298	-0.57	3	3	510	2603.04	510	2310.198	-292.842	-9	wolf's willow
160	0.3	4.466	0.94	0.3828	-4.08	3	3	480	2143.68	480	183.744	-1959.936	-64	PVG 10
530	0.2	5.104	0.22	4.9764	-0.13	4	4	2120	10820.48	2120	10549.968	-270.512	0	wolf's willow
170	0.1	5.742	0.22	4.9764	-0.77	4	4	680	3904.56	680	3383.952	-520.608	-12	
610	0	6.38	0.22	4.9764	-1.40	4	4	2440	15567.2	2440	12142.416	-3424.784	-22	
570	0.1	5.742	0.22	4.9764	-0.77	4	4	2280	13091.76	2280	11346.192	-1745.568	-12	
1300	0.4	3.828	0.27	4.6574	0.83	5	5	6500	24882	6500	30273.1	5391.1	0	PVG 10 meadow
240	0.5	3.19	0.27	4.6574	1.47	5	5	1200	3828	1200	5588.88	1760.88	0	
140	0.1	5.742	0.15	5.423	-0.32	6	6	840	4823.28	840	4555.32	-267.96	-5	wolf's willow
430	0.3	4.466	0.82	1.1484	-3.32	6	6	2580	11522.28	2580	2962.872	-8559.408	-52	PVG 10
890	0.1	5.742	0.13	5.5506	-0.19	7	7	6230	35772.66	6230	34580.238	-1192.422	-3	wolf's willow
250	0.7	1.914	0.76	1.5312	-0.38	7	7	1750	3349.5	1750	2679.6	-669.9	-6	PVG 10
230	0.1	5.742	0.13	5.5506	-0.19	7	7	1610	9244.62	1610	8936.466	-308.154	-3	wolf's willow
710	0.3	4.466	0.22	4.9764	0.51	8	8	5680	25366.88	5680	28265.952	2899.072	0	PVG 10 meadow
410	0.1	5.742	0.11	5.6782	-0.06	8	8	3280	18833.76	3280	18624.496	-209.264	-1	wolf's willow
							Total	**48,110**	**222,802**	**48,110**	**201,855**	**-20,947**	**-16**	

Table 19. Existing and Potential Solar Loads for upper South Fork Salmon River.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Upper SF Salmon River**
AU# ID17060208SL010_02														
580	0.4	3.828	0.96	0.2552	-3.57	1	1	580	2220.24	580	148.016	-2072.224	-56	PVG 10
1600	0.7	1.914	0.96	0.2552	-1.66	2	2	3200	6124.8	3200	816.64	-5308.16	-26	
100	0.5	3.19	0.92	0.5104	-2.68	4	4	400	1276	400	204.16	-1071.84	-42	
610	0.7	1.914	0.92	0.5104	-1.40	4	4	2440	4670.16	2440	1245.376	-3424.784	-22	
490	0.5	3.19	0.31	4.4022	1.21	5	5	2450	7815.5	2450	10785.39	2969.89	0	meadow 9
350	0.7	1.914	0.92	0.5104	-1.40	5	5	1750	3349.5	1750	893.2	-2456.3	-22	PVG 9
310	0.3	4.466	0.31	4.4022	-0.06	5	5	1550	6922.3	1550	6823.41	-98.89	-1	meadow 9
200	0.5	3.19	0.29	4.5298	1.34	6	6	1200	3828	1200	5435.76	1607.76	0	
190	0.7	1.914	0.89	0.7018	-1.21	6	6	1140	2181.96	1140	800.052	-1381.908	-19	PVG 9
100	0.5	3.19	0.29	4.5298	1.34	6	6	600	1914	600	2717.88	803.88	0	meadow 9
640	0.7	1.914	0.89	0.7018	-1.21	6	6	3840	7349.76	3840	2694.912	-4654.848	-19	PVG 9
310	0.3	4.466	0.29	4.5298	0.06	6	6	1860	8306.76	1860	8425.428	118.668	0	meadow 9
300	0.4	3.828	0.29	4.5298	0.70	6	6	1800	6890.4	1800	8153.64	1263.24	0	
170	0.7	1.914	0.84	1.0208	-0.89	7	7	1190	2277.66	1190	1214.752	-1062.908	-14	PVG 9
70	0.3	4.466	0.27	4.6574	0.19	7	7	490	2188.34	490	2282.126	93.786	0	meadow 9
160	0.7	1.914	0.84	1.0208	-0.89	7	7	1120	2143.68	1120	1143.296	-1000.384	-14	PVG 9
180	0.3	4.466	0.27	4.6574	0.19	7	7	1260	5627.16	1260	5868.324	241.164	0	meadow 9
360	0.7	1.914	0.76	1.5312	-0.38	7	7	2520	4823.28	2520	3858.624	-964.656	-6	PVG 10
720	0.6	2.552	0.76	1.5312	-1.02	7	7	5040	12862.08	5040	7717.248	-5144.832	-16	
							Total	**34,430**	**92,772**	**34,430**	**71,228**	**-21,543**	**-14**	

Table 20. Existing and Potential Solar Loads for upper middle South Fork Salmon River.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Upper Mid SF Salmon River**
AU# ID17060208SL010_03														
2000	0.6	2.552	0.71	1.8502	-0.70	8	8	16000	40832	16000	29603.2	-11228.8	-11	PVG 10
800	0.5	3.19	0.71	1.8502	-1.34	8	8	6400	20416	6400	11841.28	-8574.72	-21	
350	0.4	3.828	0.66	2.1692	-1.66	9	9	3150	12058.2	3150	6832.98	-5225.22	-26	
420	0.5	3.19	0.66	2.1692	-1.02	9	9	3780	12058.2	3780	8199.576	-3858.624	-16	
720	0.4	3.828	0.66	2.1692	-1.66	9	9	6480	24805.44	6480	14056.416	-10749.024	-26	
440	0.6	2.552	0.66	2.1692	-0.38	9	9	3960	10105.92	3960	8590.032	-1515.888	-6	
600	0.5	3.19	0.66	2.1692	-1.02	9	9	5400	17226	5400	11713.68	-5512.32	-16	
300	0.4	3.828	0.66	2.1692	-1.66	9	9	2700	10335.6	2700	5856.84	-4478.76	-26	
180	0.2	5.104	0.2	5.104	0.00	10	10	1800	9187.2	1800	9187.2	0	0	meadow 10
390	0.4	3.828	0.2	5.104	1.28	10	10	3900	14929.2	3900	19905.6	4976.4	0	
400	0.2	5.104	0.19	5.1678	0.06	11	11	4400	22457.6	4400	22738.32	280.72	0	
240	0.1	5.742	0.06	5.9972	0.26	11	11	2640	15158.88	2640	15832.608	673.728	0	meadow
60	0.1	5.742	0.06	5.9972	0.26	12	12	720	4134.24	720	4317.984	183.744	0	
600	0	6.38	0.06	5.9972	-0.38	12	12	7200	45936	7200	43179.84	-2756.16	-6	
190	0.1	5.742	0.06	5.9972	0.26	12	12	2280	13091.76	2280	13673.616	581.856	0	
1360	0	6.38	0.06	5.9972	-0.38	12	12	16320	104121.6	16320	97874.304	-6247.296	-6	
310	0.1	5.742	0.18	5.2316	-0.51	12	12	3720	21360.24	3720	19461.552	-1898.688	-8	meadow 10
3600	0	6.38	0.05	6.061	-0.32	13	13	46800	298584	46800	283654.8	-14929.2	-5	meadow
1500	0.1	5.742	0.16	5.3592	-0.38	14	14	21000	120582	21000	112543.2	-8038.8	-6	meadow 10
650	0	6.38	0.05	6.061	-0.32	14	14	9100	58058	9100	55155.1	-2902.9	-5	meadow
150	0.1	5.742	0.16	5.3592	-0.38	14	14	2100	12058.2	2100	11254.32	-803.88	-6	meadow 10
430	0	6.38	0.16	5.3592	-1.02	14	14	6020	38407.6	6020	32262.384	-6145.216	-16	meadow 10
420	0	6.38	0.46	3.4452	-2.93	14	14	5880	37514.4	5880	20257.776	-17256.624	-46	PVG 6
110	0.1	5.742	0.46	3.4452	-2.30	14	14	1540	8842.68	1540	5305.608	-3537.072	-36	
260	0	6.38	0.05	6.061	-0.32	14	14	3640	23223.2	3640	22062.04	-1161.16	-5	meadow
220	0.1	5.742	0.04	6.1248	0.38	15	15	3300	18948.6	3300	20211.84	1263.24	0	
450	0	6.38	0.27	4.6574	-1.72	15	15	6750	43065	6750	31437.45	-11627.55	-27	PVG 2
790	0.1	5.742	0.27	4.6574	-1.08	15	15	11850	68042.7	11850	55190.19	-12852.51	-17	
180	0.3	4.466	0.44	3.5728	-0.89	15	15	2700	12058.2	2700	9646.56	-2411.64	-14	PVG 6
320	0.1	5.742	0.44	3.5728	-2.17	15	15	4800	27561.6	4800	17149.44	-10412.16	-34	
720	0.3	4.466	0.27	4.6574	0.19	15	15	10800	48232.8	10800	50299.92	2067.12	0	PVG 2
180	0.2	5.104	0.27	4.6574	-0.45	15	15	2700	13780.8	2700	12574.98	-1205.82	-7	
170	0.2	5.104	0.46	3.4452	-1.66	15	15	2550	13015.2	2550	8785.26	-4229.94	-26	PVG 10
480	0.1	5.742	0.46	3.4452	-2.30	15	15	7200	41342.4	7200	24805.44	-16536.96	-36	
							Total	**239,580**	**1,281,531**	**239,580**	**1,115,461**	**-166,070**	**-13**	

Table 21. Existing and Potential Solar Loads for middle South Fork Salmon River.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Middle SF Salmon River**
AU# ID17060208SL010_04														
200	0.2	5.104	0.42	3.7004	-1.40	17	17	3400	17353.6	3400	12581.36	-4772.24	-22	PVG 10
320	0.1	5.742	0.42	3.7004	-2.04	17	17	5440	31236.48	5440	20130.176	-11106.304	-32	
1100	0.2	5.104	0.42	3.7004	-1.40	17	17	18700	95444.8	18700	69197.48	-26247.32	-22	
500	0	6.38	0.15	5.423	-0.96	17	17	8500	54230	8500	46095.5	-8134.5	-15	meadow 10
470	0	6.38	0.14	5.4868	-0.89	18	18	8460	53974.8	8460	46418.328	-7556.472	-14	meadow 10
610	0.1	5.742	0.4	3.828	-1.91	18	18	10980	63047.16	10980	42031.44	-21015.72	-30	
1980	0.2	5.104	0.4	3.828	-1.28	18	18	35640	181906.56	35640	136429.92	-45476.64	-20	
270	0.3	4.466	0.39	3.8918	-0.57	19	19	5130	22910.58	5130	19964.934	-2945.646	-9	
1130	0.2	5.104	0.39	3.8918	-1.21	19	19	21470	109582.88	21470	83556.946	-26025.934	-19	
1150	0.2	5.104	0.23	4.9126	-0.19	19	19	21850	111522.4	21850	107340.31	-4182.09	-3	PVG 2
370	0.1	5.742	0.33	4.2746	-1.47	19	19	7030	40366.26	7030	30050.438	-10315.822	-23	PVG 5
180	0.1	5.742	0.22	4.9764	-0.77	20	20	3600	20671.2	3600	17915.04	-2756.16	-12	PVG 2
410	0.2	5.104	0.2	5.104	0.00	20	20	8200	41852.8	8200	41852.8	0	0	barren
1380	0.2	5.104	0.37	4.0194	-1.08	20	20	27600	140870.4	27600	110935.44	-29934.96	-17	PVG 4
850	0.2	5.104	0.22	4.9764	-0.13	20	20	17000	86768	17000	84598.8	-2169.2	-2	PVG 2
470	0.2	5.104	0.21	5.0402	-0.06	21	21	9870	50376.48	9870	49746.774	-629.706	-1	
650	0	6.38	0.21	5.0402	-1.34	21	21	13650	87087	13650	68798.73	-18288.27	-21	
860	0	6.38	0.21	5.0402	-1.34	21	21	18060	115222.8	18060	91026.012	-24196.788	-21	
510	0	6.38	0.3	4.466	-1.91	21	21	10710	68329.8	10710	47830.86	-20498.94	-30	PVG 5
500	0.1	5.742	0.3	4.466	-1.28	21	21	10500	60291	10500	46893	-13398	-20	
920	0.2	5.104	0.21	5.0402	-0.06	21	21	19320	98609.28	19320	97376.664	-1232.616	-1	PVG 2
660	0	6.38	0.21	5.0402	-1.34	21	21	13860	88426.8	13860	69857.172	-18569.628	-21	
310	0.1	5.742	0.21	5.0402	-0.70	21	21	6510	37380.42	6510	32811.702	-4568.718	-11	
360	0	6.38	0.36	4.0832	-2.30	21	21	7560	48232.8	7560	30868.992	-17363.808	-36	PVG 10
690	0.1	5.742	0.21	5.0402	-0.70	21	21	14490	83201.58	14490	73032.498	-10169.082	-11	PVG 2
350	0	6.38	0.21	5.0402	-1.34	21	21	7350	46893	7350	37045.47	-9847.53	-21	
490	0.1	5.742	0.21	5.0402	-0.70	21	21	10290	59085.18	10290	51863.658	-7221.522	-11	
1110	0	6.38	0.2	5.104	-1.28	22	22	24420	155799.6	24420	124639.68	-31159.92	-20	
430	0	6.38	0.2	5.104	-1.28	22	22	9460	60354.8	9460	48283.84	-12070.96	-20	
490	0.1	5.742	0.2	5.104	-0.64	22	22	10780	61898.76	10780	55021.12	-6877.64	-10	
610	0.2	5.104	0.2	5.104	0.00	22	22	13420	68495.68	13420	68495.68	0	0	
980	0	6.38	0.2	5.104	-1.28	22	22	21560	137552.8	21560	110042.24	-27510.56	-20	
980	0.1	5.742	0.2	5.104	-0.64	22	22	21560	123797.52	21560	110042.24	-13755.28	-10	
760	0.2	5.104	0.2	5.104	0.00	22	22	16720	85338.88	16720	85338.88	0	0	
910	0.1	5.742	0.2	5.104	-0.64	22	22	20020	114954.84	20020	102182.08	-12772.76	-10	
1770	0.2	5.104	0.2	5.104	0.00	23	23	40710	207783.84	40710	207783.84	0	0	
500	0.1	5.742	0.2	5.104	-0.64	23	23	11500	66033	11500	58696	-7337	-10	
1280	0.3	4.466	0.2	5.104	0.64	23	23	29440	131479.04	29440	150261.76	18782.72	0	
910	0.1	5.742	0.2	5.104	-0.64	23	23	20930	120180.06	20930	106826.72	-13353.34	-10	
1140	0.2	5.104	0.2	5.104	0.00	23	23	26220	133826.88	26220	133826.88	0	0	
480	0.3	4.466	0.2	5.104	0.64	23	23	11040	49304.64	11040	56348.16	7043.52	0	
250	0.2	5.104	0.19	5.1678	0.06	24	24	6000	30624	6000	31006.8	382.8	0	
590	0.3	4.466	0.19	5.1678	0.70	24	24	14160	63238.56	14160	73176.048	9937.488	0	
200	0.3	4.466	0.19	5.1678	0.70	24	24	4800	21436.8	4800	24805.44	3368.64	0	
170	0.2	5.104	0.19	5.1678	0.06	24	24	4080	20824.32	4080	21084.624	260.304	0	
290	0.3	4.466	0.19	5.1678	0.70	24	24	6960	31083.36	6960	35967.888	4884.528	0	
1100	0.2	5.104	0.19	5.1678	0.06	24	24	26400	134745.6	26400	136429.92	1684.32	0	
660	0.1	5.742	0.19	5.1678	-0.57	24	24	15840	90953.28	15840	81857.952	-9095.328	-9	
400	0.3	4.466	0.19	5.1678	0.70	24	24	9600	42873.6	9600	49610.88	6737.28	0	
600	0.1	5.742	0.19	5.1678	-0.57	24	24	14400	82684.8	14400	74416.32	-8268.48	-9	
380	0.3	4.466	0.19	5.1678	0.70	24	24	9120	40729.92	9120	47130.336	6400.416	0	
1900	0.2	5.104	0.19	5.1678	0.06	24	24	45600	232742.4	45600	235651.68	2909.28	0	
620	0.3	4.466	0.18	5.2316	0.77	25	25	15500	69223	15500	81089.8	11866.8	0	
560	0.1	5.742	0.09	5.8058	0.06	25	25	14000	80388	14000	81281.2	893.2	0	barren
1050	0	6.38	0.09	5.8058	-0.57	25	25	26250	167475	26250	152402.25	-15072.75	-9	
2560	0	6.38	0.09	5.8058	-0.57	25	25	64000	408320	64000	371571.2	-36748.8	-9	
890	0	6.38	0.09	5.8058	-0.57	25	25	22250	141955	22250	129179.05	-12775.95	-9	
							Total	**921,910**	**5,090,972**	**921,910**	**4,610,701**	**-480,271**	**-11**	

Table 22. Existing and Potential Solar Loads for lower middle South Fork Salmon River.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load ($kWh/m^2/day$)	Potential Shade (fraction)	Potential Summer Load ($kWh/m^2/day$)	Potential Load minus Existing load ($kWh/m^2/day$)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Lower Mid SF Salmon River**
AU# ID17060208SL010_05														
2810	0.1	5.742	0.09	5.8058	0.06	27	27	75870	435645.54	75870	440486.046	4840.506	0	PVG 2
2770	0	6.38	0.09	5.8058	-0.57	27	27	74790	477160.2	74790	434215.782	-42944.418	-9	barren
1510	0.1	5.742	0.09	5.8058	0.06	27	27	40770	234101.34	40770	236702.466	2601.126	0	
5110	0	6.38	0.09	5.8058	-0.57	28	28	143080	912850.4	143080	830693.864	-82156.536	-9	
550	0.1	5.742	0.09	5.8058	0.06	28	28	15400	88426.8	15400	89409.32	982.52	0	
530	0	6.38	0.09	5.8058	-0.57	28	28	14840	94679.2	14840	86158.072	-8521.128	-9	
							Total	**364,750**	**2,242,863**	**364,750**	**2,117,666**	**-125,198**	**-5**	

Table 23. Existing and Potential Solar Loads for lower South Fork Salmon River.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load ($kWh/m^2/day$)	Potential Shade (fraction)	Potential Summer Load ($kWh/m^2/day$)	Potential Load minus Existing load ($kWh/m^2/day$)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Lower SF Salmon River**
AU# ID17060208SL010_06														
440	0	6.38	0.07	5.9334	-0.45	38	38	16720	106673.6	16720	99206.448	-7467.152	-7	PVG 2
860	0.1	5.742	0.06	5.9972	0.26	46	40	39560	227153.52	34400	206303.68	-20849.84	0	barren
2640	0	6.38	0.06	5.9972	-0.38	54	42	142560	909532.8	110880	664969.536	-244563.264	-6	
280	0.1	5.742	0.06	5.9972	0.26	54	42	15120	86819.04	11760	70527.072	-16291.968	0	
910	0	6.38	0.06	5.9972	-0.38	54	42	49140	313513.2	38220	229212.984	-84300.216	-6	
420	0.1	5.742	0.06	5.9972	0.26	54	42	22680	130228.56	17640	105790.608	-24437.952	0	
440	0	6.38	0.06	5.9972	-0.38	54	42	23760	151588.8	18480	110828.256	-40760.544	-6	
510	0.1	5.742	0.06	5.9972	0.26	54	42	27540	158134.68	21420	128460.024	-29674.656	0	
650	0	6.38	0.06	5.9972	-0.38	54	42	35100	223938	27300	163723.56	-60214.44	-6	
830	0.2	5.104	0.06	5.9972	0.89	54	42	44820	228761.28	34860	209062.392	-19698.888	0	
1900	0	6.38	0.06	5.9972	-0.38	54	42	102600	654588	79800	478576.56	-176011.44	-6	
690	0.1	5.742	0.06	5.9972	0.26	54	42	37260	213946.92	28980	173798.856	-40148.064	0	
2620	0	6.38	0.06	5.9972	-0.38	55	42	144100	919358	110040	659931.888	-259426.112	-6	
1100	0.1	5.742	0.06	5.9972	0.26	55	43	60500	347391	47300	283667.56	-63723.44	0	
6760	0	6.38	0.06	5.9972	-0.38	55	43	371800	2372084	290680	1743266.096	-628817.904	-6	
760	0.1	5.742	0.06	5.9972	0.26	56	43	42560	244379.52	32680	195988.496	-48391.024	0	
3120	0	6.38	0.06	5.9972	-0.38	56	43	174720	1114713.6	134160	804584.352	-310129.248	-6	
6950	0	6.38	0.06	5.9972	-0.38	56	44	389200	2483096	305800	1833943.76	-649152.24	-6	
630	0.1	5.742	0.06	5.9972	0.26	57	44	35910	206195.22	27720	166242.384	-39952.836	0	
280	0	6.38	0.06	5.9972	-0.38	57	44	15960	101824.8	12320	73885.504	-27939.296	-6	
1090	0.1	5.742	0.06	5.9972	0.26	57	44	62130	356750.46	47960	287625.712	-69124.748	0	
880	0	6.38	0.06	5.9972	-0.38	57	44	50160	320020.8	38720	232211.584	-87809.216	-6	
300	0.1	5.742	0.06	5.9972	0.26	57	44	17100	98188.2	13200	79163.04	-19025.16	0	
390	0	6.38	0.06	5.9972	-0.38	57	44	22230	141827.4	17160	102911.952	-38915.448	-6	
2390	0	6.38	0.06	5.9972	-0.38	57	45	136230	869147.4	107550	644998.86	-224148.54	-6	
410	0.1	5.742	0.06	5.9972	0.26	57	45	23370	134190.54	18450	110648.34	-23542.2	0	
20570	0	6.38	0.06	5.9972	-0.38	59	46	1213630	7742959.4	946220	5674670.584	-2068288.816	-6	
							Total	**3,316,460**	**20,857,005**	**2,590,420**	**15,534,200**	**-5,322,805**	**-3**	

Table 24. Existing and Potential Solar Loads for Trail Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Trail Creek**
AU# ID17060208SL017_02														
730	0.9	0.638	0.95	0.319	-0.32	2	2	1460	931.48	1460	465.74	-465.74	-5	PVG 6
440	0.9	0.638	0.94	0.3828	-0.26	3	3	1320	842.16	1320	505.296	-336.864	-4	PVG 4
490	0.9	0.638	0.91	0.5742	-0.06	4	4	1960	1250.48	1960	1125.432	-125.048	-1	PVG 2
1030	0.9	0.638	0.92	0.5104	-0.13	4	4	4120	2628.56	4120	2102.848	-525.712	-2	PVG 4
290	0.8	1.276	0.86	0.8932	-0.38	5	5	1450	1850.2	1450	1295.14	-555.06	-6	
900	0.8	1.276	0.84	1.0208	-0.26	5	5	4500	5742	4500	4593.6	-1148.4	-4	PVG 6
1340	0.8	1.276	0.84	1.0208	-0.26	5	5	6700	8549.2	6700	6839.36	-1709.84	-4	
720	0.8	1.276	0.7	1.914	0.64	6	6	4320	5512.32	4320	8268.48	2756.16	0	PVG 5
1300	0.8	1.276	0.72	1.7864	0.51	7	7	9100	11611.6	9100	16256.24	4644.64	0	PVG 6
							Total	**34,930**	**38,918**	**34,930**	**41,452**	**2,534**	**-3**	

Table 25. Existing and Potential Solar Loads for Trout Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Trout Creek**
AU# ID17060208SL025_02														
550	0.9	0.638	0.96	0.2552	-0.38	1	1	550	350.9	550	140.36	-210.54	-6	PVG 7
340	0.9	0.638	0.96	0.2552	-0.38	1	1	340	216.92	340	86.768	-130.152	-6	PVG 10
360	0.7	1.914	0.96	0.2552	-1.66	2	2	720	1378.08	720	183.744	-1194.336	-26	
220	0.7	1.914	0.95	0.319	-1.60	2	2	440	842.16	440	140.36	-701.8	-25	PVG 7
130	0	6.38	0.42	3.7004	-2.68	2	2	260	1658.8	260	962.104	-696.696	-42	wolf's willow
420	0.4	3.828	0.96	0.2552	-3.57	3	3	1260	4823.28	1260	321.552	-4501.728	-56	PVG 9
340	0.4	3.828	0.94	0.3828	-3.45	3	3	1020	3904.56	1020	390.456	-3514.104	-54	PVG 7
280	0.9	0.638	0.91	0.5742	-0.06	4	4	1120	714.56	1120	643.104	-71.456	-1	
160	0.9	0.638	0.92	0.5104	-0.13	4	4	640	408.32	640	326.656	-81.664	-2	PVG 10
270	0.3	4.466	0.92	0.5104	-3.96	4	4	1080	4823.28	1080	551.232	-4272.048	-62	
120	0.8	1.276	0.88	0.7656	-0.51	5	5	600	765.6	600	459.36	-306.24	-8	
400	0.5	3.19	0.31	4.4022	1.21	5	5	2000	6380	2000	8804.4	2424.4	0	PVG 9 meadow
230	0.1	5.742	0.18	5.2316	-0.51	5	5	1150	6603.3	1150	6016.34	-586.96	-8	wolf's willow
350	0	6.38	0.18	5.2316	-1.15	5	5	1750	11165	1750	9155.3	-2009.7	-18	
350	0.3	4.466	0.31	4.4022	-0.06	5	5	1750	7815.5	1750	7703.85	-111.65	-1	PVG 9 meadow
170	0.1	5.742	0.18	5.2316	-0.51	5	5	850	4880.7	850	4446.86	-433.84	-8	wolf's willow
380	0.3	4.466	0.31	4.4022	-0.06	5	5	1900	8485.4	1900	8364.18	-121.22	-1	PVG 9 meadow
170	0.2	5.104	0.18	5.2316	0.13	5	5	850	4338.4	850	4446.86	108.46	0	wolf's willow
210	0.4	3.828	0.31	4.4022	0.57	5	5	1050	4019.4	1050	4622.31	602.91	0	PVG 9 meadow
890	0.6	2.552	0.82	1.1484	-1.40	6	6	5340	13627.68	5340	6132.456	-7495.224	-22	PVG 10
480	0.7	1.914	0.89	0.7018	-1.21	6	6	2880	5512.32	2880	2021.184	-3491.136	-19	PVG 9
120	0.5	3.19	0.89	0.7018	-2.49	6	6	720	2296.8	720	505.296	-1791.504	-39	
730	0.6	2.552	0.89	0.7018	-1.85	6	6	4380	11177.76	4380	3073.884	-8103.876	-29	
550	0.6	2.552	0.8	1.276	-1.28	6	6	3300	8421.6	3300	4210.8	-4210.8	-20	PVG 4
							Total	**35,950**	**114,610**	**35,950**	**73,709**	**-40,901**	**-19**	

Table 26. Existing and Potential Solar Loads for Tyndall Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Tyndall Creek**
AU# ID17060208SL010_02														
220	0.8	1.276	0.96	0.2552	-1.02	1	1	220	280.72	220	56.144	-224.576	-16	PVG 7
320	0.8	1.276	0.96	0.2552	-1.02	1	1	320	408.32	320	81.664	-326.656	-16	PVG 6
180	0.9	0.638	0.96	0.2552	-0.38	1	1	180	114.84	180	45.936	-68.904	-6	
610	0.9	0.638	0.96	0.2552	-0.38	1	1	610	389.18	610	155.672	-233.508	-6	PVG 7
1230	0.9	0.638	0.95	0.319	-0.32	2	2	2460	1569.48	2460	784.74	-784.74	-5	PVG 6
1560	0.9	0.638	0.95	0.319	-0.32	2	2	3120	1990.56	3120	995.28	-995.28	-5	PVG 4
370	0.8	1.276	0.94	0.3828	-0.89	3	3	1110	1416.36	1110	424.908	-991.452	-14	
140	0.7	1.914	0.94	0.3828	-1.53	3	3	420	803.88	420	160.776	-643.104	-24	
380	0.7	1.914	0.94	0.3828	-1.53	3	3	1140	2181.96	1140	436.392	-1745.568	-24	PVG 10
220	0.4	3.828	0.29	4.5298	0.70	4	4	880	3368.64	880	3986.224	617.584	0	meadow 6
390	0.3	4.466	0.3	4.466	0.00	4	4	1560	6966.96	1560	6966.96	0	0	meadow 10
200	0.3	4.466	0.3	4.466	0.00	4	4	800	3572.8	800	3572.8	0	0	meadow 10
							Total	**12,820**	**23,064**	**12,820**	**17,667**	**-5,396**	**-10**	

Table 27. Existing and Potential Solar Loads for lower Warm Lake Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Lower Warm Lake Creek**
AU# ID17060208SL019_02														
100	0.2	5.104	0.88	0.7656	-4.34	5	5	500	2552	500	382.8	-2169.2	-68	PVG 10
220	0.5	3.19	0.88	0.7656	-2.42	5	5	1100	3509	1100	842.16	-2666.84	-38	
580	0.4	3.828	0.88	0.7656	-3.06	5	5	2900	11101.2	2900	2220.24	-8880.96	-48	
870	0.3	4.466	0.88	0.7656	-3.70	5	5	4350	19427.1	4350	3330.36	-16096.74	-58	
570	0.4	3.828	0.82	1.1484	-2.68	6	6	3420	13091.76	3420	3927.528	-9164.232	-42	
620	0.3	4.466	0.82	1.1484	-3.32	6	6	3720	16613.52	3720	4272.048	-12341.472	-52	
AU# ID17060208SL019_03														
440	0	6.38	0.24	4.8488	-1.53	7	7	3080	19650.4	3080	14934.304	-4716.096	-24	meadow 10
230	0.1	5.742	0.24	4.8488	-0.89	7	7	1610	9244.62	1610	7806.568	-1438.052	-14	meadow 10
290	0.2	5.104	0.76	1.5312	-3.57	7	7	2030	10361.12	2030	3108.336	-7252.784	-56	PVG 10
390	0.1	5.742	0.24	4.8488	-0.89	7	7	2730	15675.66	2730	13237.224	-2438.436	-14	meadow 10
							Total	**25,440**	**121,226**	**25,440**	**54,062**	**-67,165**	**-41**	

Table 28. Existing and Potential Solar Loads for upper Warm Lake Creek.

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Upper Warm Lake Creek**
AU# ID17060208SL020_02														
100	0.7	1.914	0.96	0.2552	-1.66	1	1	100	191.4	100	25.52	-165.88	-26	PVG 7
110	0.4	3.828	0.96	0.2552	-3.57	1	1	110	421.08	110	28.072	-393.008	-56	
400	0.7	1.914	0.96	0.2552	-1.66	1	1	400	765.6	400	102.08	-663.52	-26	
910	0.9	0.638	0.96	0.2552	-0.38	2	2	1820	1161.16	1820	464.464	-696.696	-6	PVG 10
650	0.7	1.914	0.94	0.3828	-1.53	3	3	1950	3732.3	1950	746.46	-2985.84	-24	
210	0.4	3.828	0.94	0.3828	-3.45	3	3	630	2411.64	630	241.164	-2170.476	-54	PVG 4
210	0.7	1.914	0.94	0.3828	-1.53	3	3	630	1205.82	630	241.164	-964.656	-24	
320	0.8	1.276	0.92	0.5104	-0.77	4	4	1280	1633.28	1280	653.312	-979.968	-12	
90	0.7	1.914	0.92	0.5104	-1.40	4	4	360	689.04	360	183.744	-505.296	-22	
300	0.8	1.276	0.92	0.5104	-0.77	4	4	1200	1531.2	1200	612.48	-918.72	-12	
260	0.4	3.828	0.92	0.5104	-3.32	4	4	1040	3981.12	1040	530.816	-3450.304	-52	
310	0.4	3.828	0.55	2.871	-0.96	5	5	1550	5933.4	1550	4450.05	-1483.35	-15	PVG 2
190	0.6	2.552	0.86	0.8932	-1.66	5	5	950	2424.4	950	848.54	-1575.86	-26	PVG 4
180	0.2	5.104	0.86	0.8932	-4.21	5	5	900	4593.6	900	803.88	-3789.72	-66	
270	0.4	3.828	0.86	0.8932	-2.93	5	5	1350	5167.8	1350	1205.82	-3961.98	-46	
520	0.6	2.552	0.88	0.7656	-1.79	5	5	2600	6635.2	2600	1990.56	-4644.64	-28	PVG 10
180	0.4	3.828	0.27	4.6574	0.83	5	5	900	3445.2	900	4191.66	746.46	0	meadow 10
310	0.3	4.466	0.27	4.6574	0.19	5	5	1550	6922.3	1550	7218.97	296.67	0	
520	0	6.38	0.25	4.785	-1.60	6	6	3120	19905.6	3120	14929.2	-4976.4	-25	
480	0.1	5.742	0.25	4.785	-0.96	6	6	2880	16536.96	2880	13780.8	-2756.16	-15	
290	0.2	5.104	0.25	4.785	-0.32	6	6	1740	8880.96	1740	8325.9	-555.06	-5	
370	0.3	4.466	0.25	4.785	0.32	6	6	2220	9914.52	2220	10622.7	708.18	0	
120	0.1	5.742	0.25	4.785	-0.96	6	6	720	4134.24	720	3445.2	-689.04	-15	
200	0	6.38	0.25	4.785	-1.60	6	6	1200	7656	1200	5742	-1914	-25	
140	0.3	4.466	0.25	4.785	0.32	6	6	840	3751.44	840	4019.4	267.96	0	
							Total	**32,040**	**123,625**	**32,040**	**85,404**	**-38,221**	**-23**	

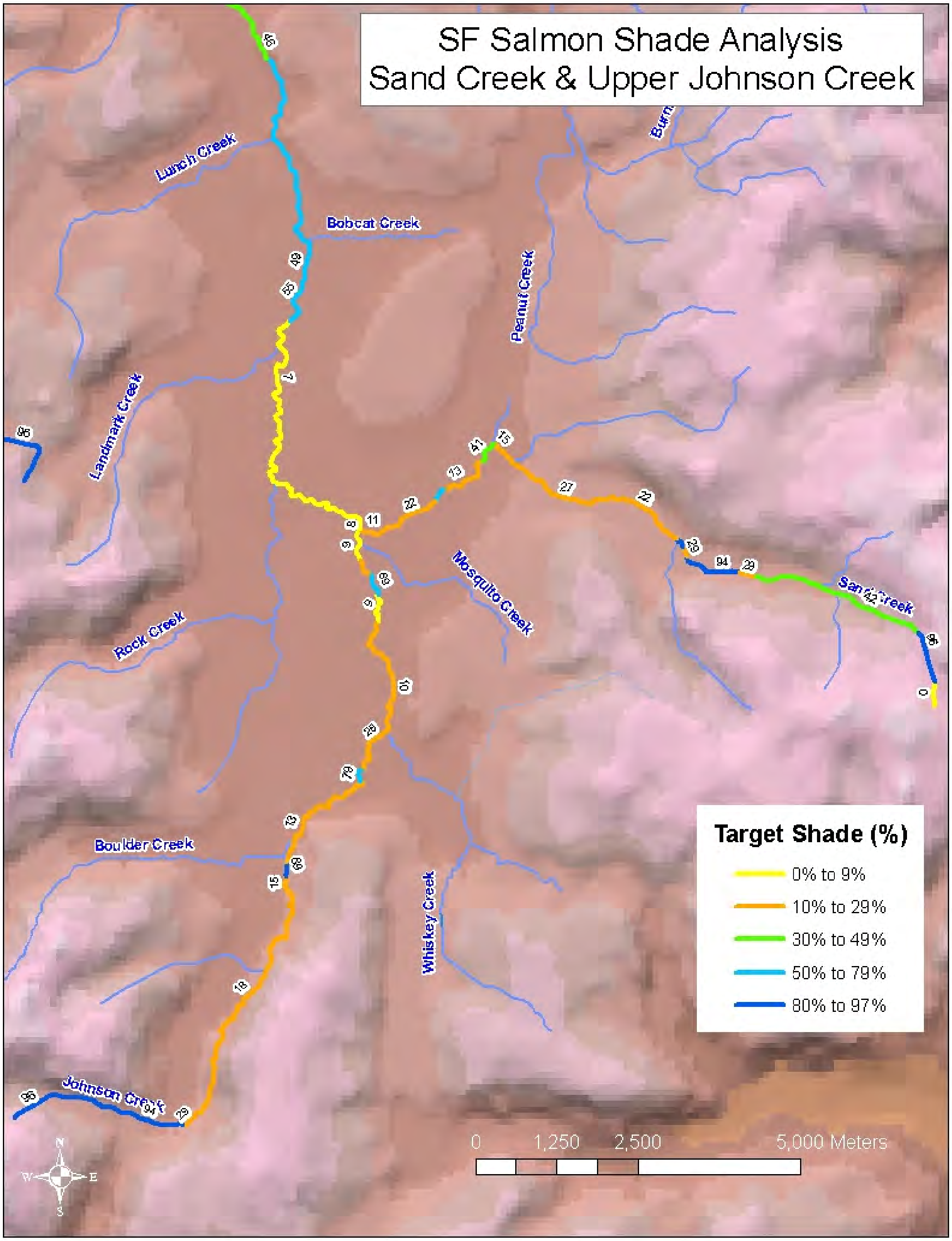

Figure 6. Target Shade for Sand Creek and upper Johnson Creek.

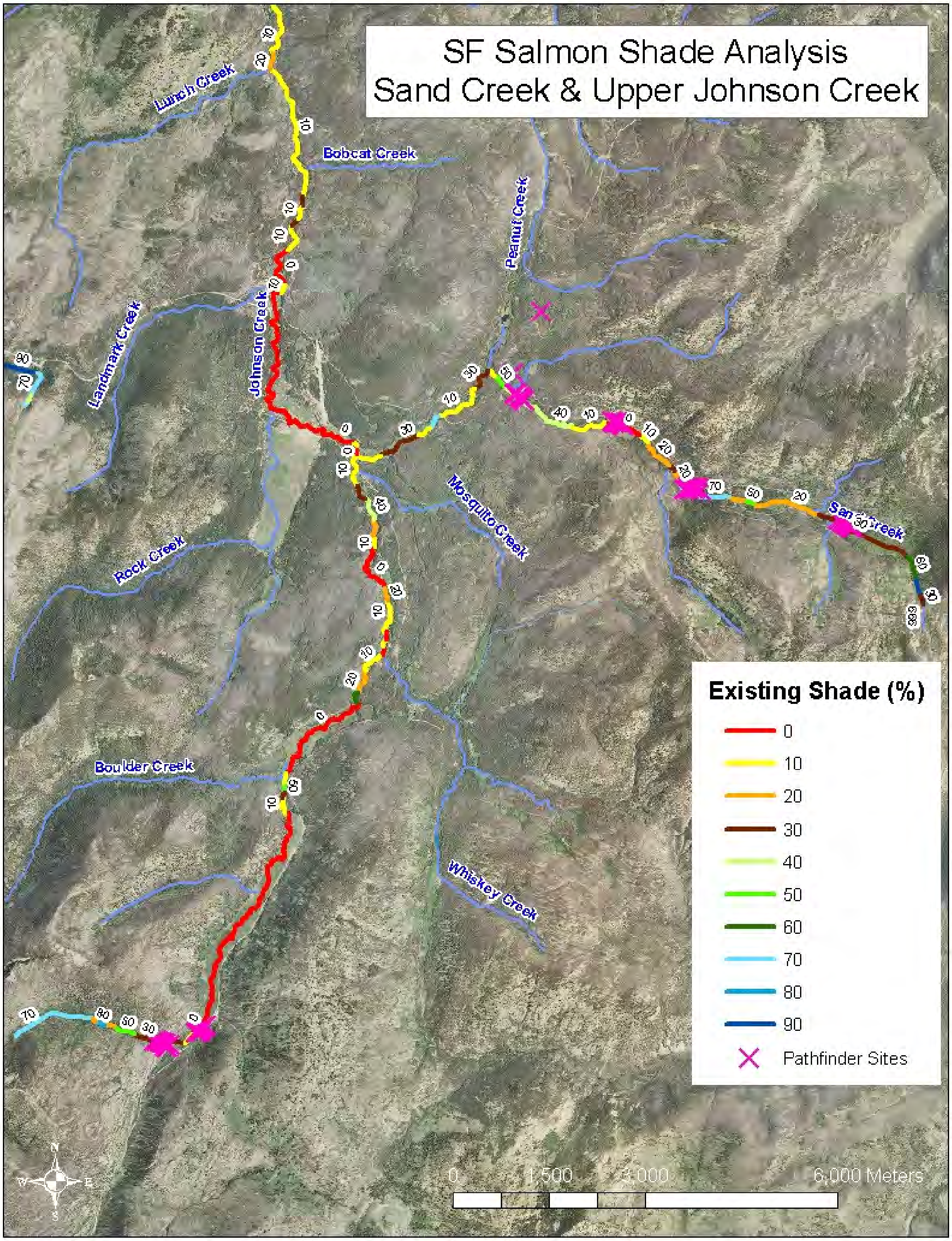

Figure 7. Existing Shade Estimated for Sand Creek and upper Johnson Creek by Aerial Photo Interpretation.

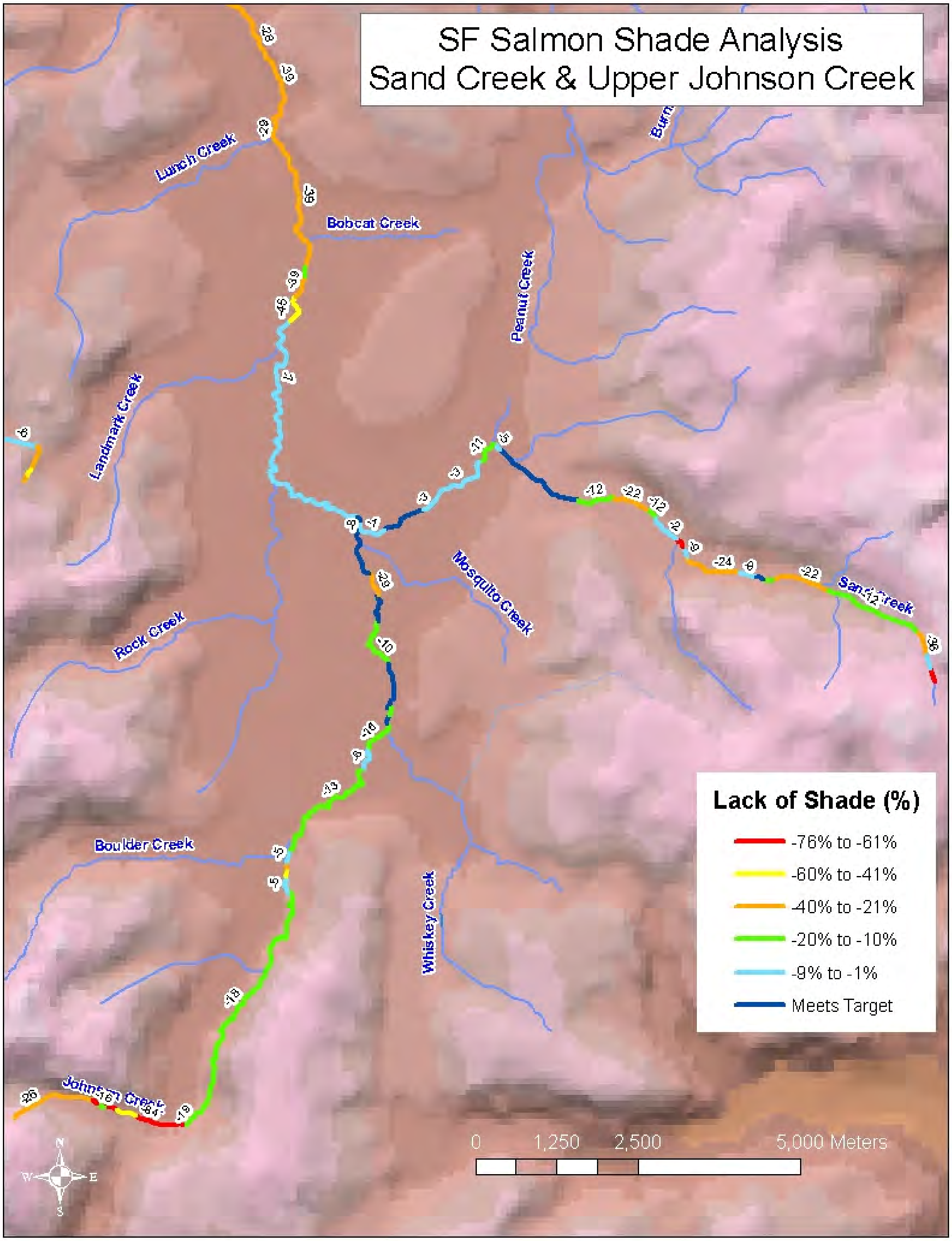

Figure 8. Lack of Shade (Difference Between Existing and Target) for Sand Creek and upper Johnson Creek.

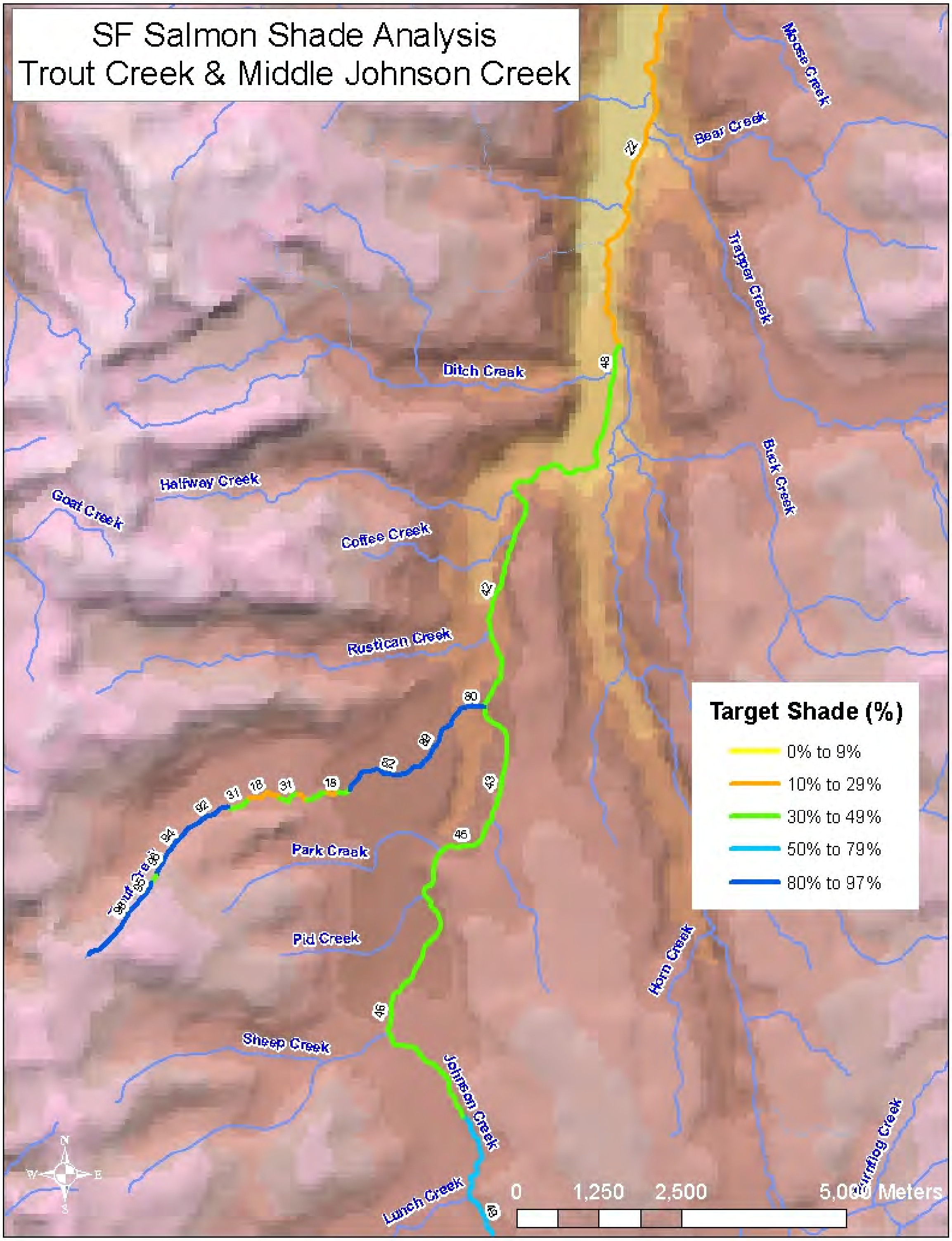

Figure 9. Target Shade for Trout Creek and middle Johnson Creek.

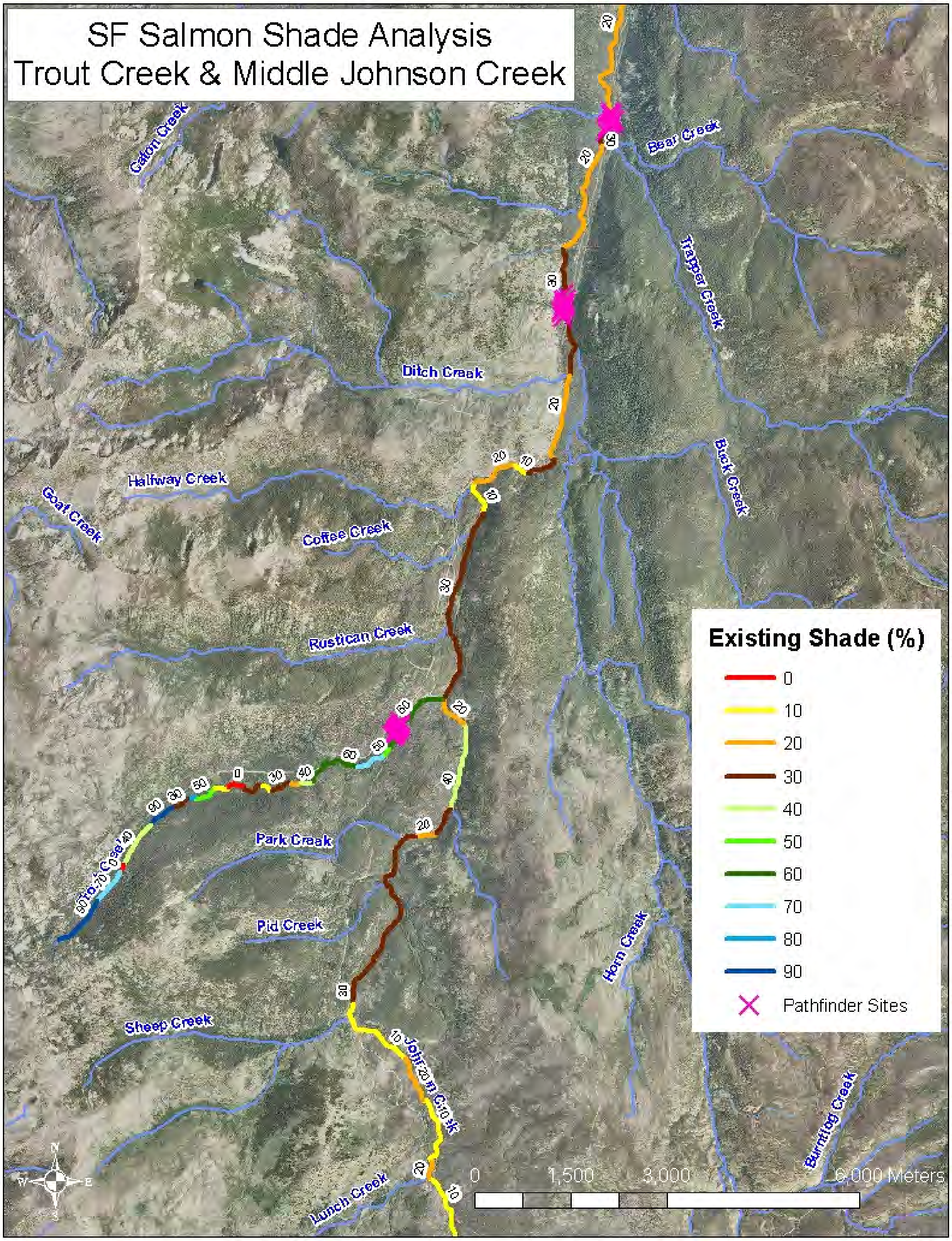

Figure 10. Existing Shade Estimated for Trout Creek and middle Johnson Creek by Aerial Photo Interpretation.

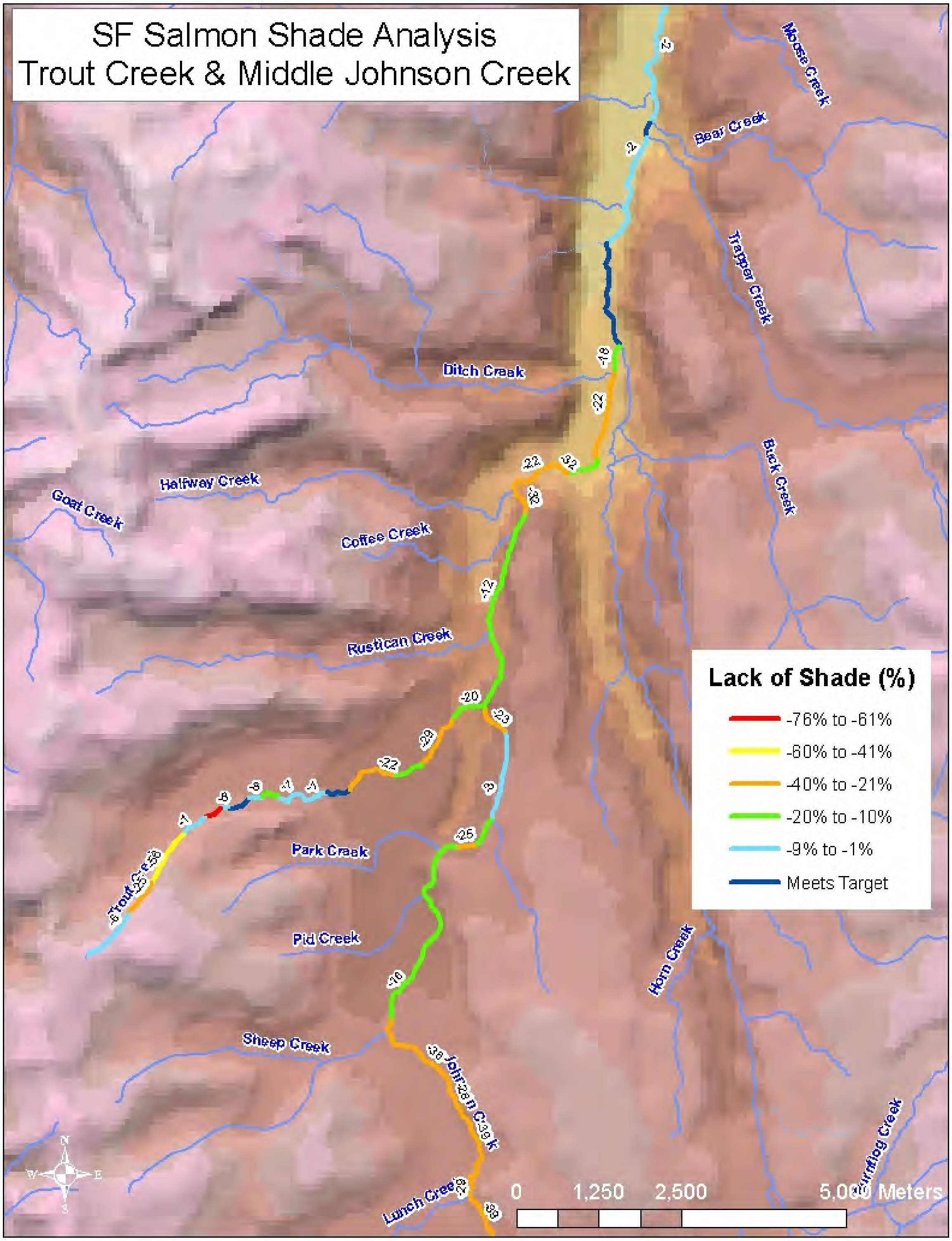

Figure 11. Lack of Shade (Difference Between Existing and Target) for Trout Creek and middle Johnson Creek.

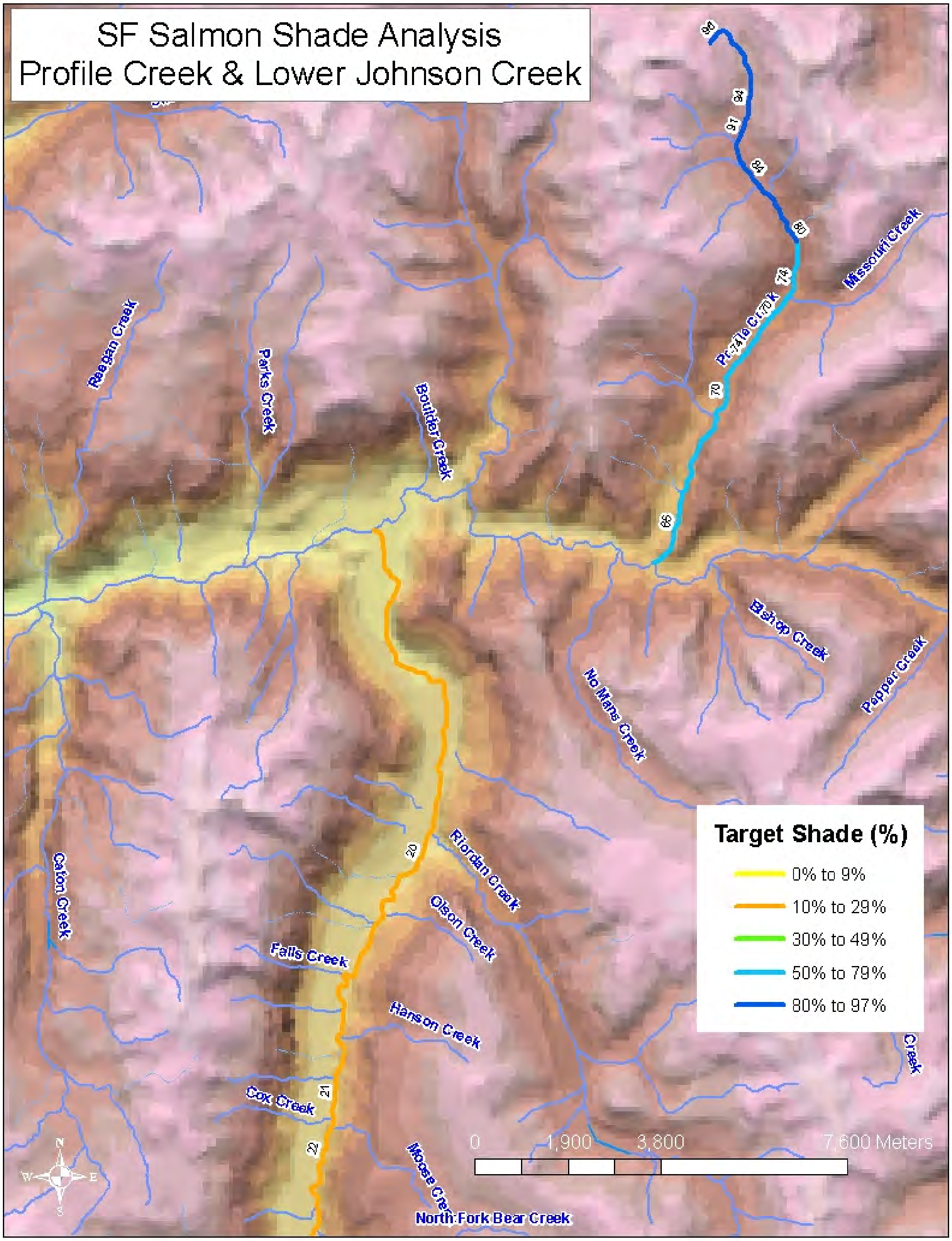

Figure 12. Target Shade for Profile Creek and lower Johnson Creek.

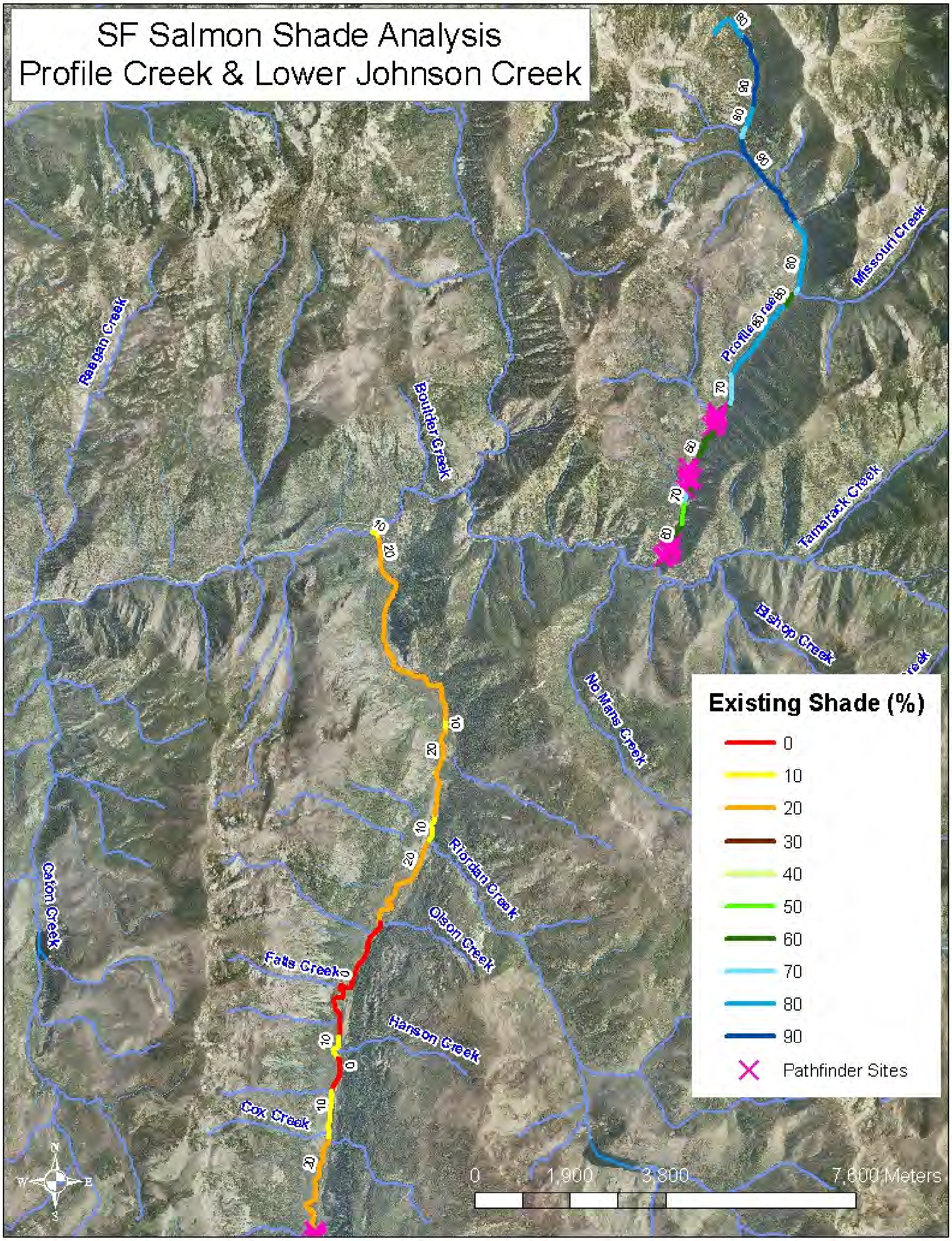

Figure 13. Existing Shade Estimated for Profile Creek and lower Johnson Creek by Aerial Photo Interpretation.

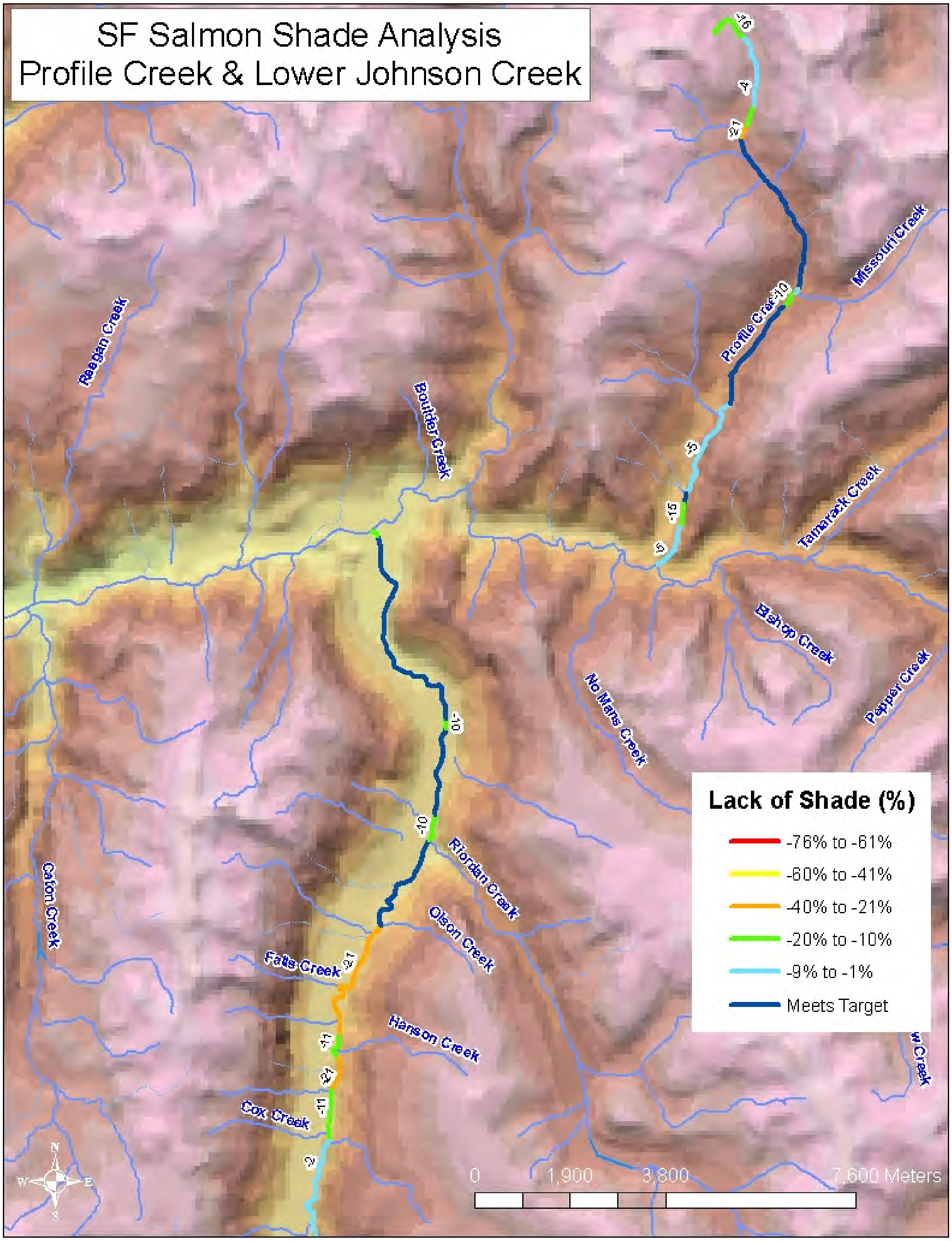

Figure 14. Lack of Shade (Difference Between Existing and Target) for Profile Creek and lower Johnson Creek.

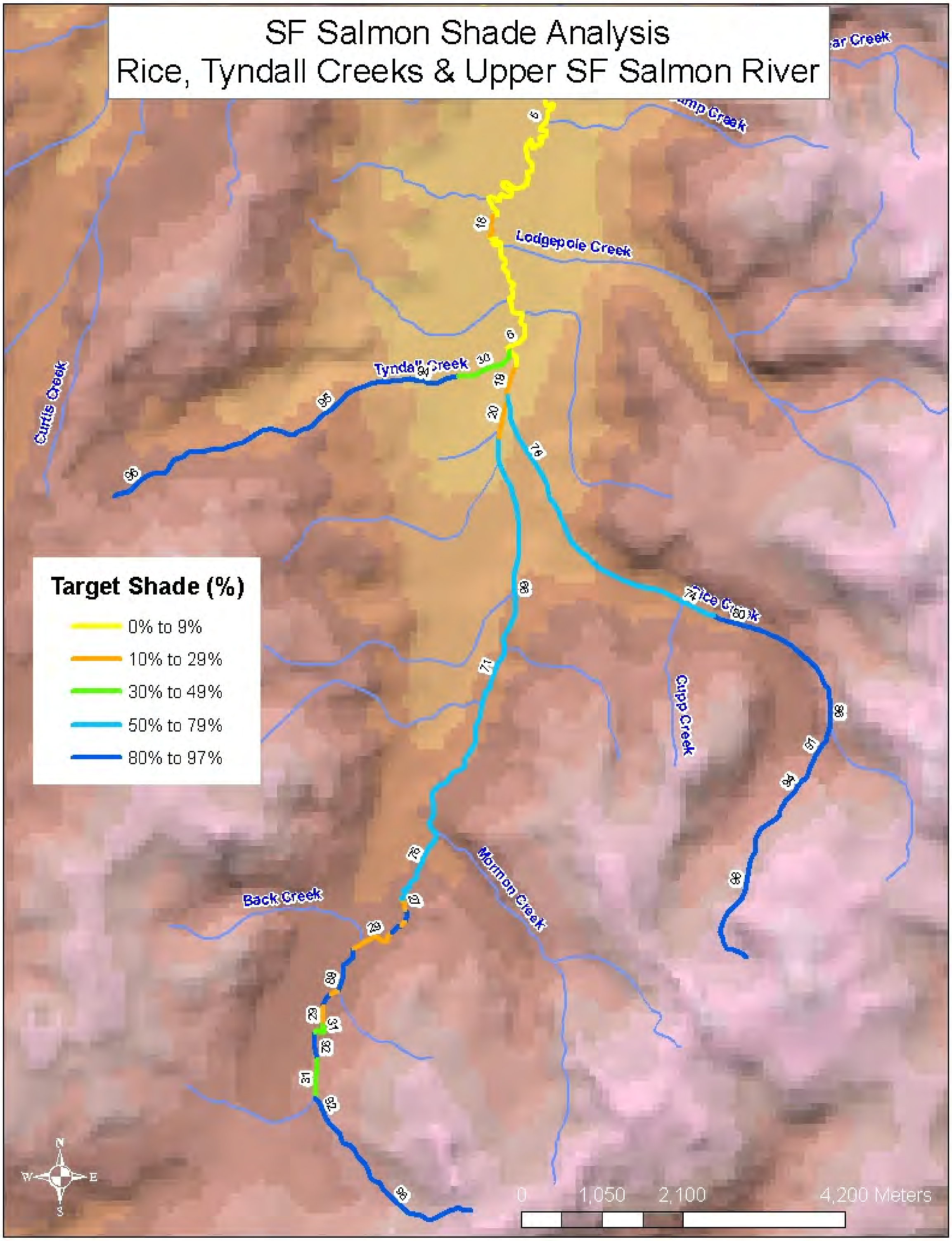

Figure 15. Target Shade for Rice Creek, Tyndall Creek and upper SF Salmon River.

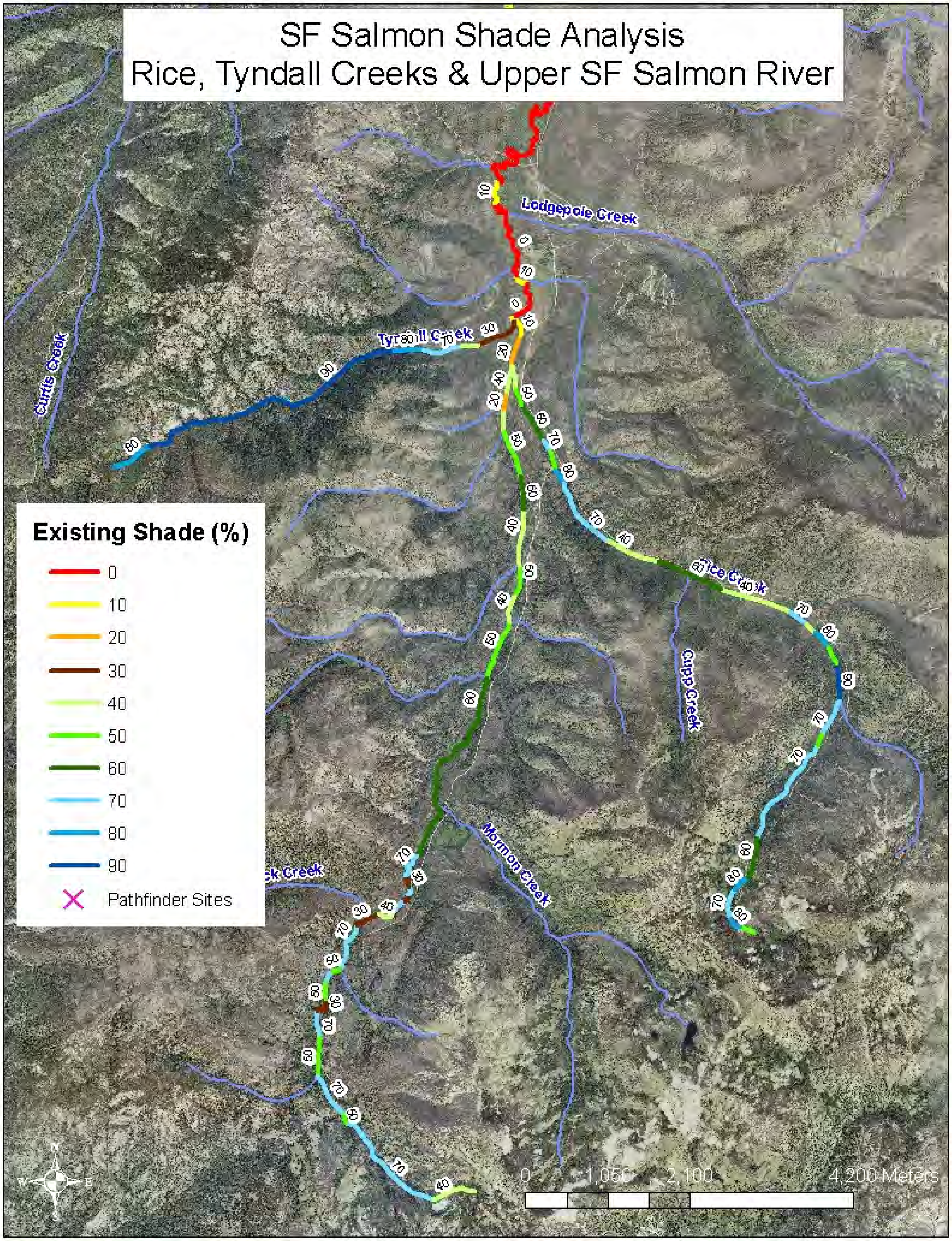

Figure 16. Existing Shade Estimated for Rice Creek, Tyndall Creek and upper SF Salmon River by Aerial Photo Interpretation.

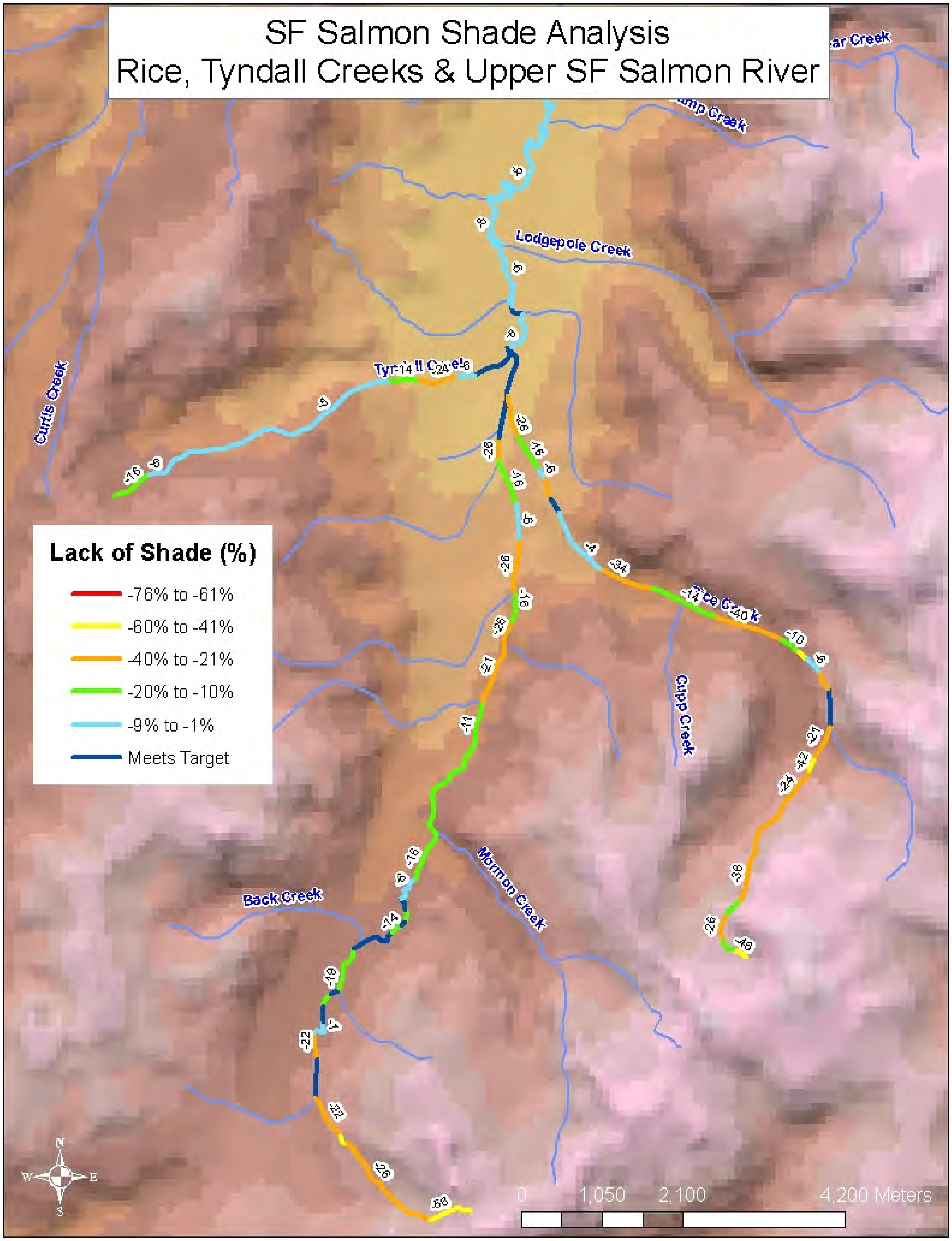

Figure 17. Lack of Shade (Difference Between Existing and Target) for Rice Creek, Tyndall Creek and upper SF Salmon River.

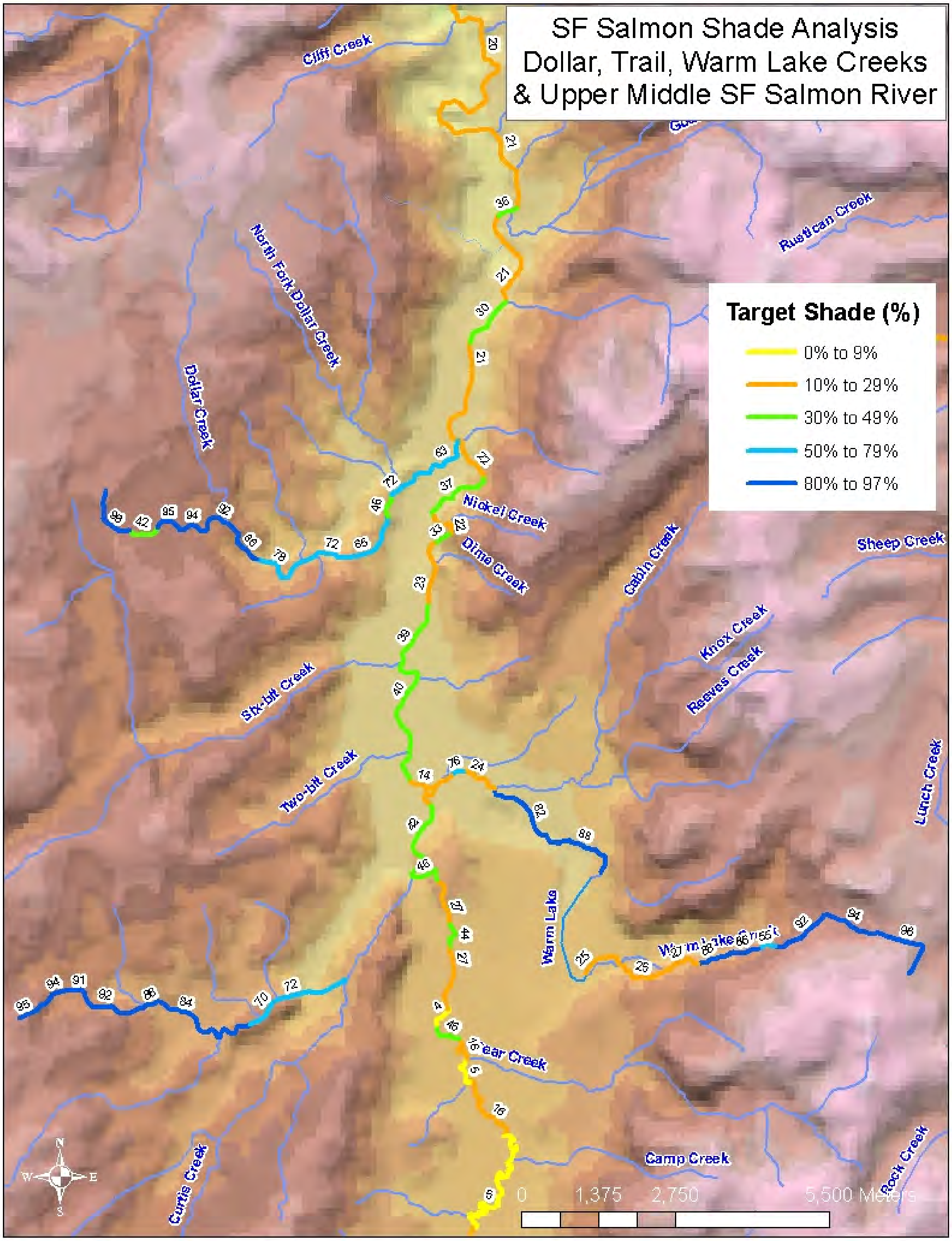

Figure 18. Target Shade for Dollar Creek, Trail Creek, Warm Lake Creek, and upper middle SF Salmon River.

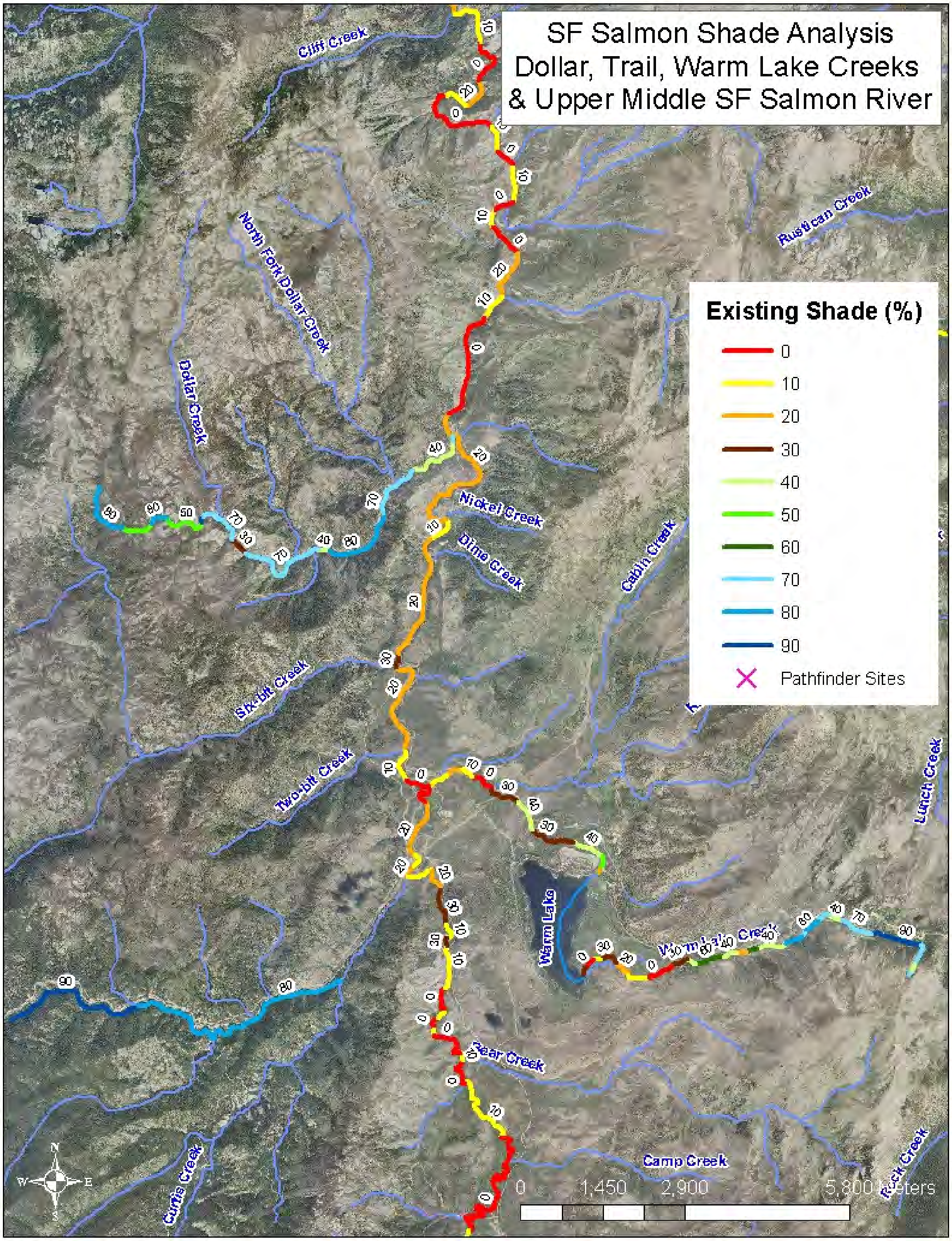

Figure 19. Existing Shade Estimated for Dollar Creek, Trail Creek, Warm Lake Creek, and upper middle SF Salmon River by Aerial Photo Interpretation.

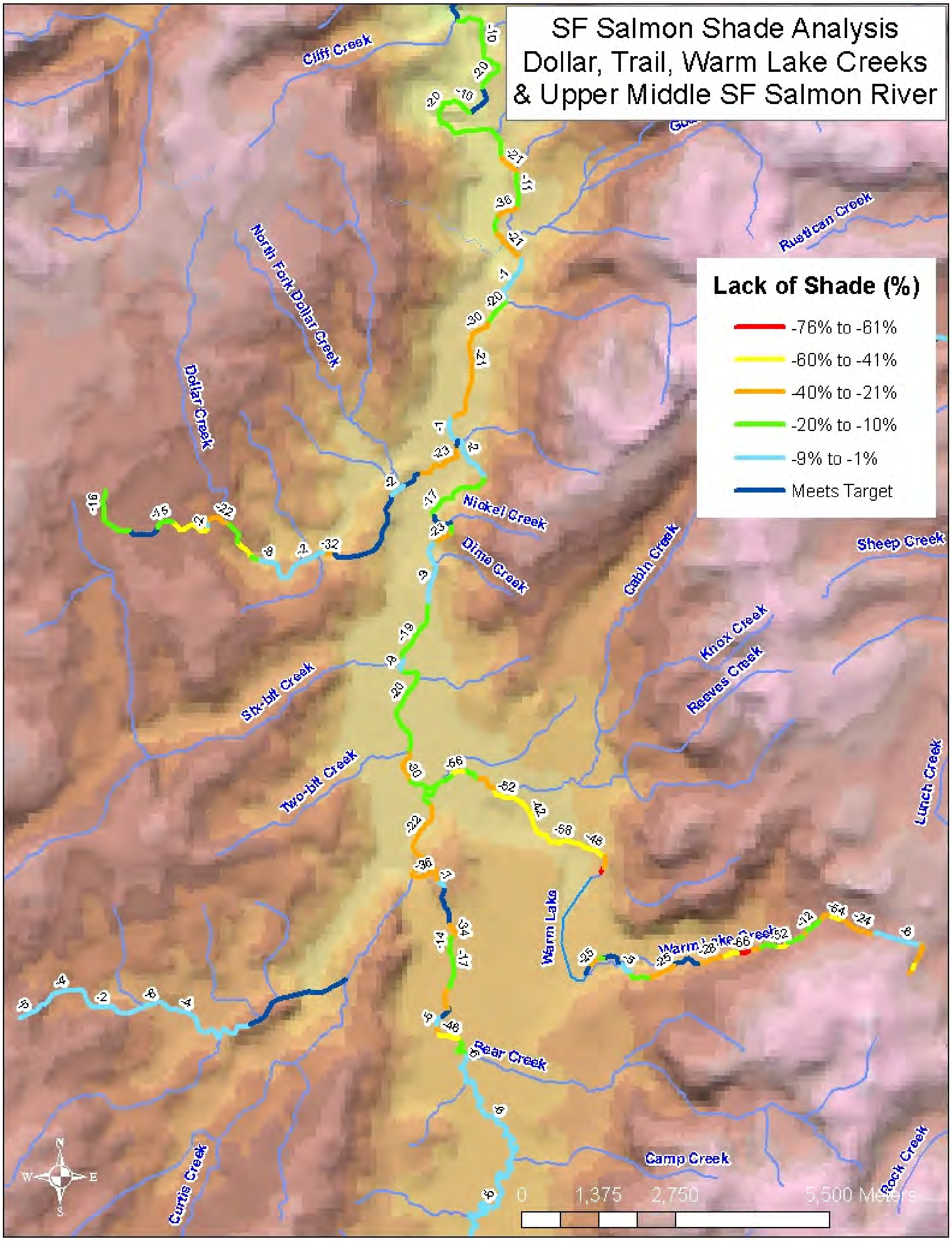

Figure 20. Lack of Shade (Difference Between Existing and Target) for Dollar Creek, Trail Creek, Warm Lake Creek, and upper middle SF Salmon River.

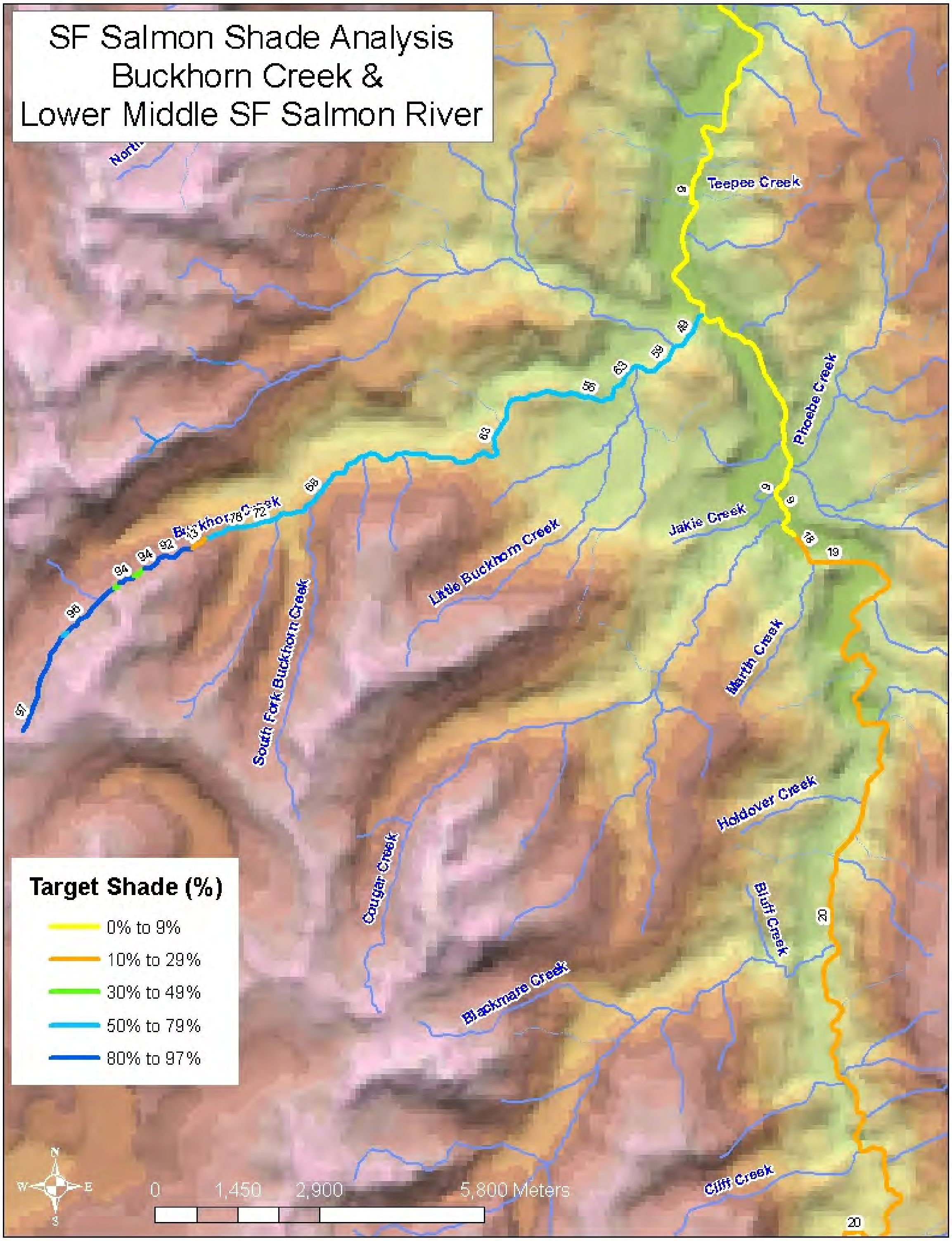

Figure 21. Target Shade for Buckhorn Creek and middle SF Salmon River.

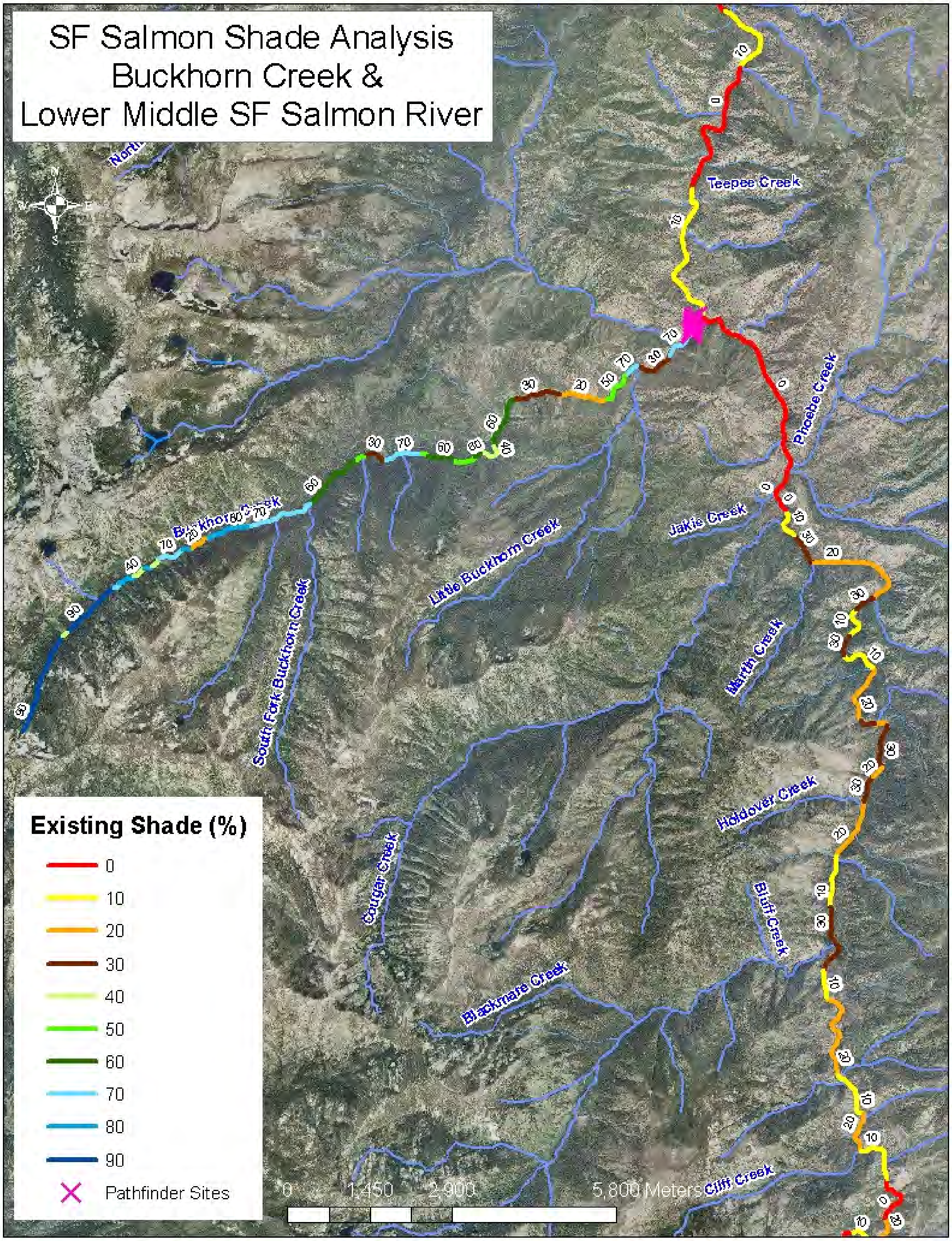

Figure 22. Existing Shade Estimated for Buckhorn Creek and middle SF Salmon River by Aerial Photo Interpretation.

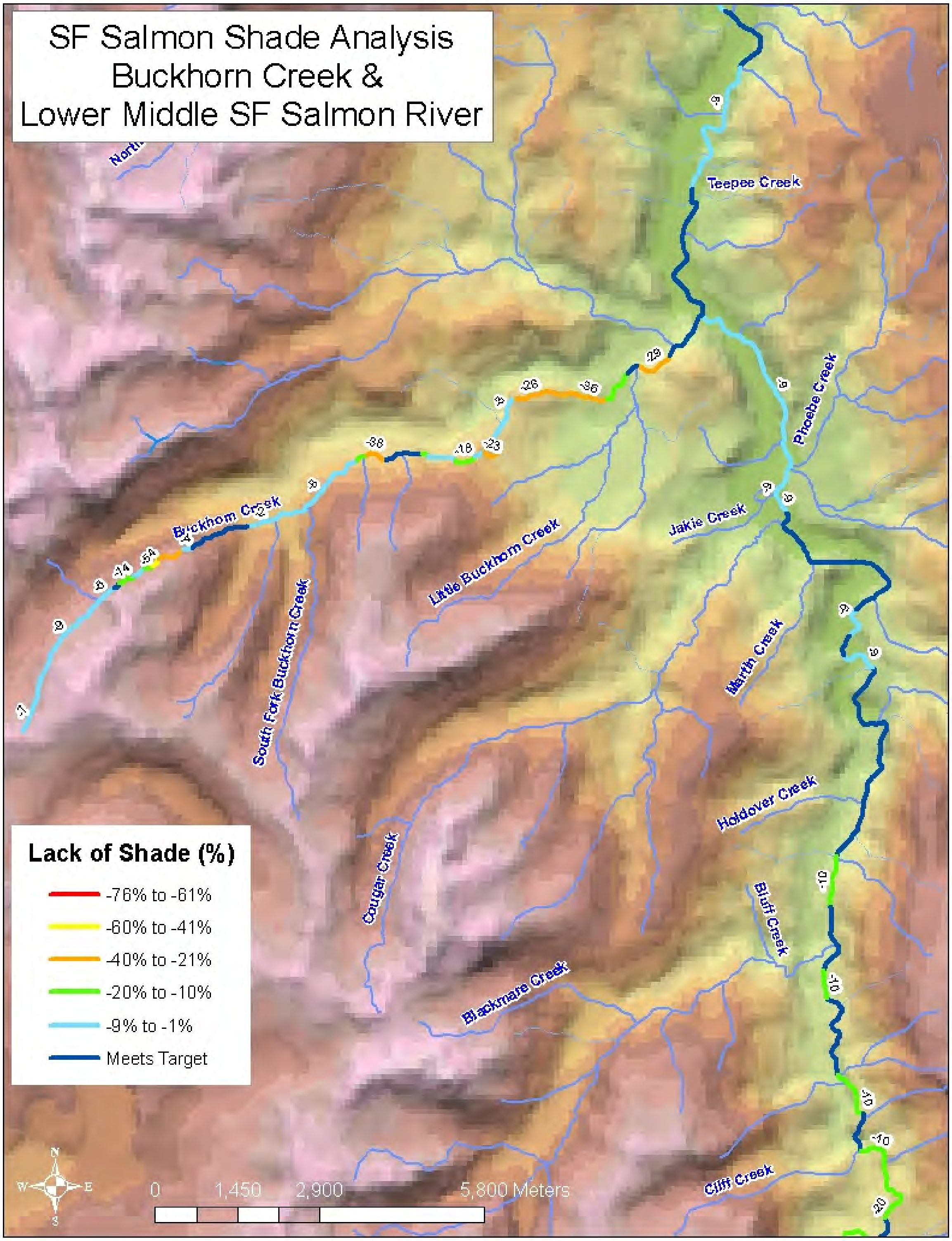

Figure 23. Lack of Shade (Difference Between Existing and Target) for Buckhorn Creek and middle SF Salmon River.

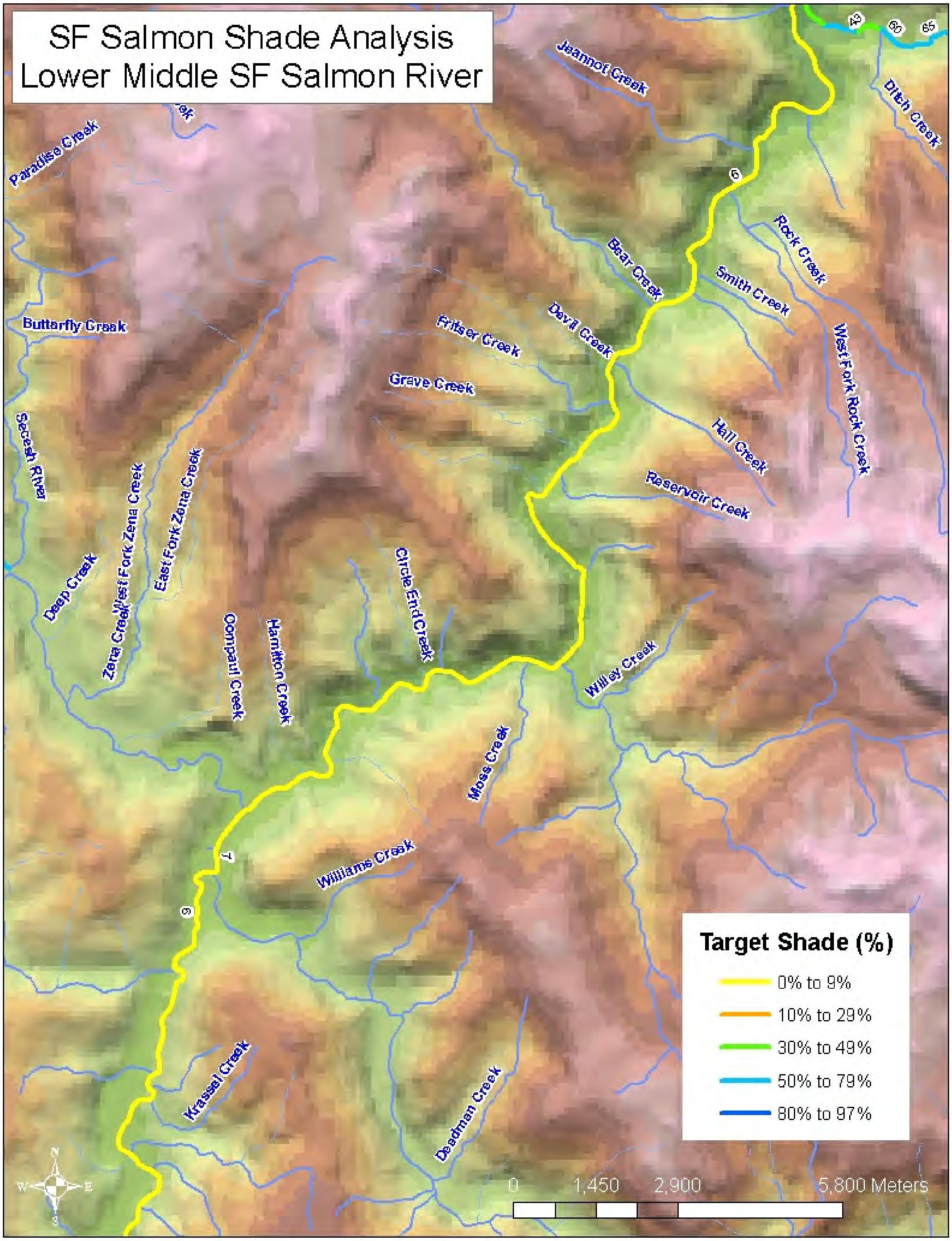

Figure 24. Target Shade for lower middle SF Salmon River.

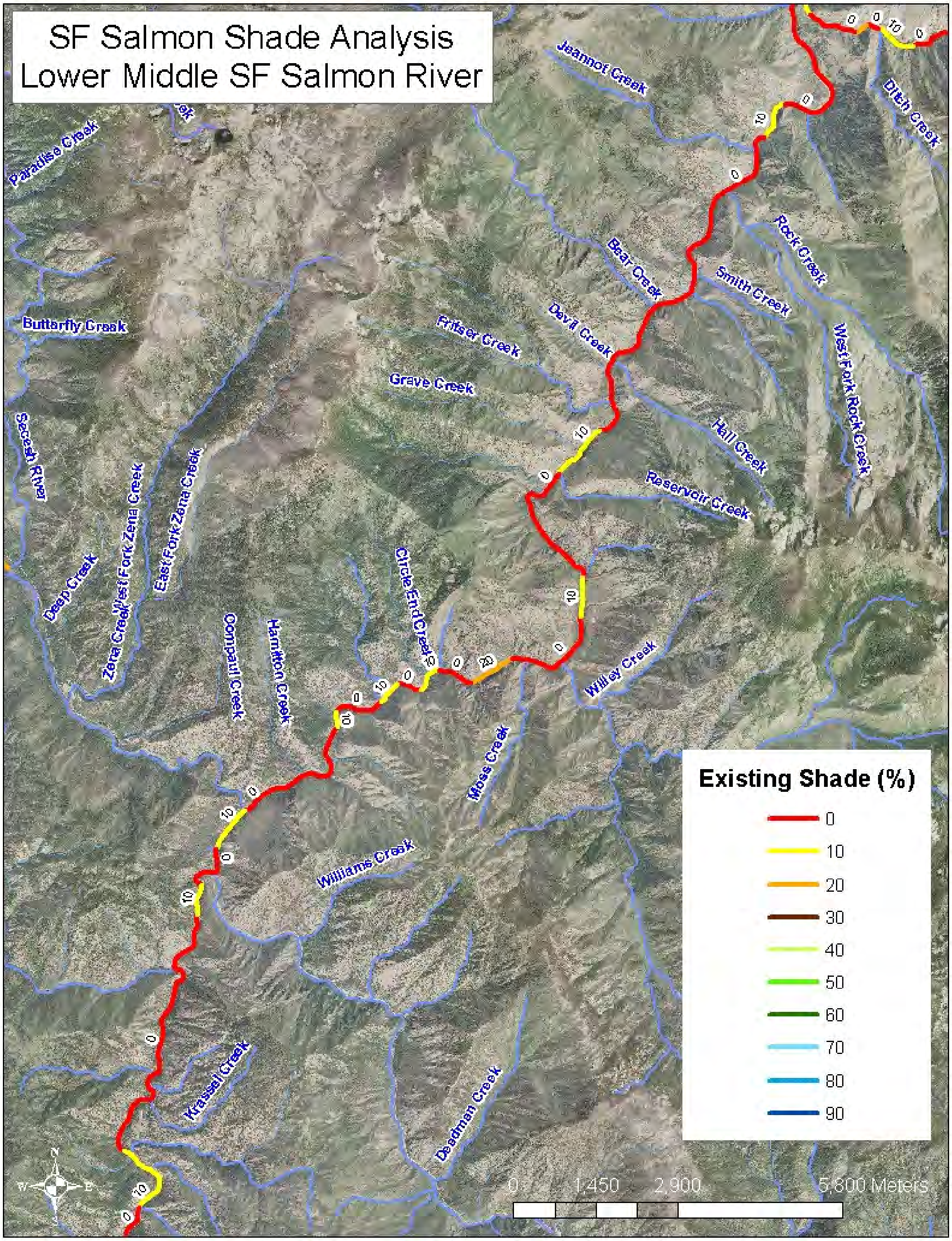

Figure 25. Existing Shade Estimated for lower middle SF Salmon River by Aerial Photo Interpretation.

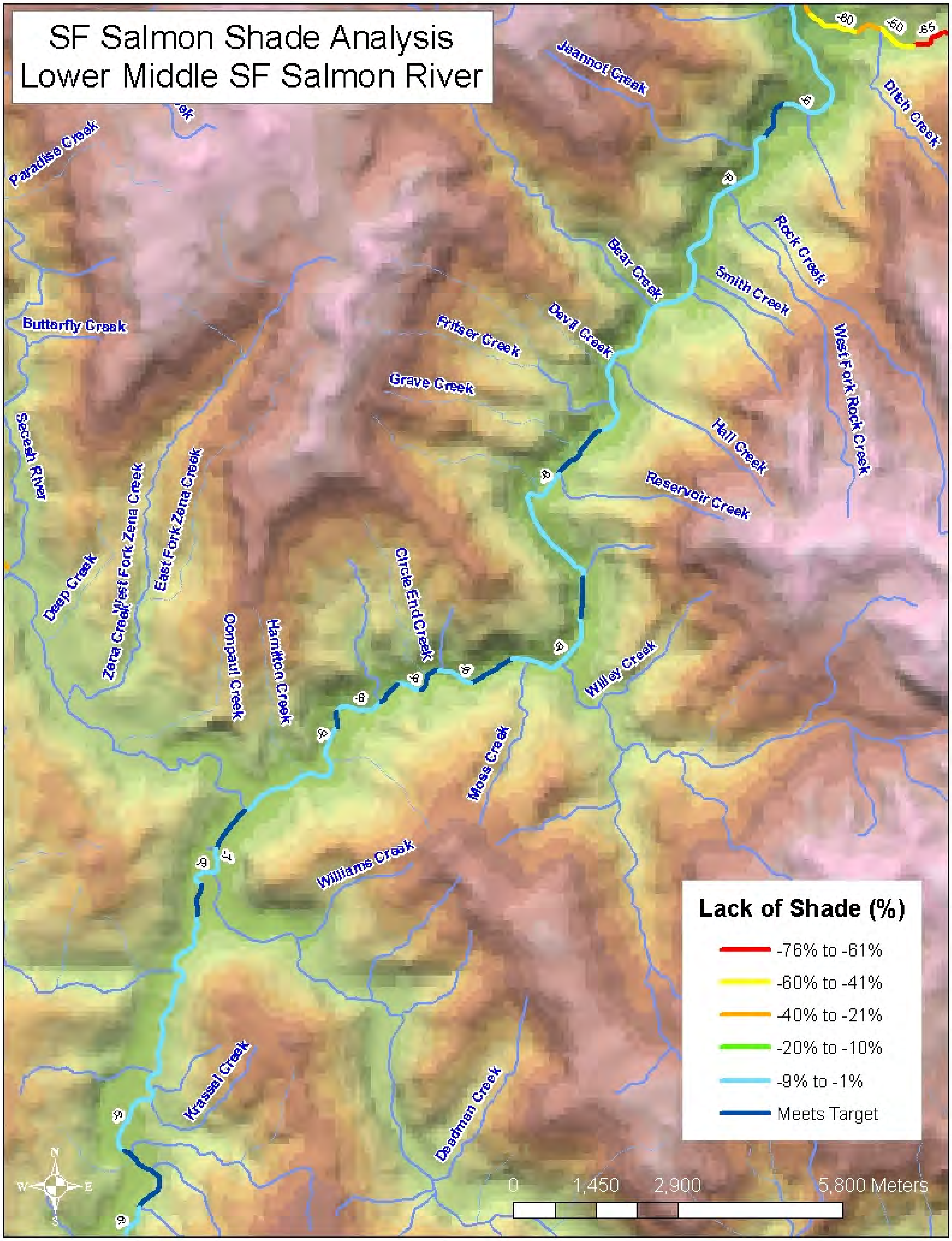

Figure 26. Lack of Shade (Difference Between Existing and Target) for lower middle SF Salmon River.

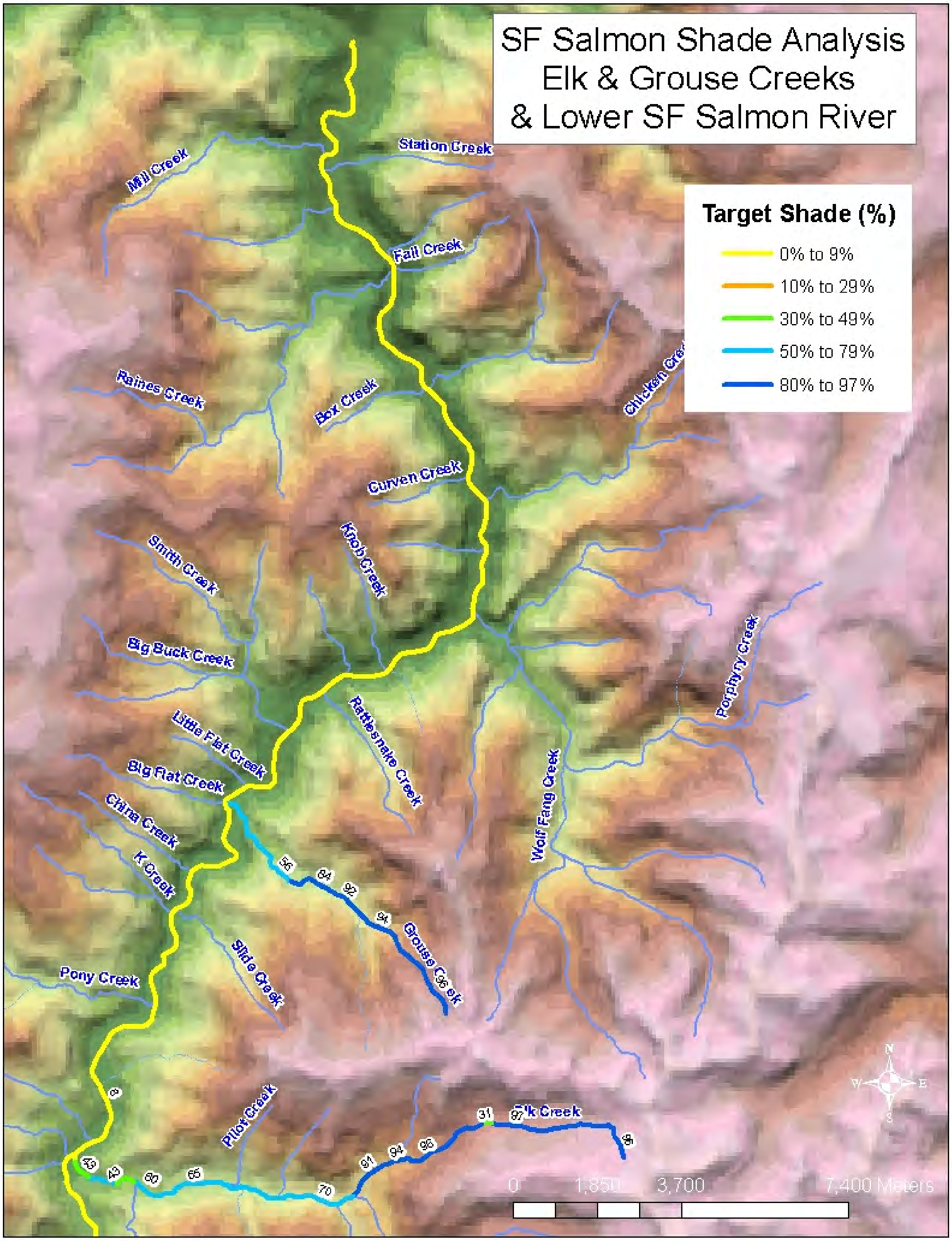

Figure 27. Target Shade for Elk Creek and lower SF Salmon River.

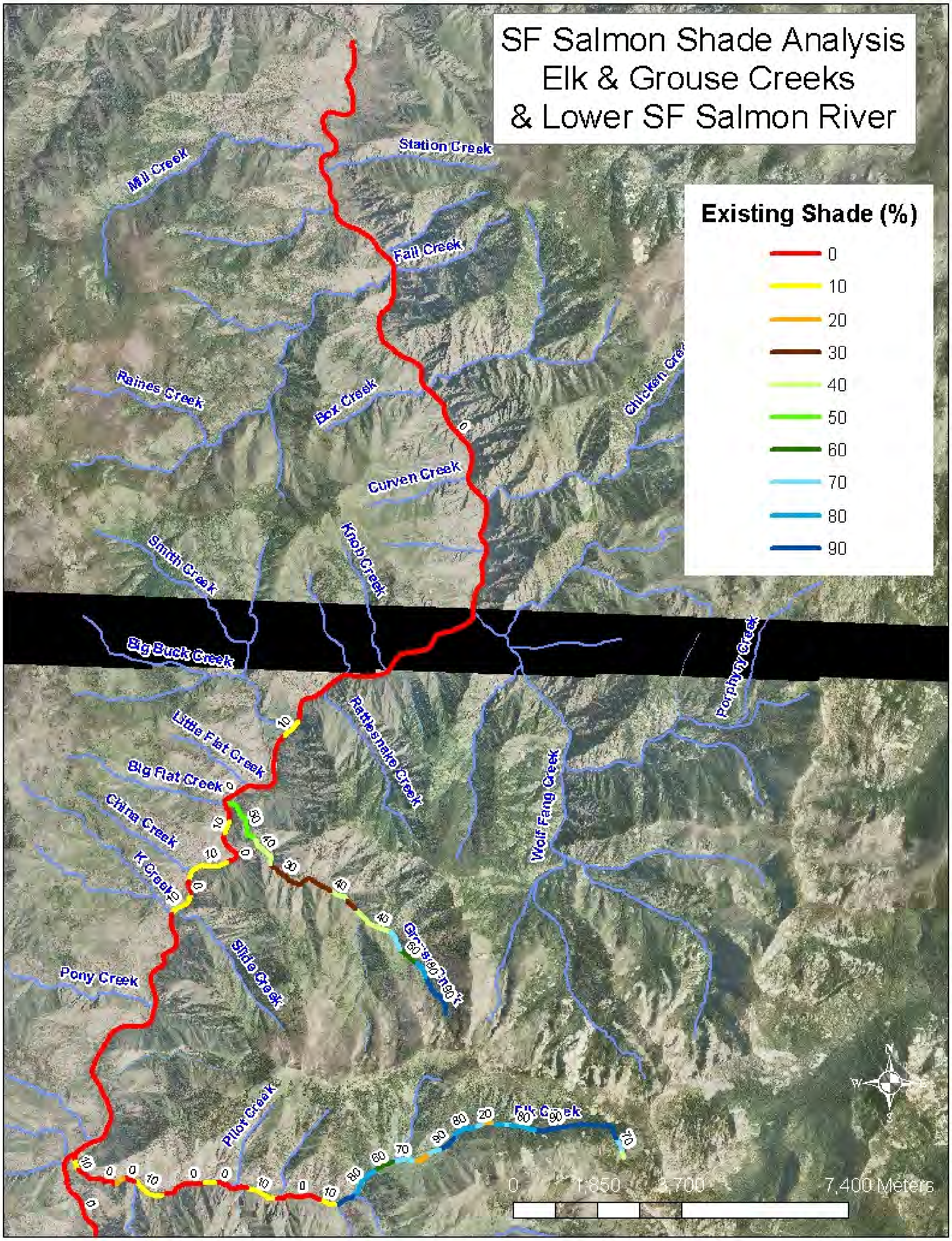

Figure 28. Existing Shade Estimated for Elk Creek and lower SF Salmon River by Aerial Photo Interpretation.

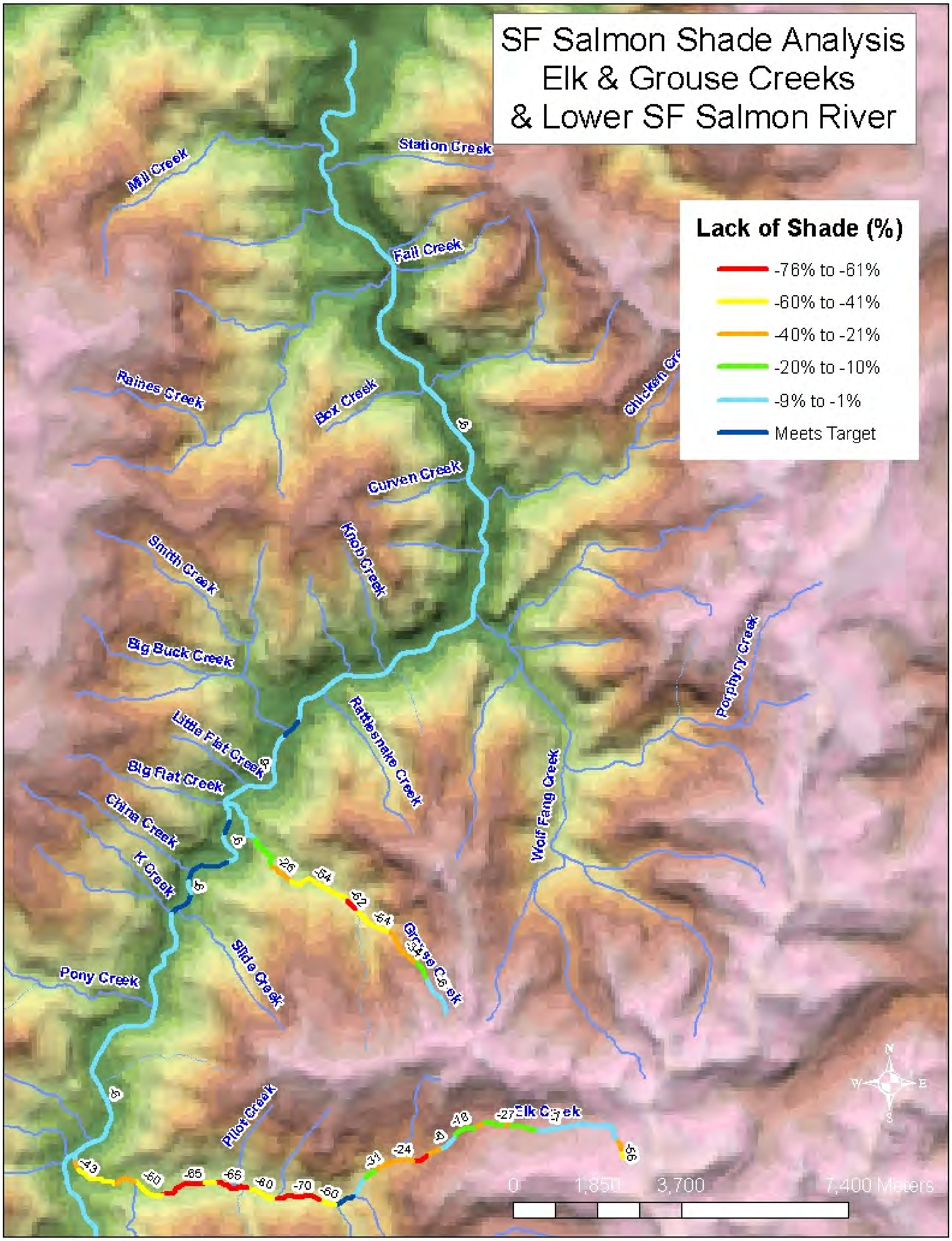

Figure 29. Lack of Shade (Difference Between Existing and Target) for Elk Creek and lower SF Salmon River.

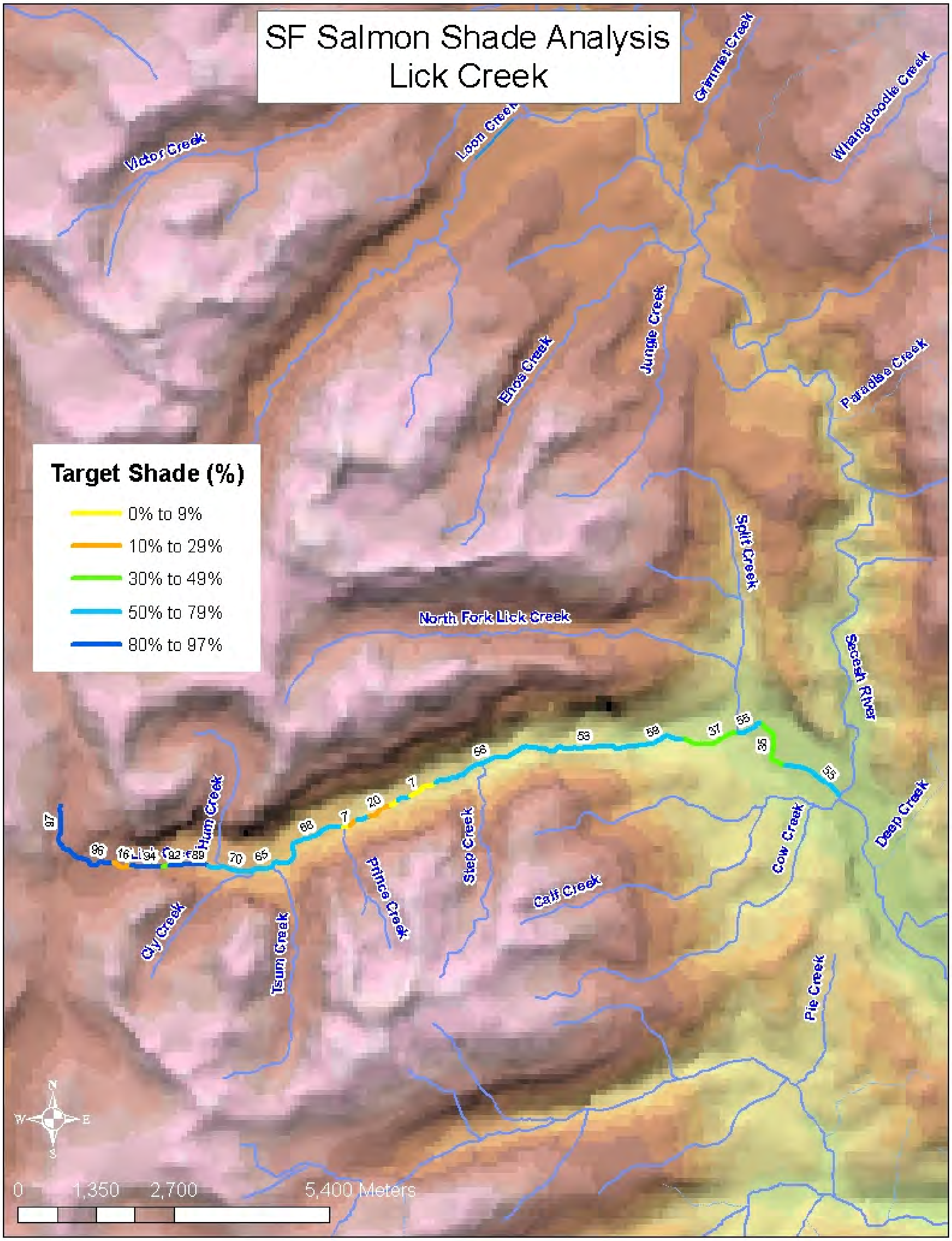

Figure 30.Target Shade for Lick Creek.

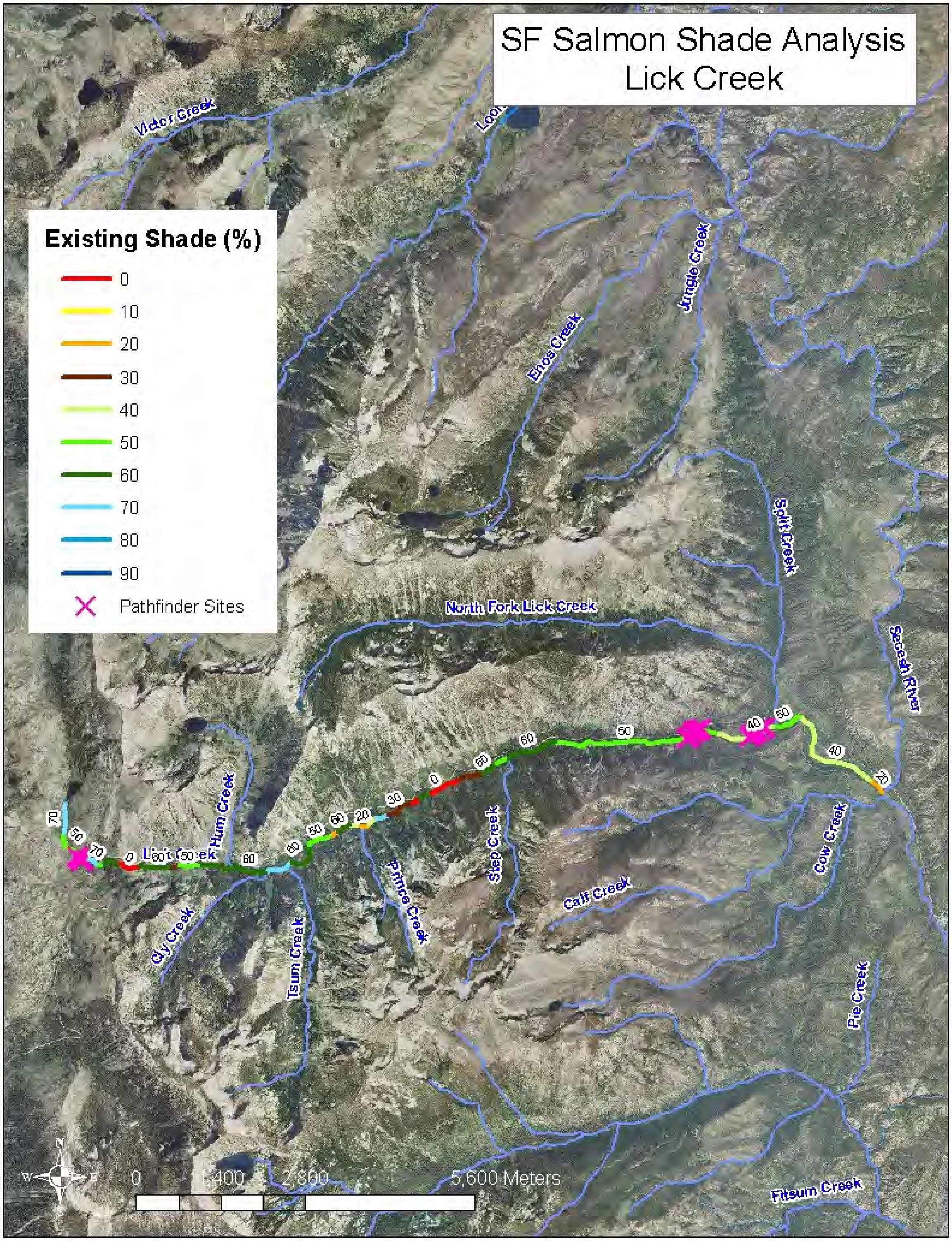

Figure 31. Existing Shade Estimated for Lick Creek by Aerial Photo Interpretation.

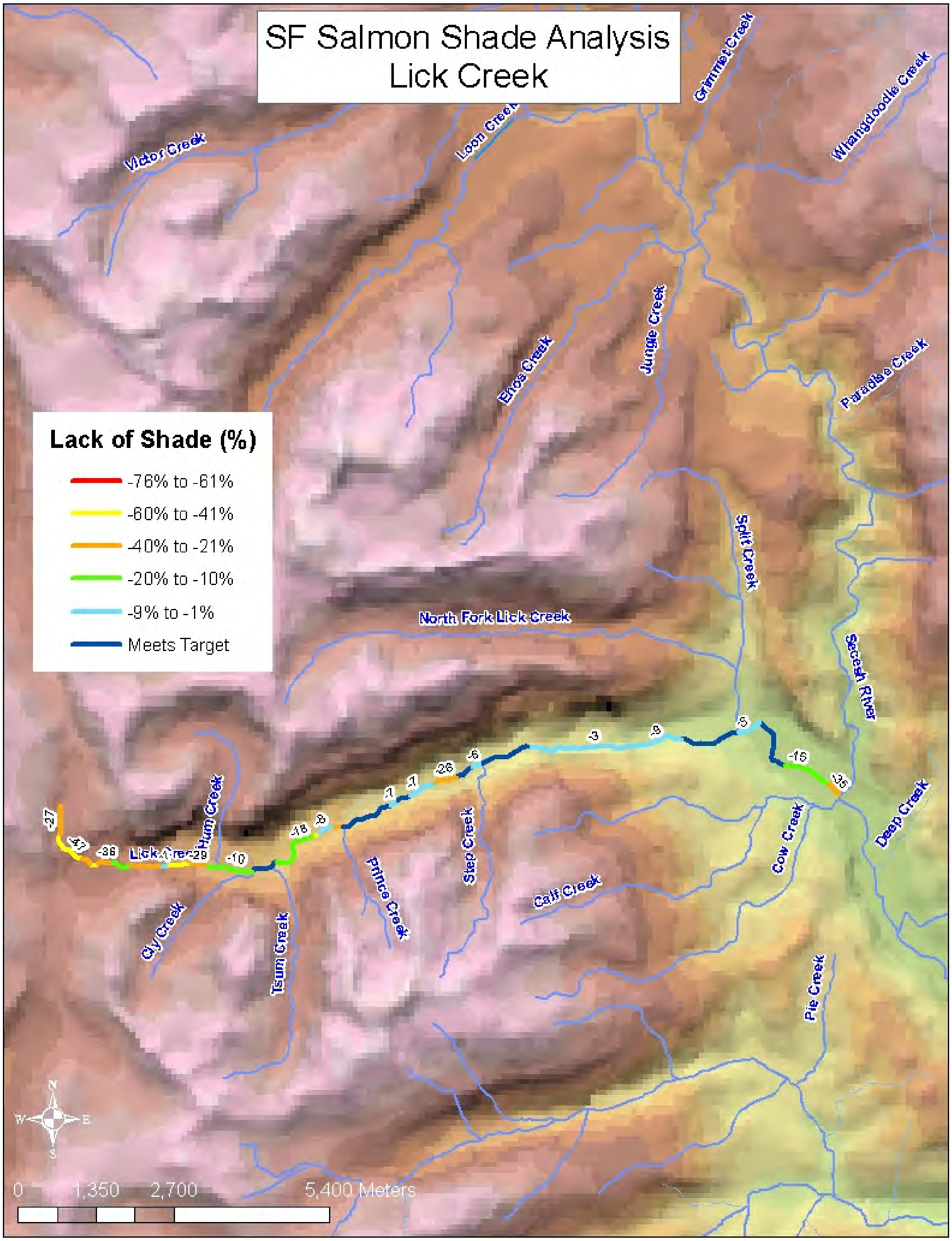

Figure 32. Lack of Shade (Difference Between Existing and Target) for Lick Creek.

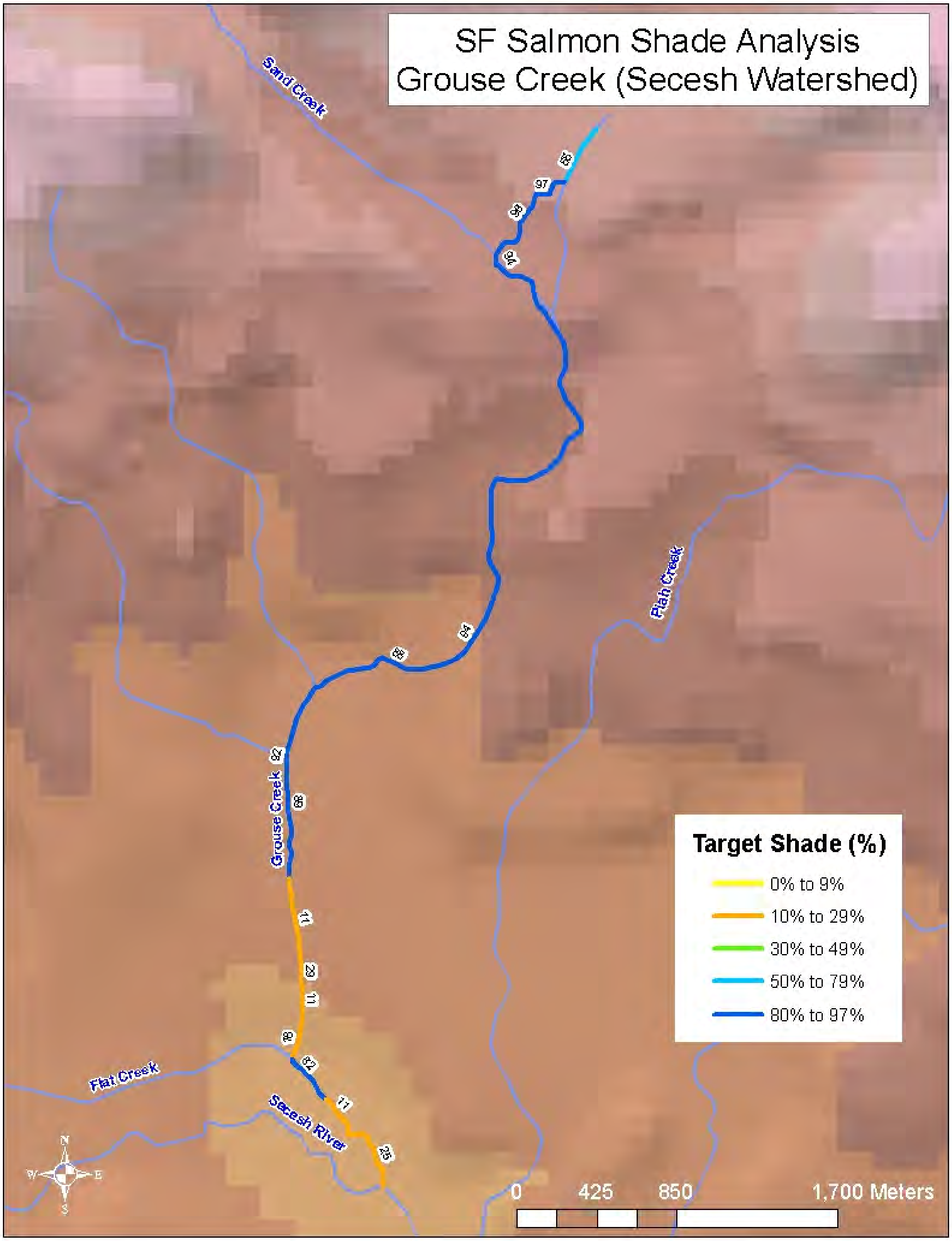

Figure 33. Target Shade for Grouse Creek (Secesh Watershed).

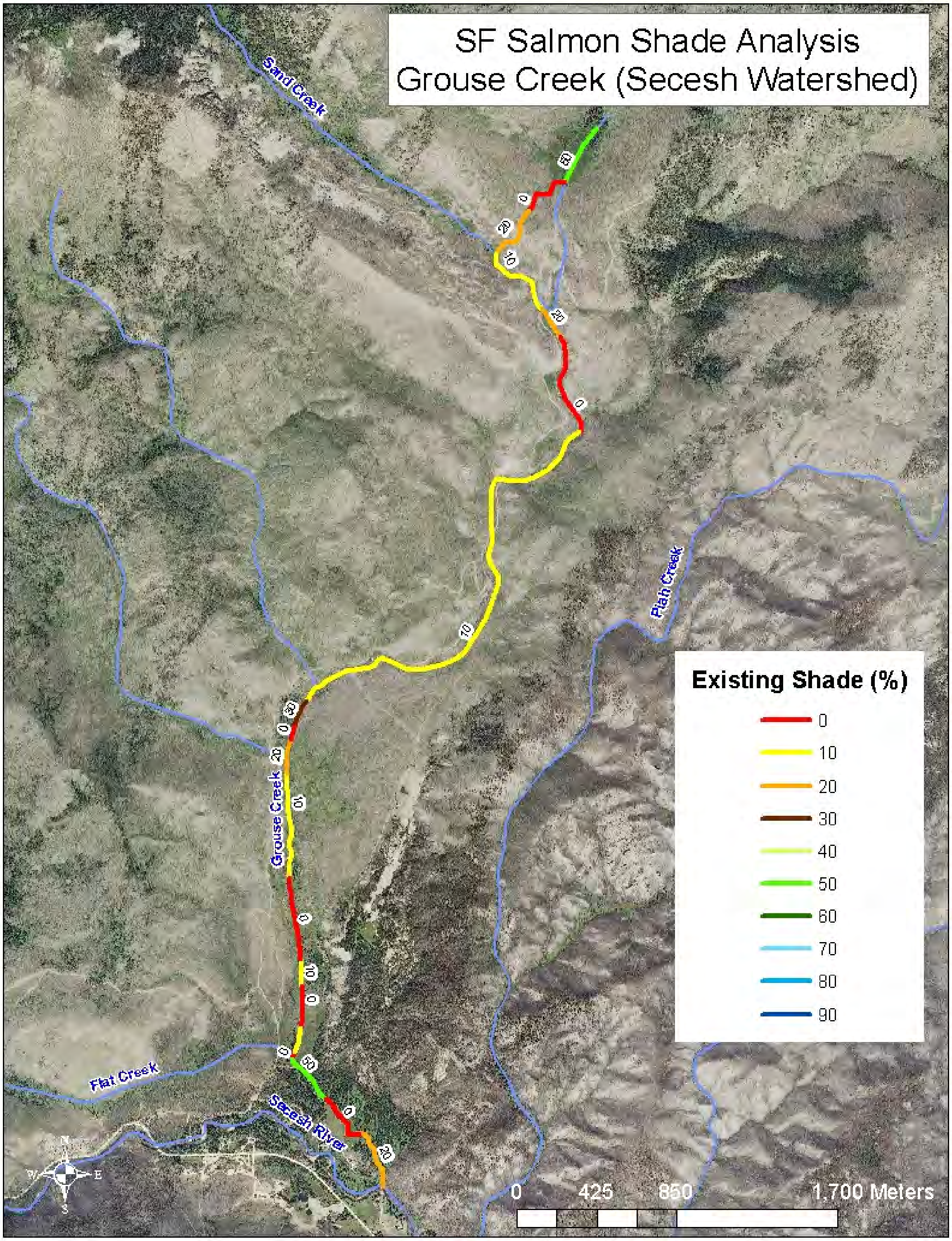

Figure 34. Existing Shade Estimated for Grouse Creek (Secesh Watershed) by Aerial Photo Interpretation.

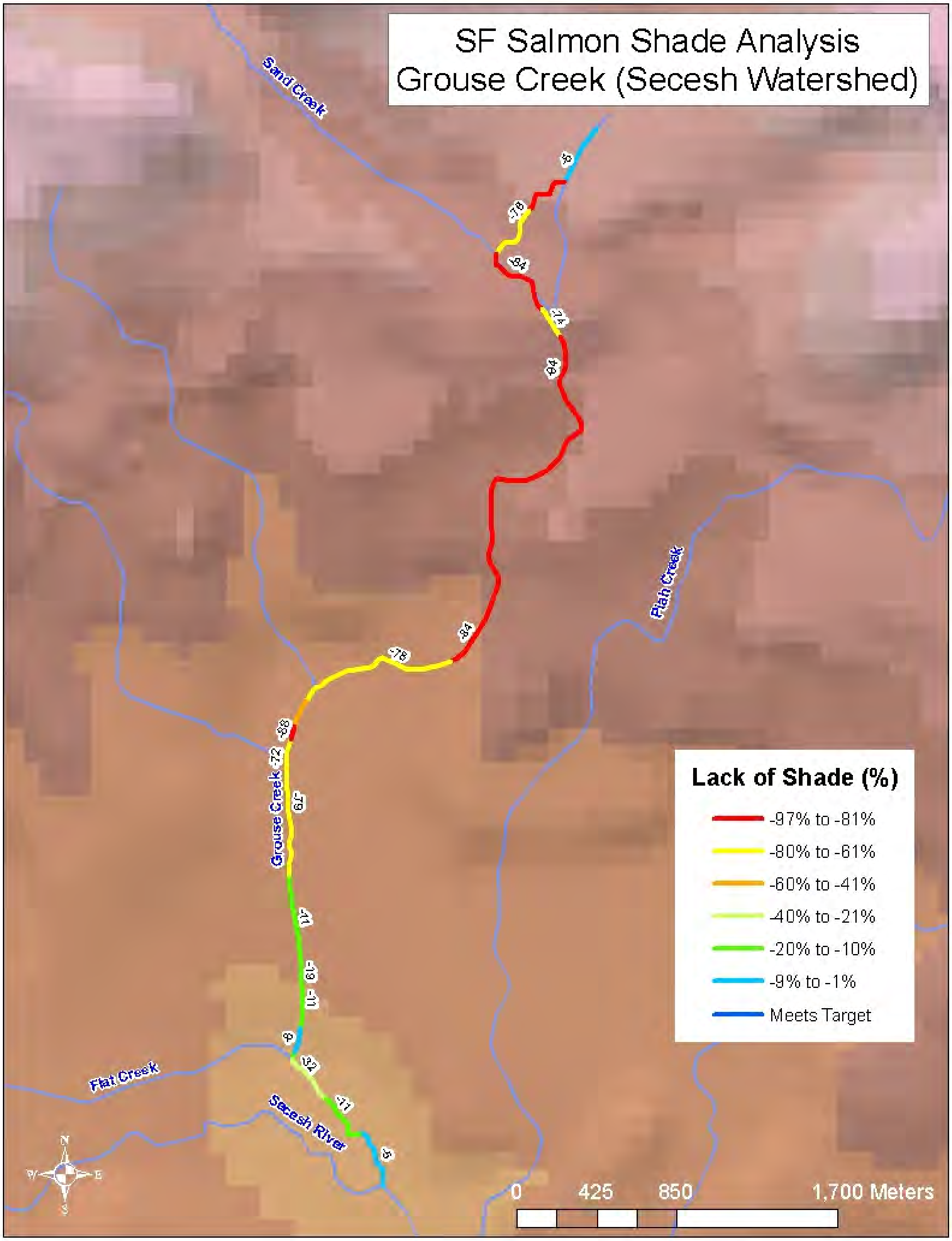

Figure 35. Lack of Shade (Difference Between Existing and Target) for Grouse Creek (Secesh Watershed).

3.4 Load Allocation

Because this TMDL is based on potential natural vegetation, which is equivalent to background loading, the load allocation is essentially the desire to achieve background conditions. However, to reach that objective, load allocations are assigned to non point source activities that have or may affect riparian vegetation and shade as a whole. Load allocations are therefore stream reach specific and are dependent upon the target load for a given reach. Table 8 through Table 28 and Figure 6, Figure 9, Figure 12, Figure 15, Figure 18, Figure 21, Figure 24, Figure 27, Figure 30, and Figure 33 show the target or potential shade which is converted to a potential summer load by multiplying the inverse fraction (1-shade fraction) by the average loading to a flat plate collector for the months of April through September. That is the loading capacity of the stream and it is necessary to achieve background conditions. There is no opportunity to further remove shade from the stream by any activity without exceeding its loading capacity. Additionally, because this TMDL is dependent upon background conditions for achieving WQS, all tributaries to the waters examined here need to be in natural conditions to prevent excess heat loads to the system.

Table 29 shows the total existing, total target, and total excess heat load (kWh/day), the proportion (%) of total existing load that was in excess, as well as average lack of shade (%) experienced by each water body examined. The size of a stream influences the size of the excess load. Large streams have higher existing and target loads by virtue of their larger channel widths as compared to smaller streams. The table lists the segments and tributaries in order of their excess loads highest to lowest; large water bodies tend to be listed first and small tributaries are listed last.

Although the following analysis dwells on total heat loads for streams in this TMDL, it is important to note that differences between existing shade and target shade, as depicted in Figure 8, Figure 11, Figure 14, Figure 17, Figure 20, Figure 23, Figure 26, Figure 29, Figure 32, and Figure 35 are the key to successfully restoring these waters to achieving WQS. Target shade levels for individual reaches should be the goal managers strive for with future implementation plans. Managers should key in on the largest differences between existing and target shade as locations to prioritize implementation efforts. Each loading table contains a final column that lists the lack of shade on the stream. It is derived from subtracting the target shade from the existing shade for each segment. Thus, stream segments with the largest lack of shade are in the worst shape. The average lack of shade listed at the bottom of that last column in each loading table is also listed in the table below and represents a general level of condition for comparison among streams.

Those streams or segments that are in the best overall condition with respect to shade are identified in Table 29 with blue shading. Trail Creek, and for the most part, Profile Creek are in the best condition with Trail Creek having no excess load and Profile Creek only 2% in excess. The lowest (4th order) portion of Johnson Creek, the fourth and fifth order portions of the SF Salmon River and Sand Creek also have reasonably low excess loads with proportions in excess from 5 to 10% of existing loads.

Those streams or segments identified in yellow shading in Table 29 have moderate levels of excess loads with 11 to 30% of existing loads in excess. The upper portions of Johnson Creek and the SF Salmon River, and several tributaries occur in this category. Despite the fact that these watersheds have been extensively burned in recent years, the fact that these streams are wide and with extensive meadow systems, which results in lower shade targets, have probably contributed to these moderate levels of excess solar load.

Table 29. Total Solar Loads and Average Lack of Shade for All Waters.

Water Body AU	Total Existing Load (kWh/day)	Total Target Load (kWh/day)	Excess Load (kWh/day)	Proportion Excess/ Existing (%)	Average Lack of Shade (%)
Lower SF Salmon River 001_06	20,857,005	15,534,200	5,322,805	26	3
Middle Johnson Creek 025_03	2,593,400	1,701,942	891,458	34	16
Middle SF Salmon River 010_04	5,090,972	4,610,701	480,271	9	11
Elk Creek 034_02 034_03 034_04	321,641	133,280	188,361	59	33
Upper middle SF Salmon River 010_03	1,281,531	1,115,461	166,070	13	13
Lower Johnson Creek 025_04	2,411,736	2,279,797	131,938	5	7
Grouse Creek (Secesh) 005_02 005_03	194,022	66,663	127,359	66	52
Lower middle SF Salmon River 010_05	2,242,863	2,117,666	125,198	6	5
Buckhorn Creek 012_02 012_03 012_04 012_05	330,446	253,694	76,751	23	11
Upper Johnson Creek 025_02	327,383	258,534	68,850	21	31
Rice Creek 018_02	134,037	65,377	68,660	51	23

Water Body AU	Total Existing Load (kWh/day)	Total Target Load (kWh/day)	Excess Load (kWh/day)	Proportion Excess/ Existing (%)	Average Lack of Shade (%)
Lower Warm Lake Creek 019_02 019_03	121,226	54,062	67,165	55	41
Lick Creek 009_02 009_03	458,409	401,304	57,105	12	15
Trout Creek 025_02	114,610	73,709	40,901	36	19
Upper Warm Lake Creek 020_02	123,625	85,404	38,221	31	23
Dollar Creek 015_02 015_03	125,807	98,043	27,764	22	12
Upper SF Salmon River 010_02	92,772	71,228	21,543	23	14
Sand Creek 025_02	222,802	201,855	20,947	9	16
Tyndall Creek 010_02	23,064	17,667	5,396	23	10
Profile Creek 031_02 031_03	153,056	149,930	3,126	2	6
Trail Creek 017_02	38,918	41,452	0	0	3

The remaining streams shaded in red in Table 29 were burned extensively. These smaller streams likely had heavier timber related shade prior to the wildfires. They received the brunt of the shade loss with excess solar loads 31 to 59% of their existing solar loads. Warm Lake Creek, Rice Creek, Trout Creek, Elk Creek, and Grouse Creek (Secesh Watershed) appear to have been especially hard hit by intense wildfire.

There may be a variety of reasons that individual reaches do not meet shade targets, including natural phenomena (beaver ponds, springs, wet meadows, past natural disturbances) and/or historic land use activities (logging, grazing, mining, etc.). It is important that each reach be field verified to determine if shade differences are real, result from activities and are controllable. Information within this TMDL (maps and load tables) should be used to guide and prioritize implementation investigations. It is recognized that the information with this TMDL may need further adjustment to reflect new information and conditions in the future.

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

3.4.1 Wasteload Allocation

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

3.4.2 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% class interval, which likely underestimates actual shade in the loading analysis. Although the loading 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 NPS activities, and can be adjusted as more information is gathered from the stream environment.

3.4.3 Seasonal Variation

This TMDL is based on average summer loads. All loads have been calculated to be inclusive of the six month period from April through September. This time period was chosen because it represents the time period when the combination of increasing air and water temperatures coincides with increasing solar inputs and increasing vegetative shade. The critical time period is April through June when spring salmonids spawning is occurring, July and August when maximum temperatures exceed cold water aquatic life criteria, and September when fall salmonids 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.

3.4.4 Construction Storm Water and TMDL Waste Load Allocations

Construction Storm Water

The Clean Water Act requires operators of construction sites to obtain permit coverage to discharge storm water to a water body or to a municipal storm sewer. In Idaho, EPA has issued a general permit for storm water discharges from construction sites. In the past storm water was treated as a non-point source of pollutants. However, because storm water can be managed on site through management practices or when discharged through a discrete conveyance such as a storm sewer, it now requires a National Pollution Discharge Elimination System (NPDES) Permit.

The Construction General Permit (CGP)

If a construction project disturbs more than one acre of land (or is part of larger common development) that will disturb more than one acre), the operator is required to apply for permit coverage from EPA after developing a site-specific Storm Water Pollution Prevention Plan.

Storm Water Pollution Prevention Plan (SWPPP)

In order to obtain the Construction General Permit operators must develop a site-specific Storm Water Pollution Prevention Plan. The operator must document the erosion, sediment, and pollution controls they intend to use, inspect the controls periodically and maintain the best management practices (BMPs) through the life of the project

Construction Storm Water Requirements

When a stream is on Idaho's § 303(d) list and has a TMDL developed DEQ now incorporates a gross waste load allocation (WLA) for anticipated construction storm water activities. TMDLs developed in the past that did not have a WLA for construction storm water activities will also be considered in compliance with provisions of the TMDL if they obtain a CGP under the NPDES program and implement the appropriate Best Management Practices.

Typically there are specific requirements you must follow to be consistent with any local pollutant allocations. Many communities throughout Idaho are currently developing rules for post-construction storm water management. Sediment is usually the main pollutant of concern in storm water from construction sites. The application of specific best management practices from *Idaho's Catalog of Storm Water Best Management Practices for Idaho Cities and Counties* is generally sufficient to meet the standards and requirements of the General Construction Permit, unless local ordinances have more stringent and site specific standards that are applicable.

3.5 Implementation Strategies

Implementation strategies for TMDLs produced using potential natural vegetation-based shade and solar loading should incorporate the loading tables presented in this TMDL. These tables need to be updated, first to field verify the existing shade levels that have not yet been field verified, and secondly to monitor progress towards achieving reductions and the goals of the TMDL. Using the solar pathfinder to measure existing shade levels in the field is important to achieving both objectives. It is likely that further field verification will find discrepancies with reported existing shade levels in the loading tables. Due to the inexact nature of the aerial photo interpretation technique, these tables should not be viewed as complete until verified. Implementation strategies should include solar pathfinder monitoring to simultaneously field verify the TMDL and mark progress towards achieving desired reductions in solar loads.

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that the TMDL goals are not being met or significant progress is not being made toward achieving the goals.

3.5.1 Time Frame

Typically riparian improvements can take between 5-15 years to realize significant differences in stream shading. Conversely, recovery of streamside forest that has been lost may take a century to reach its full potential.

3.5.2 Approach

TMDLs will be implemented through continuation of ongoing pollution control activities in the watershed. DEQ recognizes that natural background conditions may not provide the most appropriate load capacity. A successful management approach would achieve reductions based on BMP implementation

3.5.3 Responsible Parties

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

Designated state agencies are responsible for assisting with preparation of specific implementation plans, particularly for those sources which they have regulatory authority or programmatic responsibilities. Idaho’s designated state management agencies are:

- Idaho Department of Lands (IDL): timber harvest, oil and gas exploration and
- development, mining
- Idaho Soil and Water Commission (ISWC): grazing and agriculture
- Idaho Department of Transportation (ITD): public roads
- Idaho Department of Agriculture (IDA): agriculture, aquaculture, AFOs, CAFOs
- Idaho Department of Environmental Quality (DEQ): all other activities

To the maximum extent possible, the implementation plan will be developed with the participation of federal partners and land management agencies (i.e. ACOE, BLM, BNF, Natural Resources Conservation Service [NRCS]. In Idaho, these agencies and their federal and state partners are charged by the CWA to lend available technical assistance and other appropriate support to local efforts/projects for water quality improvements.

All stakeholders in the subbasin have responsibility for implementing the TMDL. DEQ and the "designated agencies" in Idaho have primary responsibility for overseeing implementation in cooperation with landowners and managers. Their general responsibilities are outlined below.

- **DEQ** will oversee and track overall progress on the specific implementation plan and monitor the watershed response.
- **IDL,** working in cooperation with USFS, will maintain and update approved BMPs for forest practices and mining. IDL is responsible for ensuring use of appropriate BMPs on state and private lands.
- **ISWC**, working in cooperation with local Soil and Water Conservation Districts and ISDA, the SWC will provide technical assistance to agricultural landowners. These agencies will help landowners design BMP systems appropriate for their property, and identify and seek appropriate cost-share funds. They also will provide periodic project reviews to ensure BMPs are working effectively.
- **ITD** will be responsible for ensuring appropriate BMPs are used for construction and maintenance of public roads.
- **IDA** will be responsible for working with agriculture and aquaculture to install appropriate pollutant control measures. Under a memorandum of understanding with EPA and DEQ, IDA also inspects AFOs, CAFOs and dairies to ensure compliance with NPDES requirements.
- **USFS,** working in cooperation with IDL**,** will maintain and update approved BMPs for forest practices and mining. The Boise National Forest and the Payette National Forest are responsible for ensuring use of appropriate BMPs on national forest lands.

The designated agencies, the WAG, and other appropriate public process participants are expected to:

- Develop and implement BMPs to achieve Load Allocations (LAs).
- Give reasonable assurance that management measures will meet LAs through both quantitative and qualitative analysis of management measures.
- Adhere to measurable milestones for progress.
- Develop a timeline for implementation, with reference to costs and funding.
- Develop and implement a monitoring plan to determine if BMPs are being implemented, BMP effectiveness, LA and WLA attainment, and WQS attainment.

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

3.6 Monitoring Strategy

Temperature monitoring will be conducted using the DEQ-approved monitoring procedure at the time of sampling. It is optimal to revisit specific locations and measure effective shade. Temperature data loggers may also be used but since natural background PNV does not necessarily correspond to temperature water quality criteria, this may not be meaningful in determining whether shading has improved.

As indicated above, shade can be measured with a solar pathfinder at any time throughout the spring and summer on any stretch of creek to see if shade is increasing. It is anticipated that as the riparian community develops, shade will increase and loadings will decrease toward PNV levels. Monitoring should be done every five years using aerial photographic analysis combined with solar pathfinder ground-truthing for sections where changes are suspected in riparian cover.

3.7 Reasonable Assurance

Current and future Nez Perce Tribe and USFS projects outlined in the SF Salmon River Five Year Review (DEQ 2011) as well as ongoing USFS management practices in riparian conservation habitat areas will result in tangible improvements to canopy cover in the 5-15 year implementation framework. In addition, monitoring in conjunction with subsequent Five Year review cycles will assist with progress tracking and identification of additional potential restoration projects.

3.8 Conclusions

Effective shade targets were established for 14 streams based on the concept of maximum shading under potential natural vegetation equals natural background temperature levels (Table 30).

Shade targets were actually derived from effective shade curves developed for similar vegetation types in Idaho. Existing shade was determined from aerial photo interpretation field verified with solar pathfinder data.

With the exception of Trail Creek and perhaps Profile Creek, all other streams in the analysis lack shade resulting in excess solar load. Many streams have been heavily impacted by recent wildfire. Tributary streams in the Warm Lake area (Warm Lake Creek, Rice Creek, and Trout Creek) have been most affected resulting in high excess solar loads. Elk Creek in the lower SF Salmon River area and Grouse Creek in the Secesh River Watershed have also been dramatically affected. Other tributary streams were not as affected and have moderate levels of shade loss and excess solar loading. The lower canyon sections of the major rivers, the South Fork Salmon and Johnson Creek, are in relatively good condition with respect to shade primarily because they are wide with low shade targets to begin with, and are in a more sparsely vegetated dry forest zone.

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

Table 30. Summary of temperature assessment outcomes.

Water Body Segment/ AU	Pollutant	TMDLs Completed	Recommended Changes to §303(d) List	Justification
Buckhorn Creek/ ID17060208SL012_02 ID17060208SL012_03 ID17060208SL012_04 ID17060208SL012_05	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; all AU's unlisted for temp but impaired
Dollar Creek/ ID17060208SL015_02 ID17060208SL015_03	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; SL015_03 unlisted for temp but impaired
Elk Creek/ ID17060208SL034_02 ID17060208SL034_03 ID17060208SL034_04	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; all AU's unlisted for temp but impaired
Grouse Creek/Secesh River Tribs ID17060208SL005_02	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade
Grouse Creek/Secesh River Tribs ID17060208SL005_03	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; unlisted for temp but impaired
Johnson Creek/Sand Creek/Trout Creek ID17060208SL025_02	Temperature	Yes	Move to Category 4A; de-list for combined biota/habitat bioassessments;	Excess Solar Load from Lack of Shade; temp found to be causal pollutant
Johnson Creek/ ID17060208SL025_03	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; unlisted for temp but impaired
Johnson Creek/ ID17060208SL025_04	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade
Lick Creek/ ID17060208SL009_02 ID17060208SL009_03	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; unlisted for temp but impaired
Profile Creek/ ID17060208SL031_02 ID17060208SL031_03	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; unlisted for temp but impaired
Rice Creek/ ID17060208SL018_02	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; unlisted for temp but impaired
Trail Creek/ ID17060208SL017_02	Temperature	No	None	No Excess Solar Load

Water Body Segment/ AU	Pollutant	TMDLs Completed	Recommended Changes to §303(d) List	Justification
South Fork Salmon River/Tyndall Creek ID17060208SL010_02 ID17060208SL010_03 ID17060208SL010_04 ID17060208SL010_05 ID17060208SL001_06	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade;unlisted for temp but impaired
Warm Lake Creek/ ID17060208SL019_02 ID17060208SL019_03 ID17060208SL020_02	Temperature	Yes	Move to Category 4a	Excess Solar Load from Lack of Shade; unlisted for temp but impaired

3.9 Public Participation

The Southwest Basin Advisory Group served as the Watershed Advisory Group for this TMDL. They reviewed the document and discussed it at their March 14, 2011 meeting. The public comment period for this document ran from June 9-July 11, 2011. The public comments and DEQ responses are found in Appendix E.

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Glossary

305(b)

Refers to section 305 subsection “b” of the Clean Water Act. The term “305(b)” generally describes a report of each state’s water quality and is the principle means by which the U.S. Environmental Protection Agency, Congress, and the public evaluate whether U.S. waters meet water quality standards, the progress made in maintaining and restoring water quality, and the extent of the remaining problems.

§303(d)

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

Anadromous

Fish, such as salmon and sea-run trout, that live part or the majority of their lives in the saltwater but return to fresh water to spawn.

Aquatic

Occurring, growing, or living in water.

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, which are recognized in water quality standards.

Beneficial Use Reconnaissance Program (BURP)

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

Best Management Practices (BMPs)

Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.

Clean Water Act (CWA)	The Federal Water Pollution Control Act (commonly known as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987, establishes a process for states to use to develop information on, and control the quality of, the nation's water resources.
Criteria	In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year. The U.S. Environmental Protection Agency develops criteria guidance; states establish criteria.
Designated Uses	Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act.
Discharge	The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs).
Dissolved Oxygen (DO)	The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.
Disturbance	Any event or series of events that disrupts ecosystem, community, or population structure and alters the physical environment.
Ecology	The scientific study of relationships between organisms and their environment; also defined as the study of the structure and function of nature.
Endangered Species	Animals, birds, fish, plants, or other living organisms threatened with imminent extinction. Requirements for declaring a species as endangered are contained in the Endangered Species Act.
Environment	The complete range of external conditions, physical and biological, that affect a particular organism or community.

Exceedance

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

Existing Beneficial Use or Existing Use

A beneficial use actually attained in waters on or after November 28, 1975, whether or not the use is designated for the waters in Idaho's *Water Quality Standards and Wastewater Treatment Requirements* (IDAPA 58.01.02).

Flow

See *Discharge*.

Fully Supporting

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

Fully Supporting Cold Water

Reliable data indicate functioning, sustainable cold water biological assemblages (e.g., fish, macroinvertebrates, or algae), none of which have been modified significantly beyond the natural range of reference conditions.

Habitat

The living place of an organism or community.

Headwater

The origin or beginning of a stream.

Hydrologic Basin

The area of land drained by a river system, a reach of a river and its tributaries in that reach, a closed basin, or a group of streams forming a drainage area (also see Watershed).

Hydrologic Cycle

The cycling of water from the atmosphere to the earth (precipitation) and back to the atmosphere (evaporation and plant transpiration). Atmospheric moisture, clouds, rainfall, runoff, surface water, ground water, and water infiltrated in soils are all part of the hydrologic cycle.

Hydrologic Unit

One of a nested series of numbered and named watersheds arising from a national standardization of watershed delineation. The initial 1974 effort (USGS 1987) described four levels (region, subregion, accounting unit, cataloging unit) of watersheds throughout the United States. The fourth level is uniquely identified by an eight-digit code built of two-digit fields for each level in the classification. Originally termed a cataloging unit, fourth field hydrologic units have been more commonly called subbasins. Fifth and sixth field hydrologic units have since been delineated for much of the country and are known as watershed and subwatersheds, respectively.

Hydrologic Unit Code (HUC)

The number assigned to a hydrologic unit. Often used to refer to fourth field hydrologic units.

Hydrology

The science dealing with the properties, distribution, and circulation of water.

Instantaneous

A condition or measurement at a moment (instant) in time.

Intergravel Dissolved Oxygen

The concentration of dissolved oxygen within spawning gravel. Consideration for determining spawning gravel includes species, water depth, velocity, and substrate.

Load Allocation (LA)

A portion of a water body's load capacity for a given pollutant that is given to a particular nonpoint source (by class, type, or geographic area).

Load(ing)

The quantity of a substance entering a receiving stream, usually expressed in pounds or kilograms per day or tons per year. Loading is the product of flow (discharge) and concentration.

Load(ing) Capacity (LC)

A determination of how much pollutant a water body can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, and a margin of safety, it becomes a total maximum daily load.

Margin of Safety (MOS)

An implicit or explicit portion of a water body's loading capacity set aside to allow the uncertainly about the relationship between the pollutant loads and the quality of the receiving water body. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The MOS is not allocated to any sources of pollution.

Mean

Describes the central tendency of a set of numbers. The arithmetic mean (calculated by adding all items in a list, then dividing by the number of items) is the statistic most familiar to most people.

Monitoring

A periodic or continuous measurement of the properties or conditions of some medium of interest, such as monitoring a water body.

Mouth

The location where flowing water enters into a larger water body.

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 or origin. They include, but are not limited to, irrigated and non-irrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.

Not Assessed (NA)

A concept and an assessment category describing water bodies that have been studied, but are missing critical information needed to complete an assessment.

Not Fully Supporting

Not in compliance with water quality standards or not within the range of biological reference conditions for any beneficial use as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).

Not Fully Supporting Cold Water

At least one biological assemblage has been significantly modified beyond the natural range of its reference condition.

Parameter

A variable, measurable property whose value is a determinant of the characteristics of a system, such as temperature, dissolved oxygen, and fish populations are parameters of a stream or lake.

Pollutant

Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.

Pollution

A very broad concept that encompasses human-caused changes in the environment which alter the functioning of natural processes and produce undesirable environmental and health effects. This includes human-induced alteration of the physical, biological, chemical, and radiological integrity of water and other media.

Reach

A stream section with fairly homogenous physical characteristics.

Reconnaissance

An exploratory or preliminary survey of an area.

Reference

A physical or chemical quantity whose value is known and thus is used to calibrate or standardize instruments.

Reference Condition

1) A condition that fully supports applicable beneficial uses with little affect from human activity and represents the highest level of support attainable. 2) A benchmark for populations of aquatic ecosystems used to describe desired conditions in a biological assessment and acceptable or unacceptable departures from them. The reference condition can be determined through examining regional reference sites, historical conditions, quantitative models, and expert judgment (Hughes 1995).

Reference Site

A specific locality on a water body that is minimally impaired and is representative of reference conditions for similar water bodies.

Riparian

Associated with aquatic (stream, river, lake) habitats. Living or located on the bank of a water body.

Riparian Habitat Conservation Area (RHCA)

A U.S. Forest Service description of land within the following number of feet up-slope of each of the banks of streams:

- 300 feet from perennial fish-bearing streams
- 150 feet from perennial non-fish-bearing streams

- 100 feet from intermittent streams, wetlands, and ponds in priority watersheds.

River

A large, natural, or human-modified stream that flows in a defined course or channel or in a series of diverging and converging channels.

Species

1) A reproductively isolated aggregate of interbreeding organisms having common attributes and usually designated by a common name. 2) An organism belonging to such a category.

Stream

A natural water course containing flowing water, at least part of the year. Together with dissolved and suspended materials, a stream normally supports communities of plants and animals within the channel and the riparian vegetation zone.

Subbasin

A large watershed of several hundred thousand acres. This is the name commonly given to 4th field hydrologic units (also see Hydrologic Unit).

Subbasin Assessment (SBA)

A watershed-based problem assessment that is the first step in developing a total maximum daily load in Idaho.

Subwatershed

A smaller watershed area delineated within a larger watershed, often for purposes of describing and managing localized conditions. Also proposed for adoption as the formal name for 6th field hydrologic units.

Surface Water

All water naturally open to the atmosphere (rivers, lakes, reservoirs, streams, impoundments, seas, estuaries, etc.) and all springs, wells, or other collectors that are directly influenced by surface water.

Threatened Species

Species, determined by the U.S. Fish and Wildlife Service, which are likely to become endangered within the foreseeable future throughout all or a significant portion of their range.

Total Maximum Daily Load (TMDL)

A TMDL is a water body’s load capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual bases. A TMDL is equal to the load capacity, such that load capacity = margin of

	safety + natural background + load allocation + wasteload allocation = TMDL. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.
Tributary	A stream feeding into a larger stream or lake.
Water Body	A stream, river, lake, estuary, coastline, or other water feature, or portion thereof.
Water Pollution	Any alteration of the physical, thermal, chemical, biological, or radioactive properties of any waters of the state, or the discharge of any pollutant into the waters of the state, which will or is likely to create a nuisance or to render such waters harmful, detrimental, or injurious to public health, safety, or welfare; to fish and wildlife; or to domestic, commercial, industrial, recreational, aesthetic, or other beneficial uses.
Water Quality	A term used to describe the biological, chemical, and physical characteristics of water with respect to its suitability for a beneficial use.
Water Quality Criteria	Levels of water quality expected to render a body of water suitable for its designated uses. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, or industrial processes.
Water Quality Standards	State-adopted and U.S. Environmental Protection Agency-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.
Watershed	1) All the land which contributes runoff to a common point in a drainage network, or to a lake outlet. Watersheds are infinitely nested, and any large watershed is composed of smaller “subwatersheds.” 2) The whole geographic region which contributes water to a point of interest in a water body.

Appendix A. Unit Conversion Chart

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Table A-1. Metric - English unit conversions.

	English Units	Metric Units	To Convert	Example
Distance	Miles (mi)	Kilometers (km)	1 mi = 1.61 km 1 km = 0.62 mi	3 mi = 4.83 km 3 km = 1.86 mi
Length	Inches (in) Feet (ft)	Centimeters (cm) Meters (m)	1 in = 2.54 cm 1 cm = 0.39 in 1 ft = 0.30 m 1 m = 3.28 ft	3 in = 7.62 cm 3 cm = 1.18 in 3 ft = 0.91 m 3 m = 9.84 ft
Area	Acres (ac) Square Feet (ft^2) Square Miles (mi^2)	Hectares (ha) Square Meters (m^2) Square Kilometers (km^2)	1 ac = 0.40 ha 1 ha = 2.47 ac 1 ft^2 = 0.09 m^2 1 m^2 = 10.76 ft^2 1 mi^2 = 2.59 km^2 1 km^2 = 0.39 mi^2	3 ac = 1.20 ha 3 ha = 7.41 ac 3 ft^2 = 0.28 m^2 3 m^2 = 32.29 ft^2 3 mi^2 = 7.77 km^2 3 km^2 = 1.16 mi^2
Volume	Gallons (gal) Cubic Feet (ft^3)	Liters (L) Cubic Meters (m^3)	1 gal = 3.78 L 1 L= 0.26 gal 1 ft^3 = 0.03 m^3 1 m^3 = 35.32 ft^3	3 gal = 11.35 L 3 L = 0.79 gal 3 ft^3 = 0.09 m^3 3 m^3 = 105.94 ft^3
Flow Rate	Cubic Feet per Second (cfs)[a]	Cubic Meters per Second (m^3/sec)	1 cfs = 0.03 m^3/sec 1 m^3/sec = 35.31cfs	3 ft^3/sec = 0.09 m^3/sec 3 m^3/sec = 105.94 ft^3/sec
Concentration	Parts per Million (ppm)	Milligrams per Liter (mg/L)	1 ppm = 1 mg/L[b]	3 ppm = 3 mg/L
Weight	Pounds (lbs)	Kilograms (kg)	1 lb = 0.45 kg 1 kg = 2.20 lbs	3 lb = 1.36 kg 3 kg = 6.61 lb
Temperature	Fahrenheit (°F)	Celsius (°C)	°C = 0.55 (F - 32) °F = (C x 1.8) + 32	3 °F = -15.95 °C 3 °C = 37.4 °F

[a] 1 cfs = 0.65 million gallons per day; 1 million gallons per day is equal to 1.55 cfs.

[b] The ratio of 1 ppm = 1 mg/L is approximate and is only accurate for water.

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Appendix B. State and Site-Specific 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 with species. For spring spawning salmonids, the default spawning and incubation period recognized by DEQ is generally from March 15th to July 1st each year (Grafe et al., 2002). Fall spawning can occur as early as August 15th and continue with incubation on into the following spring up to June 1st. As per IDAPA 58.01.02.250.02.e.ii., the water quality criteria that need to be met during that time period are:

> 13^{o}C as a daily maximum water temperature,
>
> 9^{o}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 highest annual MWMT air temperatures) is compared to the daily maximum criterion of 13^{o}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 these 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. As per IDAPA 58.01.02.200.09:

> *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, pollutant levels shall not exceed the natural background conditions, except that temperature levels may be increased above natural background conditions when allowed under Section 401.*

Section 401 relates to point source wastewater treatment requirements. In this case if temperature criteria for any aquatic life use is exceeded due to natural conditions, then a point source discharge cannot raise the water temperature by more than 0.3^{o}C (IDAPA 58.01.02.401.03.a.v.).

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Appendix C. Data Sources and Other Data

Table C-1. Data sources for SF Salmon River Subbasin TMDLs.

Water Body	Data Source	Type of Data	When Collected
14 water bodies	DEQ McCall Satellite Office & DEQ State Technical Services Office	Pathfinder effective shade and stream width	September 2009
14 water bodies	DEQ State Technical Services Office	Aerial Photo Interpretation of existing shade and stream width estimation	Summer 2009 & Winter 2009/2010
14 Water bodies	USFS and Nez Perce Tribe	Temperature Logger measurements	2005-present

Table C-2. Results of Solar Pathfinder Field Measurements at 16 Sites.

aerial class	pathfinder actual	pathfinder class	delta		
30	45.8	40	-10		sand 1
10	2.1	0	10		sand 2
80	70.3	70	10		sand 3
60	34.3	30	30		sand 4
80	65.2	60	20		trout 1
80	32.2	30	50		johnson 1
40	4.6	0	40		johnson 2
30	38.5	30	0		johnson 3
20	26.9	20	0		johnson 4
70	54.2	50	20		buckhorn 1
80	50.7	50	30		lick 1
70	46.7	40	30		lick 2
80	49	50	30		lick 3
80	59.7	60	20		profile 1
80	60.4	60	20		profile 2
70	60	60	10		profile 3
			19	average	
			15.69	std dev	
			7.69	95%CI	

aerial class	pathfinder actual	pathfinder class	delta		
30	45.8	40	-10		sand 1
10	2.1	0	10		sand 2
80	70.3	70	10		sand 3
60	34.3	30	30		sand 4
			10	average	
			16.33	std dev	
			16.00	95%CI	

80	32.2	30	50		johnson 1
40	4.6	0	40		johnson 2
30	38.5	30	0		johnson 3
20	26.9	20	0		johnson 4
			23	average	
			26.30	std dev	
			25.77	95%CI	

80	50.7	50	30		lick 1
70	46.7	40	30		lick 2
80	49	50	30		lick 3
			30	average	
			0.00	std dev	
			#NUM!	95%CI	

80	59.7	60	20		profile 1
80	60.4	60	20		profile 2
70	60	60	10		profile 3
			17	average	
			5.77	std dev	
			6.53	95%CI	

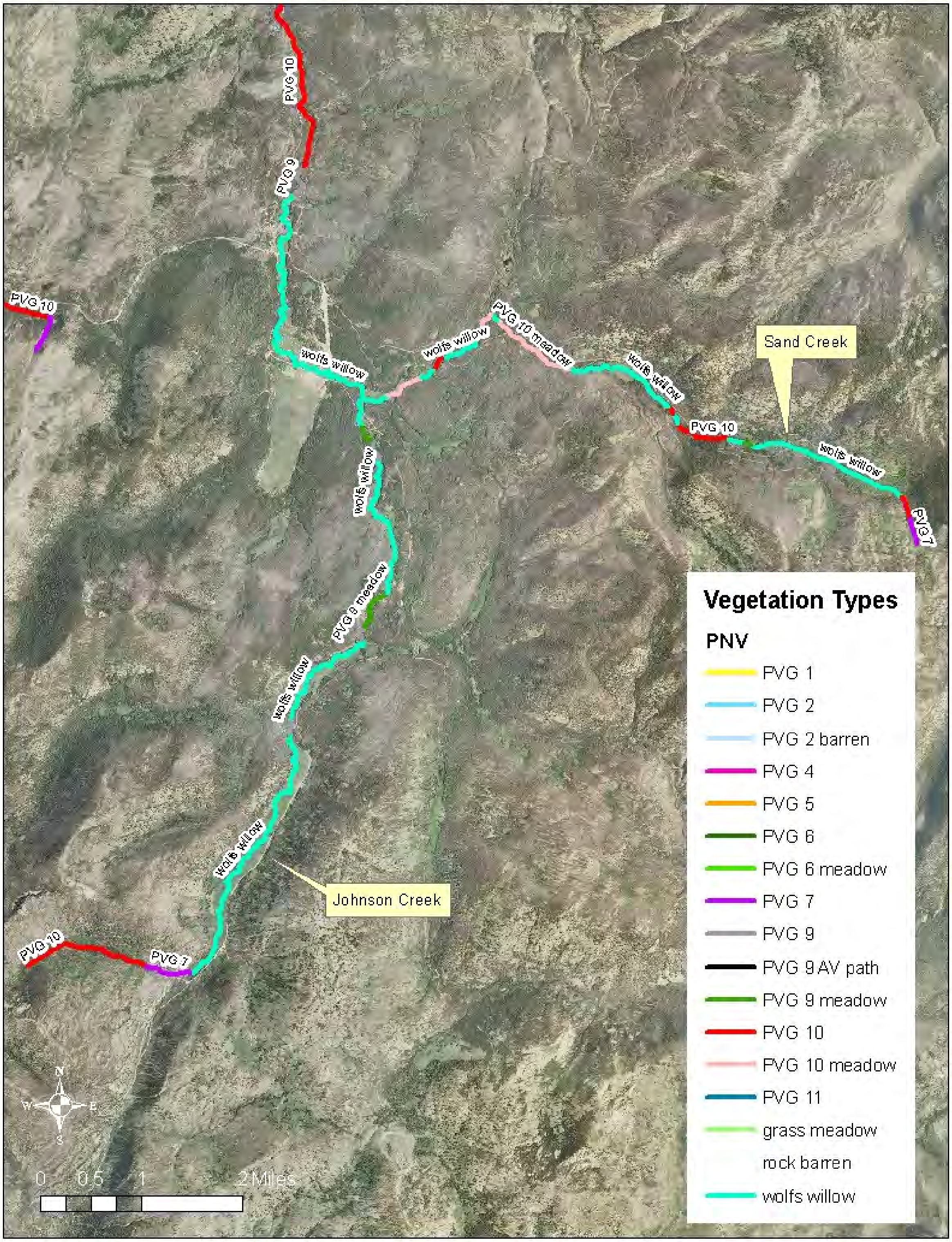


Figure C-1. PNV Vegetation Types for Sand Creek and upper Johnson Creek.

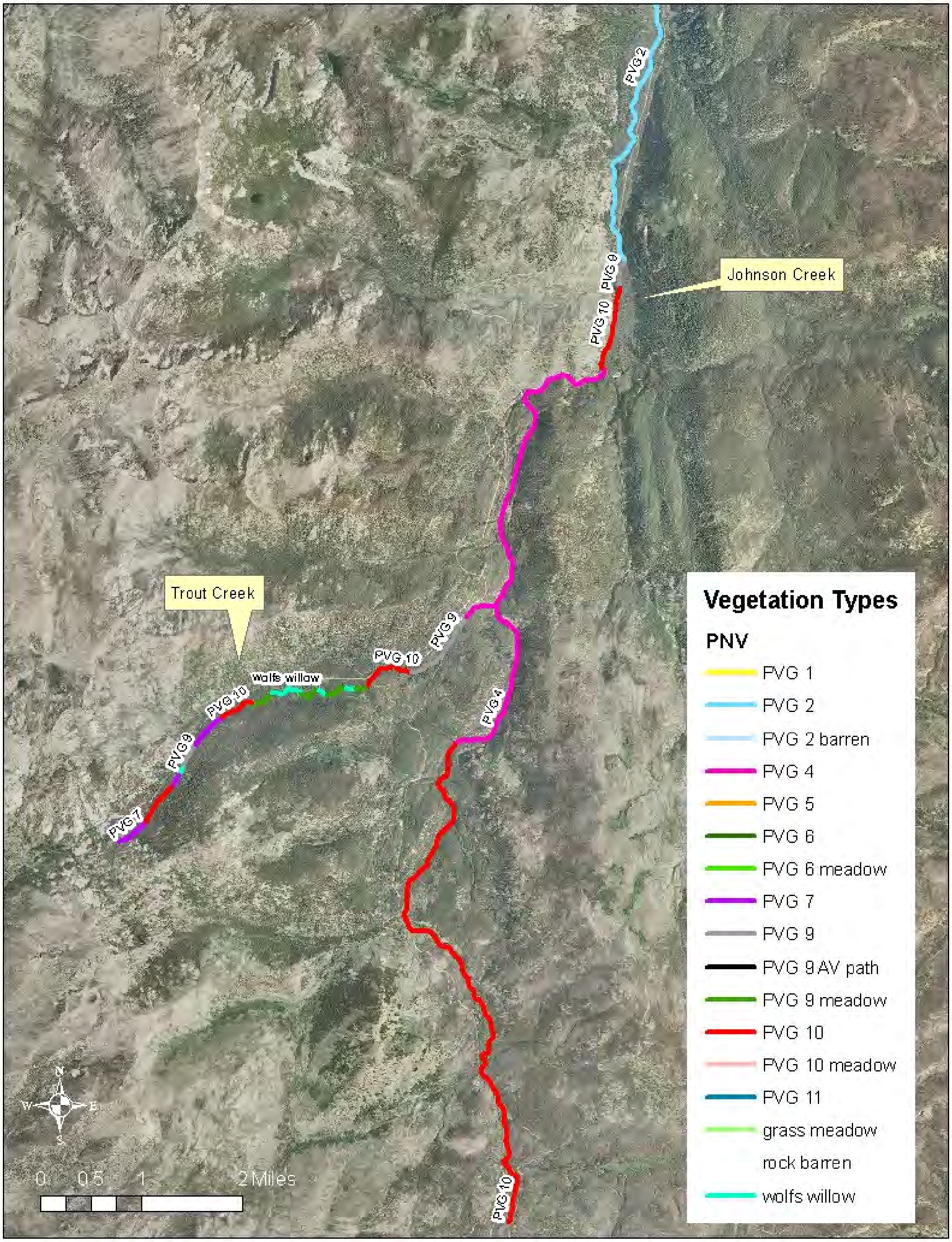


Figure C-2. PNV Vegetation Types for Trout Creek and middle Johnson Creek.

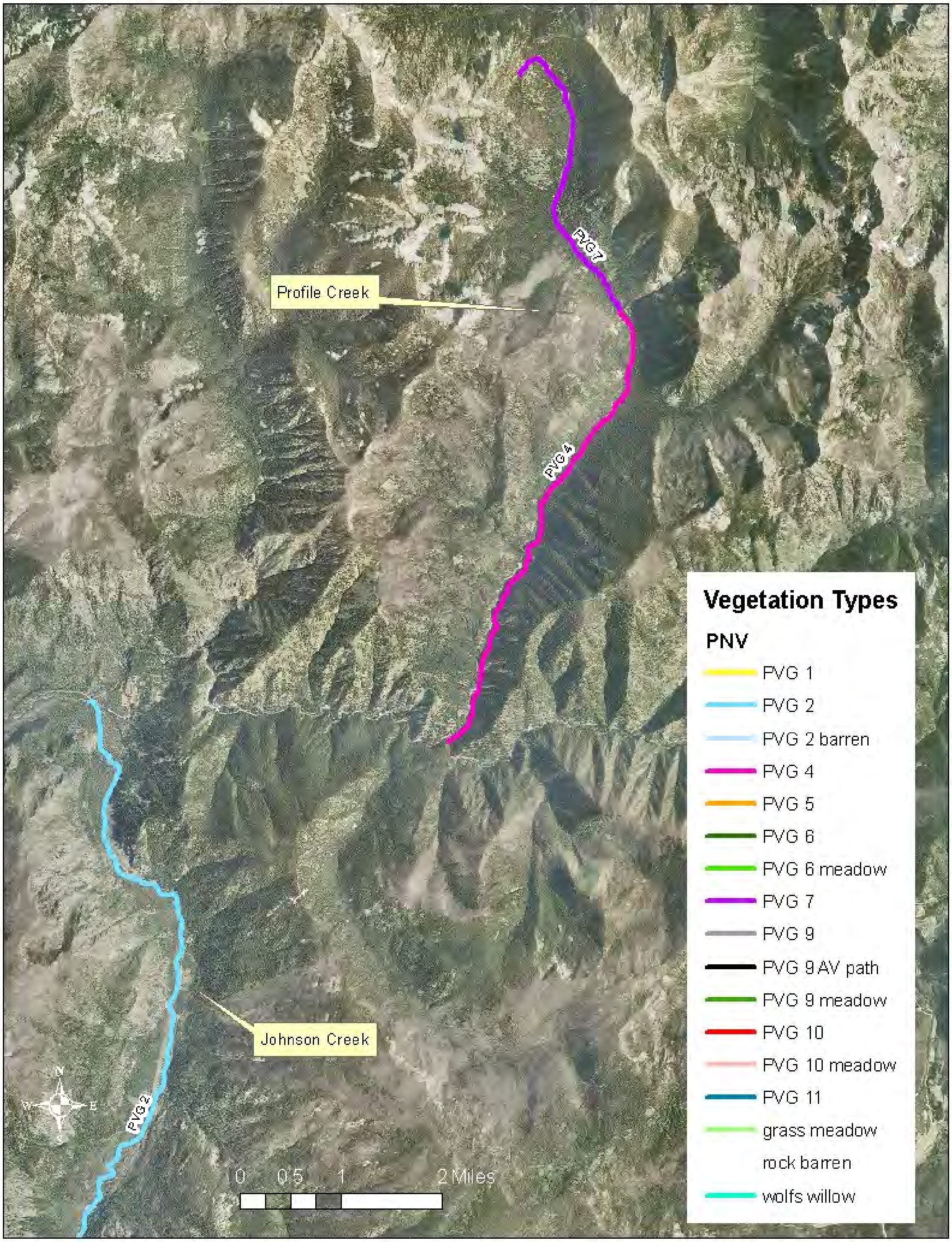


Figure C-3. PNV Vegetation Types for Profile Creek and lower Johnson Creek.

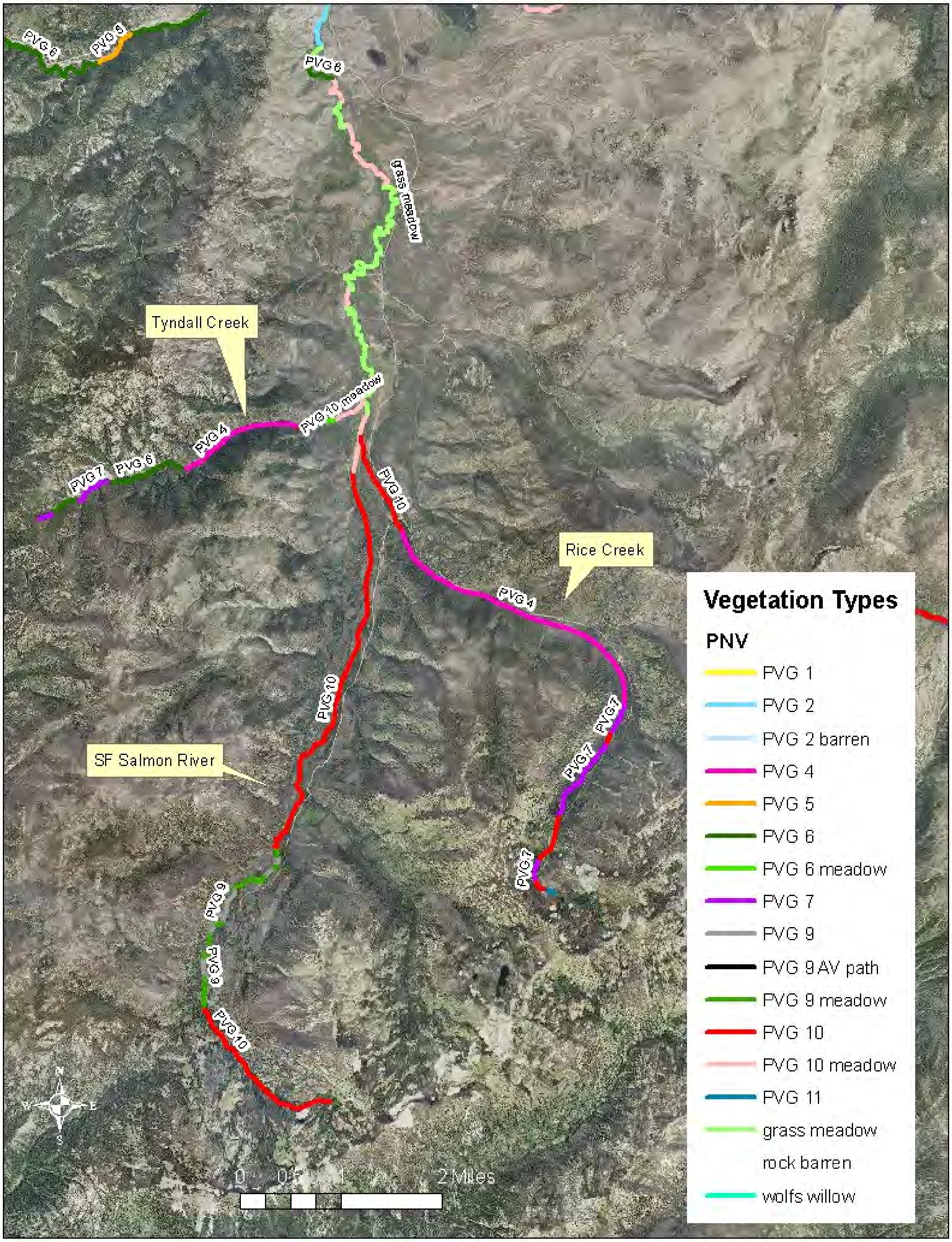


Figure C-4. PNV Vegetation Types for Rice Creek, Tyndall Creek and upper SF Salmon River.

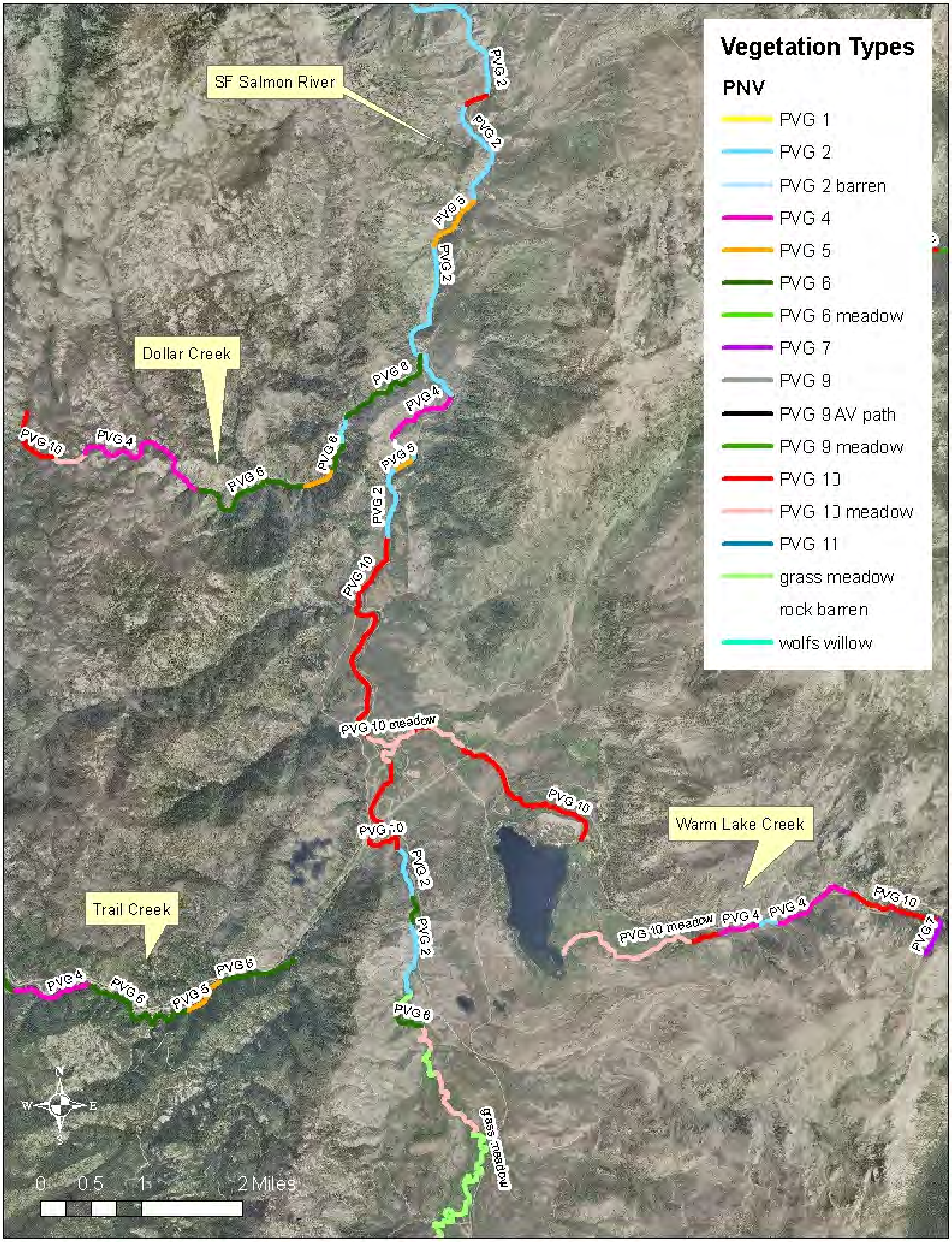


Figure C-5. PNV Vegetation Types for Dollar, Trail, Warm Lake Creeks and upper middle SF Salmon River.

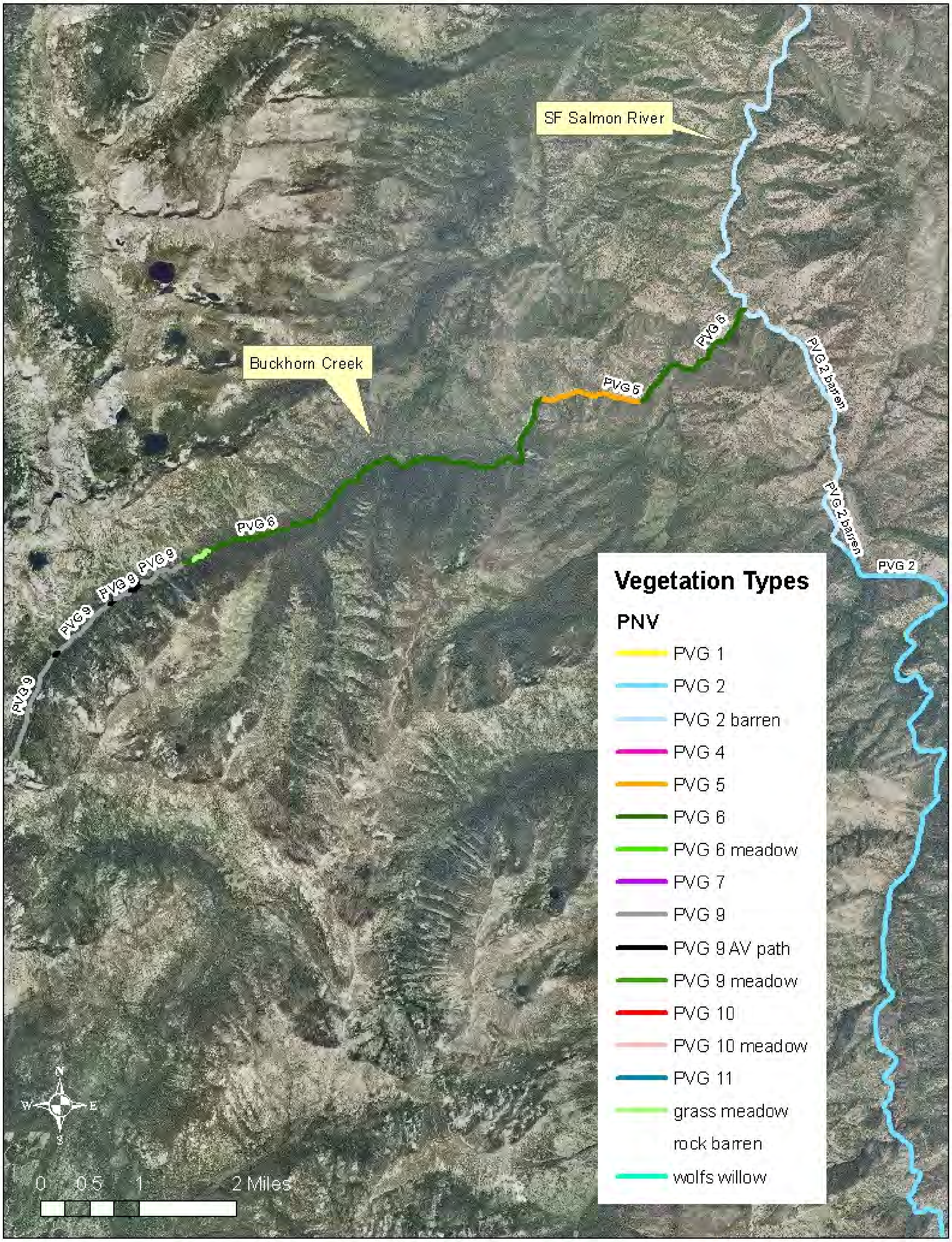


Figure C-6. PNV Vegetation Types for Buckhorn Creek and middle SF Salmon River.

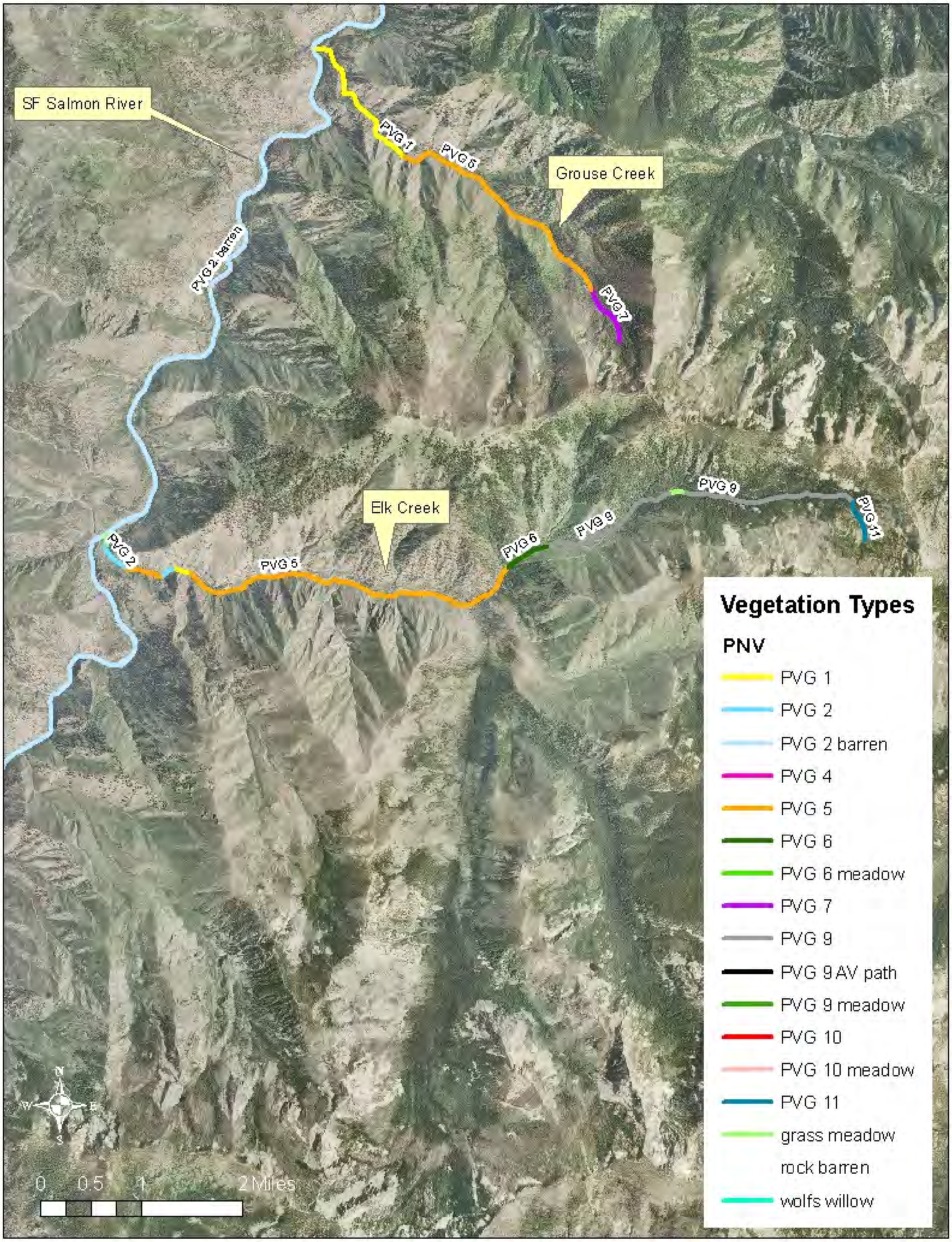


Figure C-7. PNV Vegetation Types for Elk Creek and lower middle SF Salmon River.

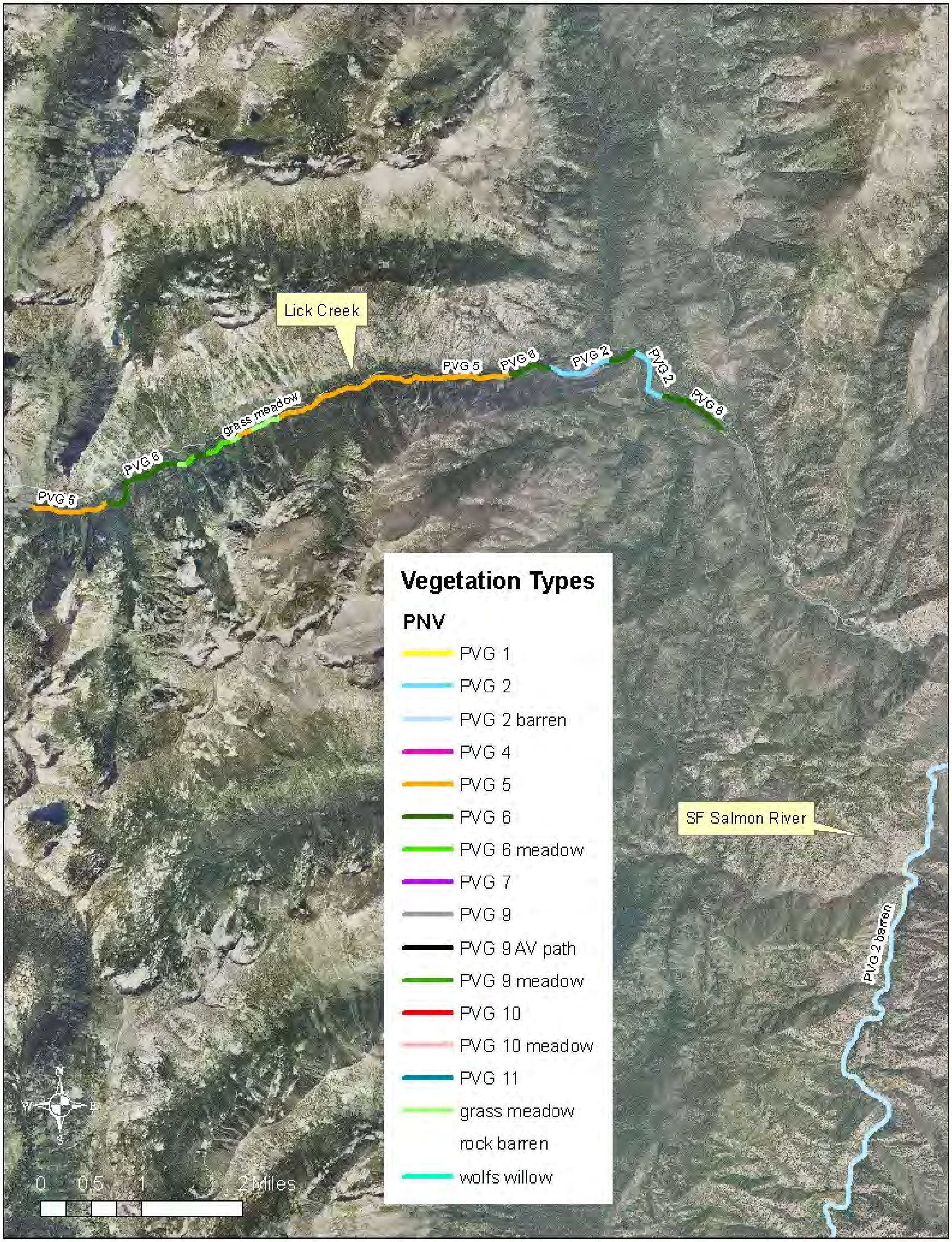


Figure C-8. PNV Vegetation Types for Lick Creek.

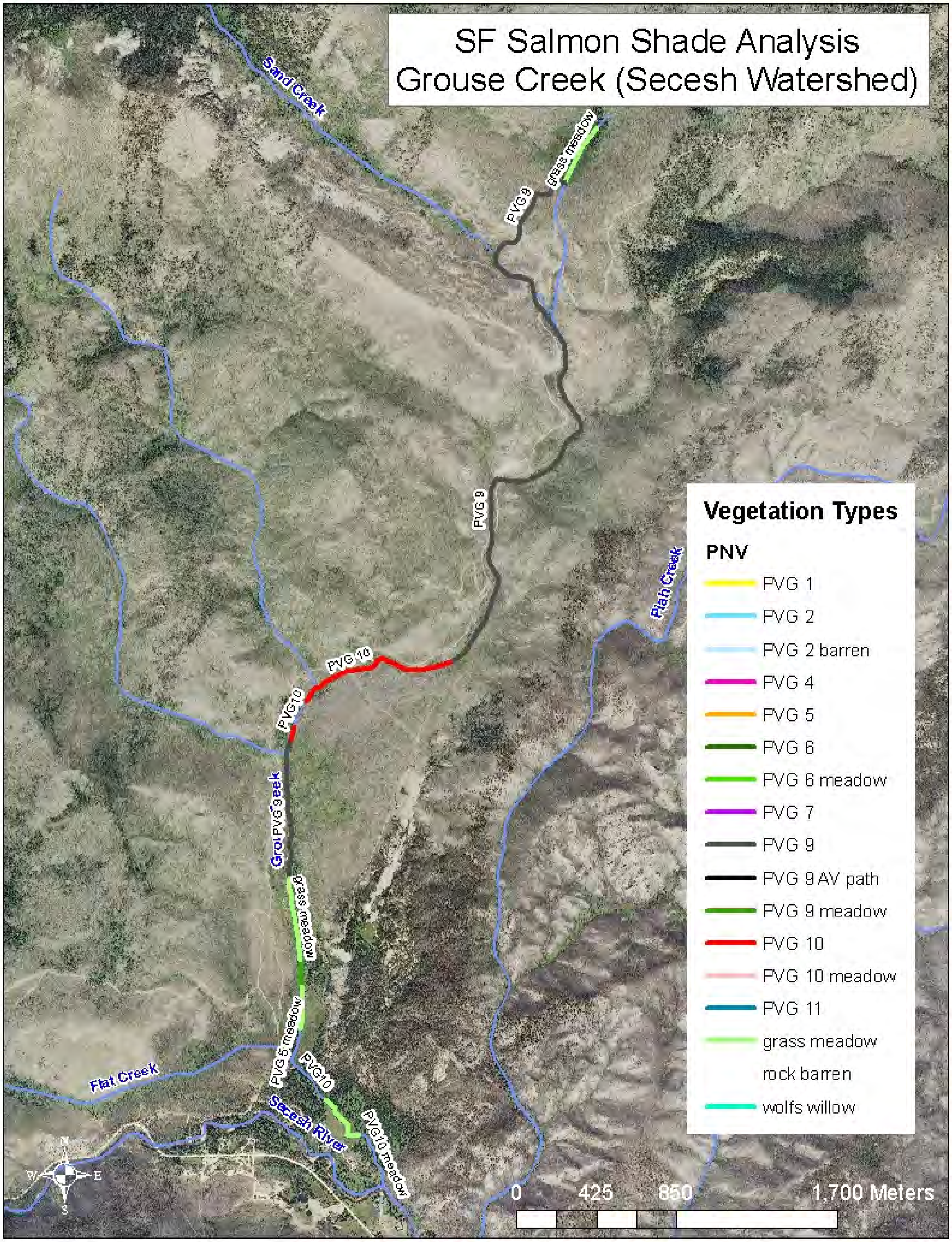
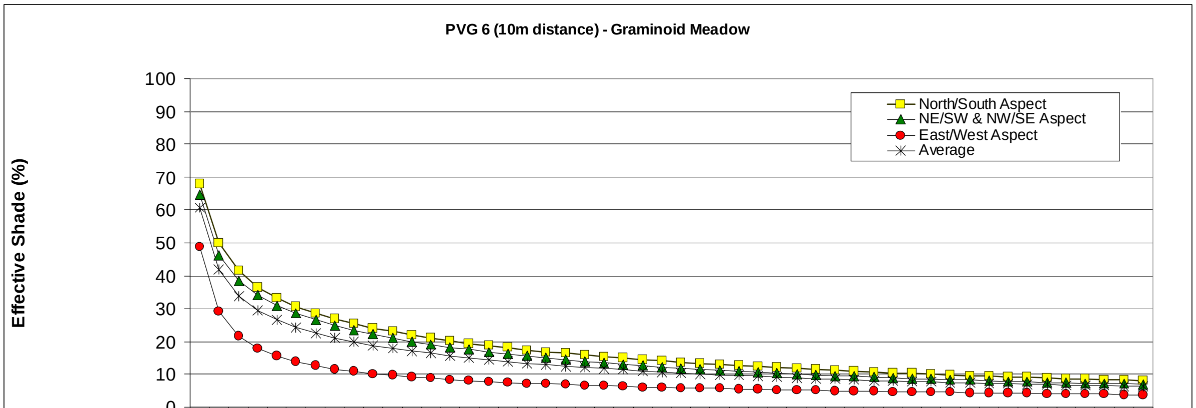


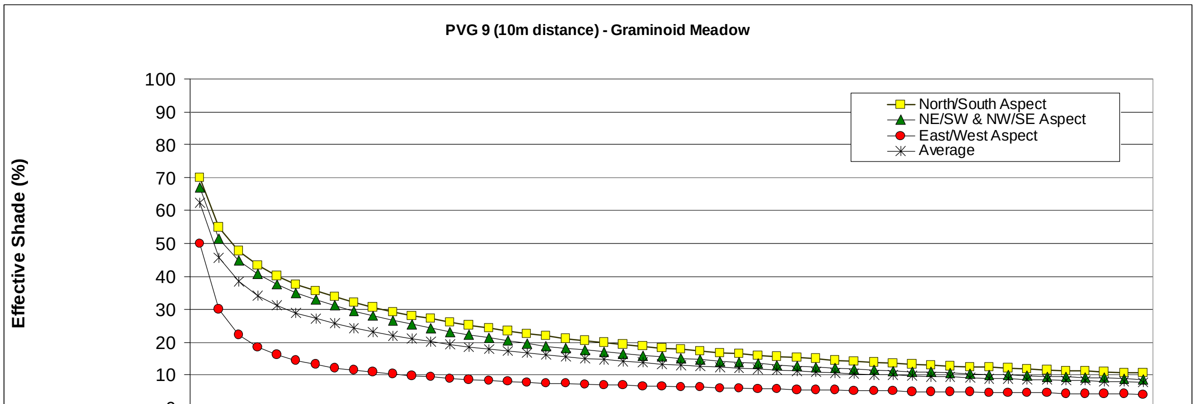
Figure C-9. PNV Vegetation Types for Grouse Creek.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North/South Aspect	68	50	42	37	33	31	29	27	25	24	23	22	21	20	19	19	18	17	17	16	16	15	15	14	14
NE/SW & NW/SE Aspect	65	46	39	34	31	29	27	25	24	22	21	20	19	18	18	17	16	16	15	14	14	13	13	13	12
East/West Aspect	49	29	22	18	15	14	13	12	11	10	10	9	9	8	8	8	8	7	7	7	7	7	6	6	6
Average	61	42	34	29	27	24	23	21	20	19	18	17	16	16	15	14	14	13	13	13	12	12	11	11	11

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	14	13	13	13	12	12	12	11	11	11	11	10	10	10	10	10	9	9	9	9	9	9	8	8	8
NE/SW & NW/SE Aspect	12	12	11	11	11	10	10	10	10	9	9	9	9	9	8	8	8	8	8	8	8	7	7	7	7
East/West Aspect	6	6	6	6	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4
Average	10	10	10	10	9	9	9	9	9	8	8	8	8	8	8	7	7	7	7	7	7	7	7	6	6

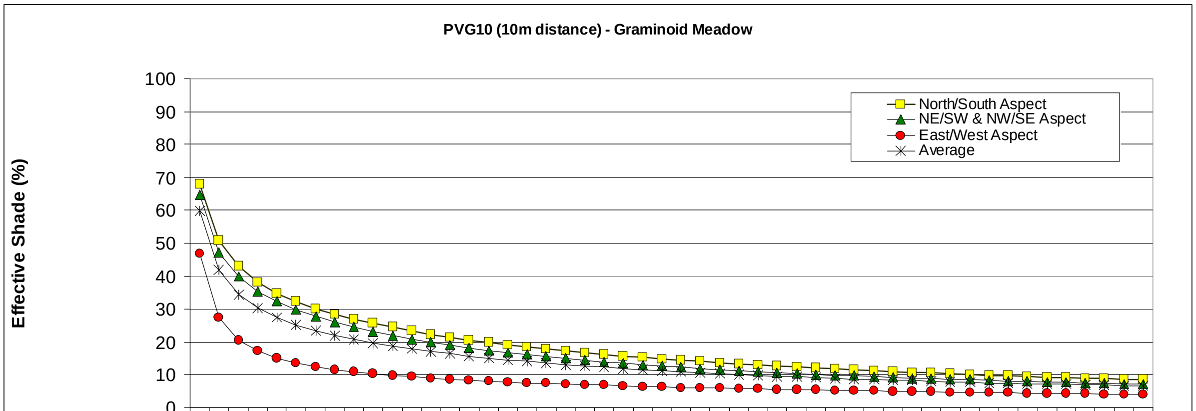
Figure C-10. Shade Curve for PVG 6 (Moist Grand Fir) Narrow Meadows.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North/South Aspect	70	55	48	43	40	38	35	34	32	31	29	28	27	26	25	24	23	23	22	21	21	20	19	19	18
NE/SW & NW/SE Aspect	67	52	45	41	38	35	33	31	29	28	27	25	24	23	22	21	20	20	19	18	18	17	16	16	15
East/West Aspect	50	30	22	19	16	14	13	12	11	11	10	10	9	9	9	8	8	8	8	7	7	7	7	7	7
Average	62	46	38	34	31	29	27	26	24	23	22	21	20	19	19	18	17	17	16	16	15	15	14	14	13

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	18	17	17	16	16	16	15	15	15	14	14	14	13	13	13	13	12	12	12	12	11	11	11	11	11
NE/SW & NW/SE Aspect	15	15	14	14	13	13	13	12	12	12	12	11	11	11	11	10	10	10	10	10	9	9	9	9	9
East/West Aspect	6	6	6	6	6	6	6	6	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4
Average	13	13	12	12	12	11	11	11	11	10	10	10	10	10	9	9	9	9	9	9	8	8	8	8	8

Figure C-11. Shade Curve for PVG 9 (Hydric Subalpine Fir) Narrow Meadows.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North/South Aspect	68	51	43	38	35	32	30	28	27	26	24	23	22	21	21	20	19	19	18	17	17	16	16	15	15
NE/SW & NW/SE Aspect	65	47	40	35	32	30	28	26	25	23	22	21	20	19	18	17	17	16	16	15	14	14	14	13	13
East/West Aspect	47	27	21	17	15	14	13	12	11	10	10	9	9	9	8	8	8	8	7	7	7	7	7	6	6
Average	60	42	34	30	27	25	24	22	21	20	19	18	17	16	16	15	15	14	14	13	13	12	12	12	11

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	14	14	14	13	13	13	12	12	12	12	11	11	11	11	10	10	10	10	10	9	9	9	9	9	9
NE/SW & NW/SE Aspect	12	12	12	11	11	11	10	10	10	10	10	9	9	9	9	9	8	8	8	8	8	8	7	7	7
East/West Aspect	6	6	6	6	6	6	5	5	5	5	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4
Average	11	11	10	10	10	9	9	9	9	9	8	8	8	8	8	8	8	7	7	7	7	7	7	7	7

Figure C-12. Shade Curve for PVG 10 (Persistent Lodgepole Pine) Narrow Meadows.

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Appendix D. Distribution List

Southwest Basin Advisory Group

US Forest Service

Nez Perce Tribe

Idaho Department of Fish and Game

Environmental Protection Agency – Region 10

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Appendix E. Public Comments

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Comments	DEQ Response
Commenter: Patricia Barclay, Idaho Council on Industry and Environment	
The Idaho Council on Industry & Environment (ICIE) is submitting the following comments on the SF Salmon River Subbasin Temperature TMDL and Revised Sediment Targets Addendum.	
ICIE is a nonprofit organization whose mission is to support factual discussions of environmental issues and to facilitate the use of sound science and facts in shaping public environmental policy.	
According to a story in the Star News, the increase of temperatures in the 14 water bodies considered in this addendum and the increased sediment are the result of fires that "burned away trees and bushes."	The article does not accurately represent what is in the TMDL document. This was listed as one of the causal factors.
The DEQ document mentioned that recovery of the streamside forest that has been lost may take a century to reach its full potential.	
DEQ's plan is to lower temperature by helping private land owners or other agencies such as the Forest Service and the Nez Perce Tribe to find funding to replant streamside vegetation.	That is one mechanism to address temperature.
Most of the land in the burned area is national forest land including designated roadless areas and wilderness areas. Active management is not allowed in wilderness areas. In addition many of the roadless areas in this basin are designated for passive restoration only, rather than active projects such as tree planting as mentioned by the DEQ document. DEQ needs to get more information on the makeup of the areas in the basin before trying to implement this TMDL.	Passive management is another method to address temperature issues
Another option mentioned in the media release was that the best option for many of these lands is to leave them alone so they can heal. Wilderness and roadless areas have very limited use and so are being left alone; however the catastrophic fires in these areas denude the land and result in landslides that effect water quality beyond their	

boundaries. While there may be some natural recovery in years after fire, there are many areas where the fires were so hot that the soil has been sterilized. In the four years since the fires, these acres show no sign of recovery. In July, 2008, there was a massive landslide on the East Fork of the South Fork of the Salmon River as a result of the 2007 fires along the East Fork. DEQ proposes that TMDLs will be implemented through continuation of ongoing pollution control activities in the watershed. DEQ recognizes that natural background conditions may not provide the most appropriate load capacity. A successful management approach would achieve reductions based on BMP implementation.	
What BMPs can be used in wilderness and roadless areas? In section 3.4.4 of the document, DEQ discusses the need for a permit to discharge storm water or a general permit to disturb more than one acre of land. Most of the disturbance of land comes from Forest Service projects to replace burned out bridges and cleaning up landslides to restore access to back country communities.	Passive restoration (letting an area come back on its own) is often a sound approach towards restoring riparian areas. Plantings can be done in roadless areas when necessary, following appropriate land management agency protocols.
In several places in this document, DEQ refers to current and future road decommissioning projects that will result in tangible improvements to canopy cover. Road decommissioning in the Yellow Pine/ Big Creek area has being challenged in court. In some instances the Forest Service has not followed the NEPA process before ripping out roads or has proposed to obliterate county roads or roads that access private property. We recommend that paragraphs touting decommissioning roads be removed until DEQ has learned more about the issue. The process of obliterating roads that the Forest Service currently uses provides more potential for sediment because if disturbs old, stable roads by using an excavator to dig deeply into the soil of the road bed, leaving loose soil that can be washed into a waterway by the next big rain event. Some of these roads were decommissioned years ago and while they can be recognized as roads, do not	DEQ intended to infer that road decommissioning is a possible tool in decreasing sediment input and increasing canopy cover, but would like to clarify that each situation needs to be evaluated independently and that the appropriate environmental analysis must take place. Because this TMDL is based on potential natural vegetation, which is equivalent to background loading, the load allocation is essentially the desire to achieve background

have culverts and are covered with grass other vegetation. According to DEQ, the natural background load is also effectively a reduction in the load capacity available for allocation to human-made pollutant sources. There is not longer any active logging or grazing in most of the areas in question. There is some mining exploration in the Stibnite area but human activity is confined largely to tourism	conditions. However, to reach that objective, load allocations are assigned to non-point source activities that have or may affect riparian vegetation and shade as a whole. Each stream needs to be investigated for TMDL implementation on an individual basis to determine if anthropogenic or natural influences have decreased the vegetation. In this case, most of the streams in this TMDL were originally monitored for temperature due to the presence of roads in riparian habitat conservation areas.
Commenter: Steve Harshfield, part-time Johnson Creek resident I whole heartedly agree with the comments by Ned N. Pence (below). I wish to add that roads in the South Fork drainage are a minor factor when compared to the 2007 fires and their aftermath. Moreover, I have not met a single user that wants road removal to be put before re-forestation. The public is not impressed with how eagerly the Forest Service is willing to give up the long and hard fought for PUBLIC access. Please note that just because the Forest Service thinks that road closing is a great idea, does not mean that closing roads will help the water in any way comparable to the damage done during the 2007 fires. Moreover, much of the forest/stream damage was self inflicted by the Forest Service. A little historic research will show much of the South Fork was burned by fire fighter backfires. The Cascade Complex fire fighters even burned their camp with their own backfires. http://www.youtube.com/watch?v=RLJYigWchf0 If you don't think incompetence had something to do with this, please note that I and others can testify that the Cascade Complex manager was on Johnson Creek eating dinner when all hell blew up in Warm Lake. Even before this, the Payette Forest neglected to put out small fires, which ultimately put the Cascade Complex fire fighters in a dangerous position.	 DEQ did not mean to infer that road decommissioning is the only tool available for water quality improvement. These were simply the projects documented by the Forest Service as implementation efforts. Each future road decommissioning project should be evaluated on a case by case basis to ensure that it will have an environmental benefit.

Basically, the public access should not suffer because the Forest Service refused to heed common sense in the driest year on record.	
Commenter: Ned Pence, Retired Forester I am impressed with the effort that DEQ put into the Draft South Fork Salmon River Subbasin Temperature Total Maximum Daily Loads and Revised Sediment Targets. I am very familiar with the history of sediment and stream temperature management problems in the South Fork of the Salmon River (SFSR). I was District Forest Ranger for the Krassel Ranger District of the Payette National Forest from 1971 to 1976. At that time there was deep concern over sedimentation caused by logging that started in 1941. The 1964-1965 flood had resulted in severe sedimentation as many roads constructed for logging by the Idaho jammer method had failed. The 1964-1965 flood resulted from unusual fall precipitation followed by a cold spell in early November and December that froze the soil with an early deep snow pack. The cold spell was followed by heavy rain on snow the last of December 1964 and early January 1965. Concern over sedimentation of the SFSR resulted in the Regional Forester placing a moratorium on SFSR logging in 1967. My primary assignment as Krassel DFR was to work with the DFR of the Cascade Ranger District of the Boise National Forest and develop a Land Use Plan for the SFSR under the NEPA. The Land Use Plan and EIS was intended to implement a plan for management of this sensitive area of the Idaho Batholith. The Land Use Plan was approved by Forest Supervisors W.B.Sendt and Edward Maw in October 1975,then appealed by the Sierra Club. The Land Use Plan was upheld by Regional Forester Vern Hamre and then appealed to Forest Service Chief Edward Cliff. Chief Edward Cliff remanded the plan back to the Forests. The remand resulted in an expanded effort and a Land Management Plan for the SFSR that was approved by the Regional Forester on September 26, 1977. That plan was also appealed by the Sierra Club and then upheld by Chief Cliff. The plans clearly illustrated the concern both the Boise and Payette National Forests had over building fuel loads as climax species were replacing the seral species. Fires were becoming more difficult and costly to suppress due to increasing fuel loads. The plans were for a program of active forest management including logging using the rapid improvement in logging technology and prescribed fire. However, after a few timber sales the plans were never fully implemented in favor of a policy that emphasized no active management. The policy of no	‘Natural’ is defined to the best of DEQ’s ability to reflect the vegetation that would be there under natural conditions and can be refined as additional information is gathered. It does not refer to the conditions that led to the development of the TMDL. DEQ acknowledges that returning to a natural condition could take decades for some streams. However, most of the streams with TMDLs with the exceptions of middle Johnson Creek, Grouse Creek, Elk Creek, Rice Creek, Trout Creek and Lower Warm Lake creek had low percentages of ‘lack of shade’, meaning that they should recover faster and are already close to meeting PNV conditions. Thank you for your comments and providing historical context. DEQ does not prescribe land management actions for land management agencies although DEQ will comment on any environmental concerns relating to new projects that are in a scoping phase. The USFS has actively solicited comments on these actions.

or little active management resulted in increasing fuel loads leading to large catastrophic wildfires starting in 1990 and ending with the very large catastrophic fire in 2007. The above brief history of problems with management of the SFSR brings me to the subject Draft. It is my opinion that this attempt to reach satisfactory total maximum daily loads (TMDL) will require decades and perhaps even a century. As a Professional Forester familiar with the Idaho Batholith I understand the problem. Riparian areas do not burn often; however,when they do burn they burn with intense fire due to the fuel loading and topography leading to a chimney effect. Fire behavior depends on fuel loading, weather and topography. All three factors have been present during the intense wildfires since 1990. The factors were all predicted in the land management planning efforts of the 1970s. There is nothing that management can do to resolve weather and topography factors; however active management can resolve fuel loading problems. The fuel loading problem is measured by ground fuels that results in intense fire behavior. One only needs to observe the dead timber in riparian areas resulting from wildfire and beetle attacks to recognize the future very intense fires that will result in the SFSR. The timing of these future intense fires cannot be predicted; however, one can learn from the intense 1910 Idaho and Montana fire. Much of this large area was reburned in the 1930s with more intense fire. Some of the riparian areas in the 1910 fire have not returned to what DEQ would consider potential natural vegetation (PNV) 100 years later. The use of "natural" in the draft is a problem. How can natural be defined? The 2007 intense catastrophic fire was not a natural event. The fuel loading in the SFSR is the result of human decisions to attempt elimination of fire and also eliminate active forest management. The fuel loading for catastrophic fires starting in 1990 exceeded historical fuel loading by a significant amount leading to fire intensity exceeding any historical "natural" fire event. The decisions by the Payette and Boise National forests to eliminate fire, and active management, and a final decision after several lightning started fires to implement a "point protection" fire suppression strategy has led to a total maximum daily load (TMDL) that cannot be defined as "natural". Returning to a condition that DEQ could consider PNV or satisfactory maximum weekly maximum temperature (MWMT), and total maximum daily load (TMDL) will require decades even if best management practices (BMP) are defined and implemented.	

In summary it is too late for the SFSR to reach a satisfactory condition as defined by DEQ without decades of best management practices. The lesson that should be learned from the SFSR experience can be applied to other watersheds. Land management practices should not eliminate active management including utilization of forest biomass and use of prescribed fire.	
Chris Schwarzhoff Please push to get the Forest Service to manage their lands in the South Fork drainage so as to reduce the wildfires. So long as the FS continues to manage those lands in such a way as to encourage big fires and then not aggressively fight the wildfires, sediment and high stream temperatures will continue. Closing roads and prohibiting public access is not the answer. Solve the big problems not the little ones.	Thank you for your comment. DEQ will provide comments regarding water quality issues, when appropriate, on scoping documents for the USFS.
Becky Johnstone Thank you for the opportunity to comment on the South Fork Salmon River Addendum. It is very frustrating to watch property owners try to improve their properties and water quality in Idaho and to watch the Forest Service's management of the lands under their jurisdiction. In addition, most of the area being discussed is Inventoried Roadless Area recommended for Wilderness consideration or under the Passive Restoration classification. Contrary to what many people believe, no trees are being replanted or other vegetation. Noxious weeds about in many of the burned areas. Areas that burned in 2000 reburned in 2007. Areas that reburned burned as very high temperatures. We will never know how many acres were burned in backfires. The Forest Service set many backfires right on the rivers and streams edges The Forest Service should be required to manage the lands they are responsible for. You would require action from a private landowner in these circumstances. Obliterating roads is not the answer to reducing temperatures and sediment releases in this area. Reducing roads in the area will guarantee larger fires in the futures. The Forest Service cites lack of access as one of the reasons they can't control fires on the Payette National Forest year after year. They have aerial tools that can be used but planes, helicopters and jumper crews are not always available while fire are small and can be	Road decommissioning/obliteration was mentioned as one method to reduce temperature and sediment, but DEQ did not intend to infer that road decommissioning/obliteration is a stand-alone water quality improvement measure. Each project should be examined on a case by case basis for its environmental benefits. DEQ appreciates your concern about our role in commenting on Forest Service activities, and we will comment, when appropriate, on Forest Service activities during the scoping phase.

controlled. In 2007 over 800,000 acres burned in the Payette, Boise and adjacent forests. The Forest Service made the determination early to allow small lightning strike fires to burn. They had projections for where these fires would burn and they knew what the moisture content of the vegetation was. Air quality was seriously affected from July through September. The fires didn't go out until the snow fell. When the fire was slowed by rains, the Forest Service reignited so they could burn all of the area they wanted to burn. While it is outside the scope of this document to tell the Forest Service what to do, Idaho DEQ must take a more active role in commenting on Forest Service activities.

Huge amounts of mercury and phosphorus were released during the 2000 and 2007 fire years. PM 2.5's were far in excess of all guidelines. The 2010 Hurd Fire burned near or through uranium mining claims. Saving cabins on the Secesh River protected riverside vegetation and was, in my opinion, of at least equal value to saving cabins (mine among them). While cabins can be rebuilt, it will take 70-100 years to replace the vegetation that was burned.
Less vegetation is growing in following the 2007 reburn of the Grouse Creek drainage that feeds into the Secesh River.

You see very little vegetation on the foreground and you see the ridge in the background that burned in 2000 and 2007 with not even any standing snags


Most of the standing snags were burned to no more than ash in 2007.


Everywhere you look you see the results of the 2000 and 2007 fires.


Grouse Creek isn't large but the damage around it is devastating even now 4 years later. There is almost no new coniferous tree growth.

 Look at the difference in new tree grown in this picture. This area was heavily thinned before it was ignited. Trees have started growing. It will still be years before they will be large enough to provide stream shading. Flat Creek Road was obliterated following the 2007 fire and access to water to fight fires was covered with logs and large boulders. It won't be accessible in future fires. Road obliteration, especially in burned areas allows more sediment to enter the rivers and streams. DEQ should not be advocating for the removal of roads. The Forest Service has been abusing the recommendations of other agencies regarding the closing of roads and has been obliterating them, causing generation of large amounts of sediment, the killing of live trees, reduction of access for future fire control and public access. Road obliteration, as practiced by the Forest Service even disrupts game trails.	For the purposes of the PNV TMDL, DEQ recognizes that there are instances where meeting the shade targets may take decades. However, the riparian shrub component will come back more quickly. Road decommissioning is one type of Best Management practice but must be evaluated on a case by case basis. DEQ did not mean to infer that it is appropriate in all situations.
How is DEQ placing temperature sensors? Most of the streams in this area are heavily spring fed. You will find many deep, cold pools that provide adequate escape from warmer waters. Warmer waters allow for greater food production for the fish. Grouse Creek is probably only used seasonally if at all. Since you are unable to make recommendations for planting of trees in this Passive Restoration area and all roads except Grouse Creek Road have already been obliterated by the Forest Service, you should consider making recommendations that include some positive steps the Forest Service can follow such as thin the forests prior to allowing too dense, beetle killed stands to burn. Beetle numbers soared	In this particular case, DEQ relied on USFS data. The sensors were placed in the main current or as close to the main current as is possible. You are correct that there are areas in a stream that are colder due to pools or springs. However, to give a better idea of overall stream temperatures, placing the sensors in areas of current provides a more consistent and conservative

following the 2007 fires. Once their food source passed its prime in the burned stands they began moving to living trees. If you go out to the forest now you will be able to hear the beetles eating their numbers are so great. Studies have revealed that forests are healthier, wildlife is more abundant and diverse in the state managed forests in Montana. I think you will find the same is true in Idaho. The Forest Service must be encouraged to actively manage the forests and to do what is necessary to stem large, catastrophic wildfires. DEQ should investigate the levels of mercury and phosphorus released by wildfires. They should make comments regarding the management of the forests and fires in Idaho to the Forest Service. If you are recommending the closing of roads you should provide clear data that shows that closing specific roads will result in less sediment or lower temperatures in the specific streams in the area near those roads you are recommending closures on. Roads provide very effective fire breaks and even when fires are stopped they drop dramatically in intensity when they encounter roads and reduced fuels. It is dangerous to make the assumption that closing all roads will result in lower sediment levels and temperatures. Roads do have positive values in allowing access to control fires. Active forest management requires access and will result in smaller, less intense fires and less impact on the waters in Idaho. Rafters and kayakers frequently access the rivers and streams in this are by going directly down the banks. You may want to encourage the Forest Service to build access sites or designate sites that will result in the least amount of sediment going into the rivers and streams. This would have a much more significant impact on sediment delivery to water than closing more roads. Active road densities are very low in this area. Educate the rafting and kayaking public regarding where they are entering and exiting bodies of water. Rafting and kayaking are increasing in this area.	approach. Deep pools may be colder, but there are also incidences where due to lack of current, they may actually be warmer, deploying the logger in current provides for more consistent data collection. DEQ supports actions by land management agencies and private landowners that will result in improved water quality and/or air quality. In general, DEQ does not prescribe specific actions to be taken by management agencies or landowners instead relying on their experience and expertise to determine what would work best in a particular area. For water quality purposes the Forest Service and private timber landowners follow the Forest Practices Act best management practices to protect water quality. DEQ will provide comments on Forest Service scoping documents where appropriate. Thank you for the suggestion-this suggestion will be passed onto FS personnel.
Commenter: Martha Turvey *Environmental Protection Agency* Provide the rationale or basis as to why the revised targets are protective of the beneficial uses. If this is included in other documents, such as developed by the USFS, it would help to explain that more fully in the text, and to provide references to the appropriate document(s). Without reviewing the basis for the targets, we are unable to determine whether the change in the target is	Additional text regarding the derivation of targets has been added to Section 1.2 In response to the comments above, which point out the difficulty of differentiating between natural and anthropogenic sediment

acceptable and can be approved as a TMDL revision Please provide information on free matrix criteria and why cobble embeddedness in the mainstem is no longer used to define targets. Is a free matrix count a more or less conservative approach to assessing a target and why**?** Will the revision result in a change in the loading analysis, load capacity or any of the load allocations, and if so, what those changes will be?	inputs, a more conservative monitoring target is being put forth to ensure that all beneficial uses, particularly salmonid spawning, will be supported. Free matrix and cobble embeddedness measurements are used to characterize the interstitial space found in streams on the streambed surface, which is typically a matrix of free and embedded particles. The interstitial environment is of interest because it provides hiding cover for small fish, including young salmonids, and provides essential habitat for aquatic invertebrates, the principal food source for most stream fish. Criticisms of cobble embeddedness as a monitoring technique involve primarily technical issues relating to standardization of methods, definitions, variability, and measurement precision. Free matrix provides the same type of results with better replicability. Free matrix counts are simpler to perform than cobble embeddedness measurements, are likely subject to less observer error, provide a reach-level habitat condition index, and can be used to estimate or predict cobble embeddedness. Some cobble embeddedness sampling (‘double sampling’ in concert with free matrix sampling) still occurs in the SFSR drainage to serve as QA check that the free matrix results are a reliable indicator of cobble embeddedness.

	The revision will not result in a change in load allocations because the TMDL is based upon sediment modeling results and achieving natural background sediment loading to the South Fork Salmon from the surrounding landscape. The change in the targets does not affect the load allocations. The targets are an indicator of when beneficial uses are supported. It is expected that when the TMDL is met that excess sediment that is already in the system will still need to be processed and that when that occurs that the targets will be met. There will be a lag time between meeting the TMDL and seeing these changes in the system due to the processing of legacy sediment.

Appendix F. Reference Streams

Table F-1 Reference Streams

Catchment	Watershed	Subwatershed	Acres
Upper South Fork Salmon River	Blackmare Creek	Blackmare Creek	11,243
	Fourmile Creek	Fourmile Creek	9,817
Lower South Fork Salmon River	Sheep Creek	Sheep Creek	16,262
	Porphyry Creek	Porphyry Creek	11,923
		Wolf Fang Creek	10,142
Secesh River	Lick Creek	Lick Creek	21,825
East Fork South Fork Salmon River	Tamarack Creek	Tamarack Creek	11,716
	Quartz Creek	Quartz Creek	12,290
	Parks Creek	Parks Creek	4,582
Chamberlain Creek	Chamberlain Creek	Lower Chamberlain	10,526
		Middle Chamberlain	22,545
		Flossie	11,009
		Upper Chamberlain	17,368
		West Fork Chamberlain	14,389
		Moose Creek	8,579
		Lodgepole Creek	11,517
		McCalla Creek	26,924
		Lower Whimstick Creek	6,390
		Upper Whimstick Creek	19,532
Middle Fork Salmon River	Jacobs Ladder Creek	Jacobs Ladder Creek	NA
	Monumental Creek	Snowslide Creek	13,381
		West Fork	14,243

Reference Conditions

Statistical analyses were performed using SAS® 8.01 for Windows®. Simple univariate statistics obtained with PROC UNIVRIATE were used to assess the sediment conditions of reference sites by watershed and by drainage group defined by parent geology and to produce frequency distributions of the individual sediment indices by drainage group. Box and whisker plots were produced using PROC BOXPLOT to display data distributions and means by watershed and drainage group for visual comparison of parameters. Comparisons of surficial and interstitial sediment indices between drainage groups were performed using PROC NPAR1WAY with the “Wilkoxon” option, which produces a nonparametric Wilcoxon rank sum test (statistically equivalent to the Mann-Whitney U-test and analogous to a parametric ttest) tests of core sampling variates among watersheds were also conducted using PROC NPAR1WAY with the “Wilkoxon” option, which, in this case, produces a Kruskall-Wallis test (statistically analogous to parametric analysis of variance). Tests were performed on the means from each site from each sampled year rather than by pooling the entire data set to help normalize the data distributions, although no assumptions of normality have been made. These results were used to describe the distributions of the sediment data and to provide a framework from which to determine appropriate values for sediment indicators of salmonid habitat condition (USFS 2005).

End