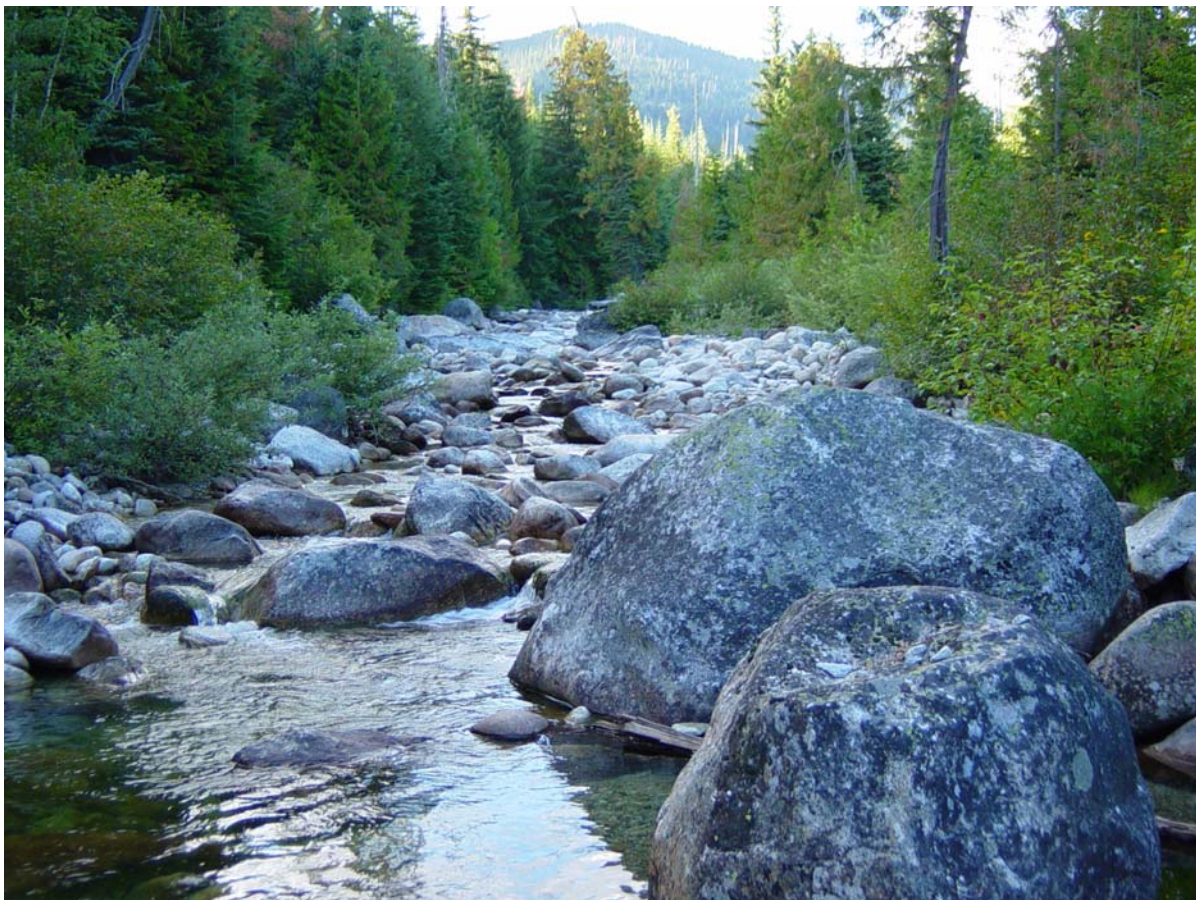


Pend Oreille Lake Tributaries Temperature Total Maximum Daily Loads:

Addendum to the Pend Oreille Lake Subbasin Assessment and TMDL



Department of Environmental Quality

November 2007

Pend Oreille Lake Tributaries Temperature TMDLs

November 2007

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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	IDWR	Idaho Department of Water Resources
AU	assessment unit	LA	load allocation
BMP	best management practice	LC	load capacity
BURP	Beneficial Use Reconnaissance Program	m	meter
C	Celsius	MD	method difference
CWA	Clean Water Act	mi	mile
CWE	cumulative watershed effects	mi²	square miles
DEQ	Department of Environmental Quality	MOS	margin of safety
EPA	United States Environmental Protection Agency	MWMT	maximum weekly maximum temperature
FPA	Idaho Forest Practices Act	n.a.	not applicable
FWS	U.S. Fish and Wildlife Service	NA	not assessed
GIS	Geographical Information Systems	NB	natural background
HUC	Hydrologic Unit Code	nd	no data (data not available)
I.C.	Idaho Code	NPDES	National Pollutant Discharge Elimination System
IDAPA	Refers to citations of Idaho administrative rules	PNV	potential natural vegetation
IDFG	Idaho Department of Fish and Game	SBA	subbasin assessment
IDL	Idaho Department of Lands	STATSGO	State Soil Geographic Database
		TMDL	total maximum daily load
		U.S.	United States
		U.S.C.	United States Code

USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USFS	United States Forest Service
USGS Survey	United States Geological
WAG	Watershed Advisory Group
WLA	wasteload allocation
WQLS	water quality limited segment
WQMP plan	water quality management
WQRP	water quality restoration plan
WQS	water quality standard

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 19 water bodies in the Pend Oreille Lake Subbasin that have been placed on Idaho's current §303(d) list. This document only addresses the temperature TMDLs for these streams. For more information about these watersheds and the subbasin as a whole see the Clark Fork/Pend Oreille Subbasin Assessment and Total Maximum Daily Loads (IDEQ, 2001).

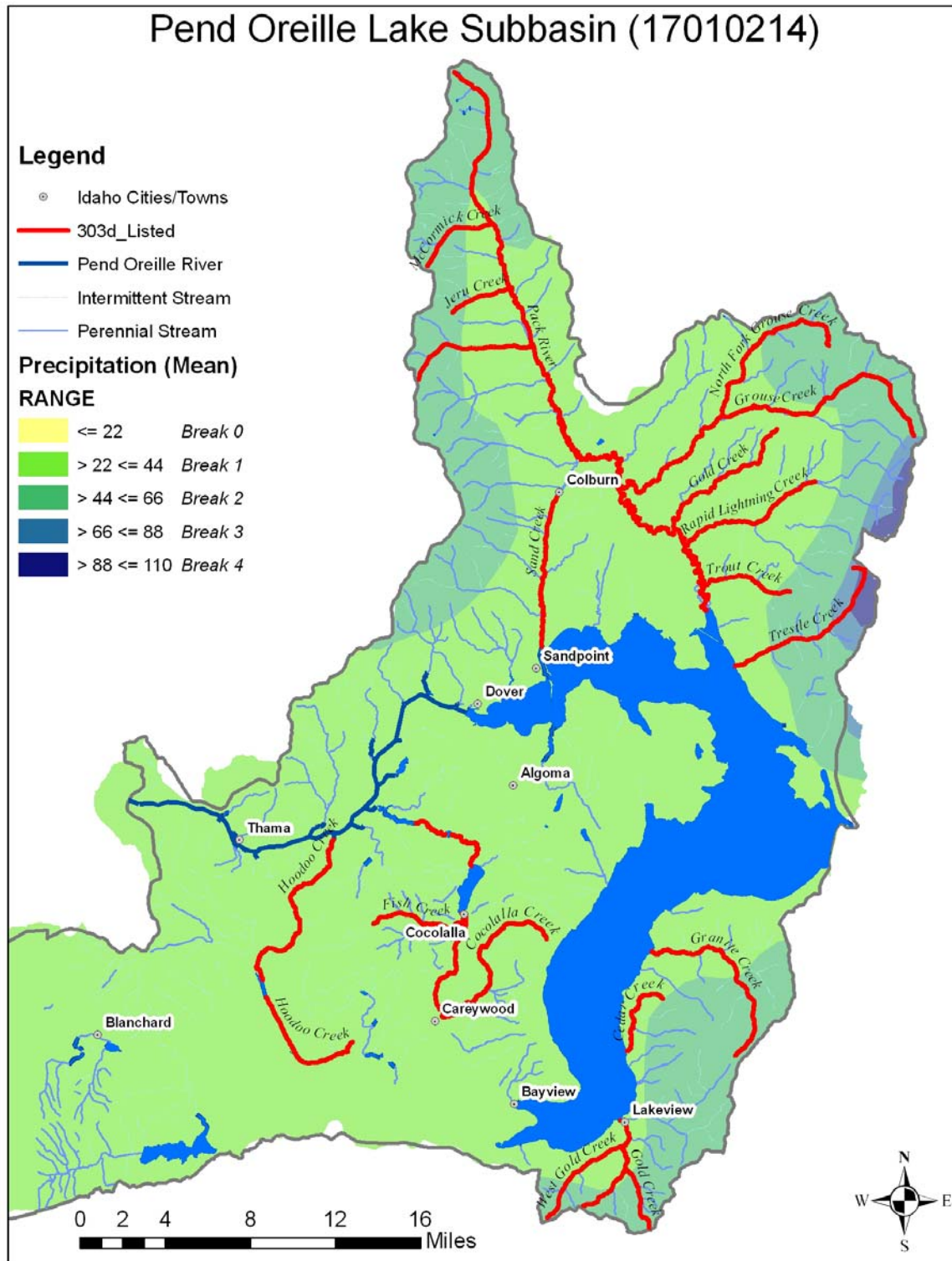
This TMDL analysis has been developed to comply with Idaho's TMDL schedule. The TMDL analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards.

Subbasin at a Glance

The Pend Oreille Lake Subbasin (17010214) is located in the northern Idaho panhandle. Listed on the Idaho 1998 303d list for temperature pollution were Hoodoo Creek, Cocolalla Creek, and Fish Creek. The Environmental Protection Agency (EPA) added streams to Idaho's 1998 303d list of impaired waters that exceeded Idaho's temperature criteria. In the Pend Oreille Lake Subbasin, Granite Creek, Grouse Creek, Pack River, and Trestle Creek were among those EPA additions (Figure A). A number of other streams were also examined in this analysis including those additional streams listed for temperature pollution on the Idaho 2002 303d list (Cedar Creek, Chloride Gulch Creek, 'South' Gold Creek, West Gold Creek, Hellroaring Creek, Jeru Creek, McCormick Creek, NF Grouse Creek, North Gold Creek, Rapid Lightning Creek, 'West' Sand Creek, and Trout Creek)*. Streams not listed but examined in this analysis were done so for the purpose of determining potential heat loading to listed segments.

* 'South' and 'West' are references to location for different streams having the same name.

Figure A. Subbasin at a Glance.



Key Findings

Nineteen water bodies were placed on the 1998 303d list of impaired waters by EPA for reasons associated with temperature criteria violations (Table A). Effective shade targets were established for these streams based on the concept of maximum shading under potential natural vegetation equals natural background temperature levels. Shade targets were actually derived from effective shade curves developed for similar vegetation types in the Northwest. Existing shade was determined from aerial photo interpretation field verified with solar pathfinder data.

Most streams examined in this TMDL had excess solar loads greater than that created by the Method Difference (difference between existing shade as a 10%-class interval and target shade as a unique integer). Notably, the Pack River and several of its larger tributaries (Grouse Creek, Rapid Lightning Creek, McCormick Creek, and Hellroaring Creek) had high excess loads with percent reductions needed to achieve target levels in the neighborhood of 30% to 90%. Hoodoo Creek and upper Cocolalla Creek also had high excess loads, however their percent reductions needed were generally less than 30%.

Several streams stood out as having excess loads less than what you would expect from having the existing shade at the same 10% class-interval as the target shade (Method Difference excess load). These streams (North Fork Grouse Creek and Granite Creek) are recommended for delisting from the 303d list for temperature (Table B).

Table A. Streams and Pollutants for which TMDLs were Developed.

Stream	Pollutant(s)
Hoodoo Creek	Temperature
Cocolalla Creek	Temperature
Fish Creek	Temperature
Granite Creek	Temperature
Grouse Creek	Temperature
Pack River	Temperature
Trestle Creek	Temperature
Cedar Creek	Temperature
'South' Gold Creek	Temperature
West Gold Creek	Temperature
Chloride Gulch Creek	Temperature
Hellroaring Creek	Temperature
Jeru Creek	Temperature
McCormick Creek	Temperature
NF Grouse Creek	Temperature
North Gold Creek	Temperature
Rapid Lightning Creek	Temperature
'West' Sand Creek	Temperature
Trout Creek	Temperature

Table B. Summary of Assessment Outcomes.

Water Body Segment/ AU	Pollutant	TMDL(s) Completed	Recommended Changes to §303(d) List	Justification
Pack River/ ID17010214PN031_04 ID17010214PN039_03 ID17010214PN039_04 ID17010214PN041_02 ID17010214PN041_03	Temperature	Yes	n.a.	Existing Shade
Rapid Lightning Creek/ ID17010214PN033_03	Temperature	Yes	n.a.	Existing Shade
North Gold Creek/ ID17010214PN034_02	Temperature	Yes	n.a.	Existing Shade
Grouse Creek/ ID17010214PN035_03 ID17010214PN036_02 ID17010214PN036_03	Temperature	Yes	n.a.	Existing Shade
NF Grouse Creek/ ID17010214PN037_02	Temperature	Yes	delist	Existing Shade
Trout Creek/ ID17010214PN032_02	Temperature	Yes	n.a.	Existing Shade
Hellroaring Creek/ ID17010214PN044_02	Temperature	Yes	n.a.	Existing Shade
Jeru Creek/ ID17010214PN043_02	Temperature	Yes	n.a.	Existing Shade
McCormick Creek/ ID17010214PN042_02	Temperature	Yes	n.a.	Existing Shade
Sand Creek/ ID17010214PN048_03 ID17010214PN049_02 ID17010214PN049_03	Temperature	Yes	n.a.	Existing Shade
Upper Cocolalla Creek/ ID17010214PN014_02 ID17010214PN014_03 ID17010214PN014_04	Temperature	Yes	n.a.	Existing Shade
Lower Cocolalla Creek/ ID17010214PN012_04	Temperature	Yes	n.a.	Existing Shade
Fish Creek/ ID17010214PN015_03	Temperature	Yes	n.a.	Existing Shade
Hoodoo Creek/ ID17010214PN003_02a ID17010214PN003_02	Temperature	Yes	n.a.	Existing Shade
Granite Creek/ ID17010214PN027_02 ID17010214PN027_03	Temperature	Yes	delist	Existing Shade
Cedar Creek/ ID17010214PN026_02	Temperature	Yes	n.a.	Existing Shade

'South' Gold Creek watershed (incls Chloride Gulch & West Gold)/ ID17010214PN021_02 ID17010214PN021_03 ID17010214PN022_02 ID17010214PN023_02 ID17010214PN023_03 ID17010214PN024_02	Temperature	Yes	n.a.	Existing Shade
Trestle Creek/ ID17010214PN030_02	Temperature	Yes	n.a.	Existing Shade

Public Input and Meetings

In compliance with Idaho Code §39-3611(8), the development of the Pend Oreille River TMDL included extensive public participation by the Pend Oreille River TMDL Watershed Advisory Group (WAG), the Pend Oreille River Tributary Work Group, and other interested parties. In October 2006, a Tributary Work Group was formed with the purpose to assist with the technical portion of the Pend Oreille River tributary TMDL development. The following is a summary of the public process.

WAG Meetings (relative to the Pend Oreille River tributary temperature TMDL)

October 20, 2005: topics covered were the specifics of the TMDL process for the Pend Oreille River in Idaho and Washington, the Memorandum of Agreement signed by the two states, the Kalispel Tribe and EPA to develop one TMDL for temperature, and the rolls and responsibilities of the WAG during TMDL development.

May 26, 2006: topics covered were approaches to the temperature TMDL by Washington and Idaho, the Pend Oreille River tributary TMDLs in both Idaho and Washington, and monitoring efforts by the Pend Oreille Conservation District and the Kalispel Tribe.

May 10, 2007: among topics covered was the role of the Idaho Tributary Work Group in the decision-making process.

June 25, 2007: the WAG formally gave authority to the Work Group to recommend tributary TMDLs (and to proceed with public comment on those TMDLs) to the panhandle Basin Advisory Group.

Tributary Work Group Meetings

October 26, 2006: topics covered were Tributary Work Group interaction with Pend Oreille River mainstem WAG, impaired water bodies in the subbasin, stressor identification reports for water bodies with "unknown" pollutants, and the sediment TMDL.

February 13, 2007: topics covered were sediment modeling results and the nutrient and temperature TMDL progress for the Pend Oreille River tributaries.

March 20, 2007: topics covered were the approach to the nutrient TMDL for the Lower Pack River and tributaries, the revised land use coverages and sediment model results.

May 23, 2007: topics covered were the approval process and interaction with Pend Oreille River mainstem WAG, regionally specific vegetation types and shade curves, and the potential natural vegetation (PNV) TMDLs.

June 14, 2007: topics covered were the revised sediment TMDL and allocations.

July 19, 2007: topics covered were the nutrient TMDL for the lower Pack River, sediment and temperature TMDLs, and impairments in Sand Creek.

Sept 18, 2007: topics covered were the release of the draft nutrient, temperature and sediment TMDLs released to the public and the meeting was opened up to answer questions by the public.

October 16, 2007: public comments received on the nutrient, temperature and sediment TMDLs were shared and there was a request for a consensus to proceed with submission of the final TMDL for EPA approval.

Public Comment Period for the Pend Oreille Tributary TMDLs

On September 4th, 2007, the Pend Oreille Tributary TMDLs were posted on the DEQ website for public comment, and the comment period closed October 4th, 2007. Comments received were individually addressed by DEQ and the final TMDL was sent for EPA approval in November 2007 (Appendix D).

Idaho DEQ has complied with the WAG consultation requirements set forth in Idaho Code §39-3611. DEQ has provided the WAG with all available information concerning applicable water quality standards, water quality data, monitoring, assessments, reports, procedures, and schedules. All presentations and drafts provided at WAG meetings were made available on the DEQ website devoted to the Pend Oreille River WAG throughout the process.

DEQ utilized the knowledge, expertise, experience, and information of the WAG in developing this TMDL. DEQ also provided the WAG with an adequate opportunity to participate in drafting the TMDL and to suggest changes to the document. Final copies of the TMDL will be made available to the general public and distributed to WAG and Tributary Work Group members (Appendix E).

5. 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 certain pollutants whose effects are long term, such as sediment and nutrients, EPA allows for seasonal or annual loads.

5.1 In-stream Water Quality Targets

For the Pend Oreille Lake subbasin temperature TMDLs we utilize 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 this section. 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 (IDEQ, 2004)

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 has grown 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 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 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 or cover was estimated for water bodies in the Pend Oreille Lake subbasin 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 in other TMDLs. 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, an average of two stations (Spokane, WA and Kalispell, MT) 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.

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. In order 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 true 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 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 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 densiometer readings at the same location as solar pathfinder traces. This provides the potential to develop relationships between canopy cover and effective shade for a given stream.

Aerial Photo Interpretation

Canopy coverage estimates or 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%-canopy coverage or shade class as described below (*adapted from the CWE process, IDL, 2000*). For example, if we estimate that canopy cover 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. The typical vegetation type (below) shows the kind of landscape a particular cover class usually falls into for a stream 5m wide or less. For example, if a section of a 5m wide stream is identified as 20% cover class, it is usually because it is in agricultural land, meadows, open areas, or clearcuts. However, that does not mean that the 20% cover class cannot occur in shrublands and forests, because it does on wider streams.

<u>Cover class</u>	<u>Typical vegetation type on 5m wide stream</u>
0 = 0 – 9% cover	agricultural land, denuded areas
10 = 10 – 19%	ag land, meadows, open areas, clearcuts
20 = 20 – 29%	ag land, meadows, open areas, clearcuts
30 = 30 – 39%	ag land, meadows, open areas, clearcuts
40 = 40 – 49%	shrublands/meadows
50 = 50 – 59%	shrublands/meadows, open forests
60 = 60 – 69%	shrublands/meadows, open forests
70 = 70 – 79%	forested
80 = 80 – 89%	forested
90 = 90 – 100%	forested

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 will 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.

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.

The only factor not developed from the aerial photo work described previously is channel width (i.e., NSDZ or Bankfull Width). 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 1), to estimate natural bankfull width.

For each stream evaluated in the loading analysis, bankfull width is estimated based on drainage area and the Pend Oreille curve from Figure 1 and presented in Table 1. Additionally, existing width is evaluated from available BURP data and from the Pack River Stream Channel Assessment (Golder, 2003). Although existing data is limited in scope, if the stream's existing width is substantially wider than that predicted by the Pend Oreille curve in Figure 1, then the curve estimate of bankfull width is used in the loading analysis for natural bankfull width. If existing width is substantially smaller, then existing width is used in the loading analysis for natural bankfull width. In many cases, there is no existing width data and the curve estimate of bankfull width is used for both natural and existing bankfull width in the loading analyses. There are a few locations, especially along the Pack River where existing bankfull widths are much larger than curve estimated natural bankfull widths.

Table 1. Bankfull Widths Estimated by Drainage Area and Existing Measurements.

Location	area (sq mi)	PendOreille (m)	Existing (m)
1st West-side Pack Tributary @ mouth	1.33	3	
Beehive Creek @ mouth	0.91	2	
Slide Creek @ mouth	1.13	3	
Thor Creek @ mouth	1.82	3	
Zuni Creek @ mouth	1.14	3	
West Branch Creek @ mouth	5.22	5	
1st Tributary to W. Branch @ mouth	0.46	2	
2nd Tributary to W. Branch @ mouth	1.18	3	
3rd Tributary to W. Branch @ mouth	0.77	2	
1st West-side Pack Trib bl W.Branch	0.51	2	
1st East-side Pack Trib bl W.Branch	0.7	2	
2nd East-side Pack Trib bl W.Branch	1.34	3	
McCormick Creek @ mouth	6.7	5	9.5
1st Trib from McCormick Lake @ confluence	0.27	2	
1st Trib from Fault Lake @ confluence	0.62	2	
1st Tributary to McCormick @ mouth	1.22	3	
2nd Tributary to McCormick @ mouth	0.84	2	
Gunsight Creek @ mouth	0.98	3	
4th Tributary to McCormick @ mouth	0.25	1	
1st East-side Pack Trib bl McCormick	0.27	2	
Torrent Creek @ mouth	0.7	2	1.6
Zee Creek @ mouth	0.39	2	
Youngs Creek @ mouth	1.1	3	3
Homestead Creek @ mouth	2.85	4	7
Homestead Creek ab Youngs Creek	1.63	3	
Tributary to Homestead Creek @ mouth	0.34	2	
1st East-side Pack Trib bl Homestead	0.46	2	
1st West-side Pack Trib bl Homestead	0.76	2	2.2
2nd East-side Pack Trib bl Homestead	0.23	1	
Jeru Creek @ mouth	5.24	5	7.3
Upper fork to Jeru Creek ab confluence	1.07	3	
Lower fork to Jeru Creek ab confluence	1.33	3	
Forked Tributary to Jeru @ mouth	2.55	4	
Pearson Creek @ mouth	3.04	4	
Martin Creek @ mouth	3.39	4	5.3
Tributary to Martin Creek @ mouth	0.79	2	
Blane Creek @ mouth	1.46	3	
Upper fork to Blane Creek	0.39	2	
Lower fork to Blane Creek	0.91	2	
Lindsey Creek @ mouth	2.94	4	
Tributary to Lindsey Creek @ mouth	0.57	2	
Hellroaring Creek @ mouth	10.9	7	4.9
Hellroaring Creek bl fork @ 3730ft	5.46	5	
Hellroaring Creek bl hdwtr forks @ 4290ft	1.64	3	
Upper hdwtr fork Hellroaring @ confluence	0.48	2	
Lower hdwtr fork Hellroaring @ confluence	1.13	3	
3rd tributary to Hellroaring @ mouth	2.49	4	
4th tributary to Hellroaring @ mouth	0.97	3	
Pack River bl Rapid Lightning Cr.	270	24	
Pack River bl Grouse Cr.	198	21	37
Pack River bl gage (Hwy 95)	121	17	
Pack River bl Hellroaring Cr.	71.9	14	28.7, 44.3, 30.8*
Pack River bl Jeru Cr.	46.8	12	22.8, 22.7, 22*
Pack River ab McCormick Cr.	24.3	9	21, 12.2*
Pack River ab West Branch	14.8	7	13.6

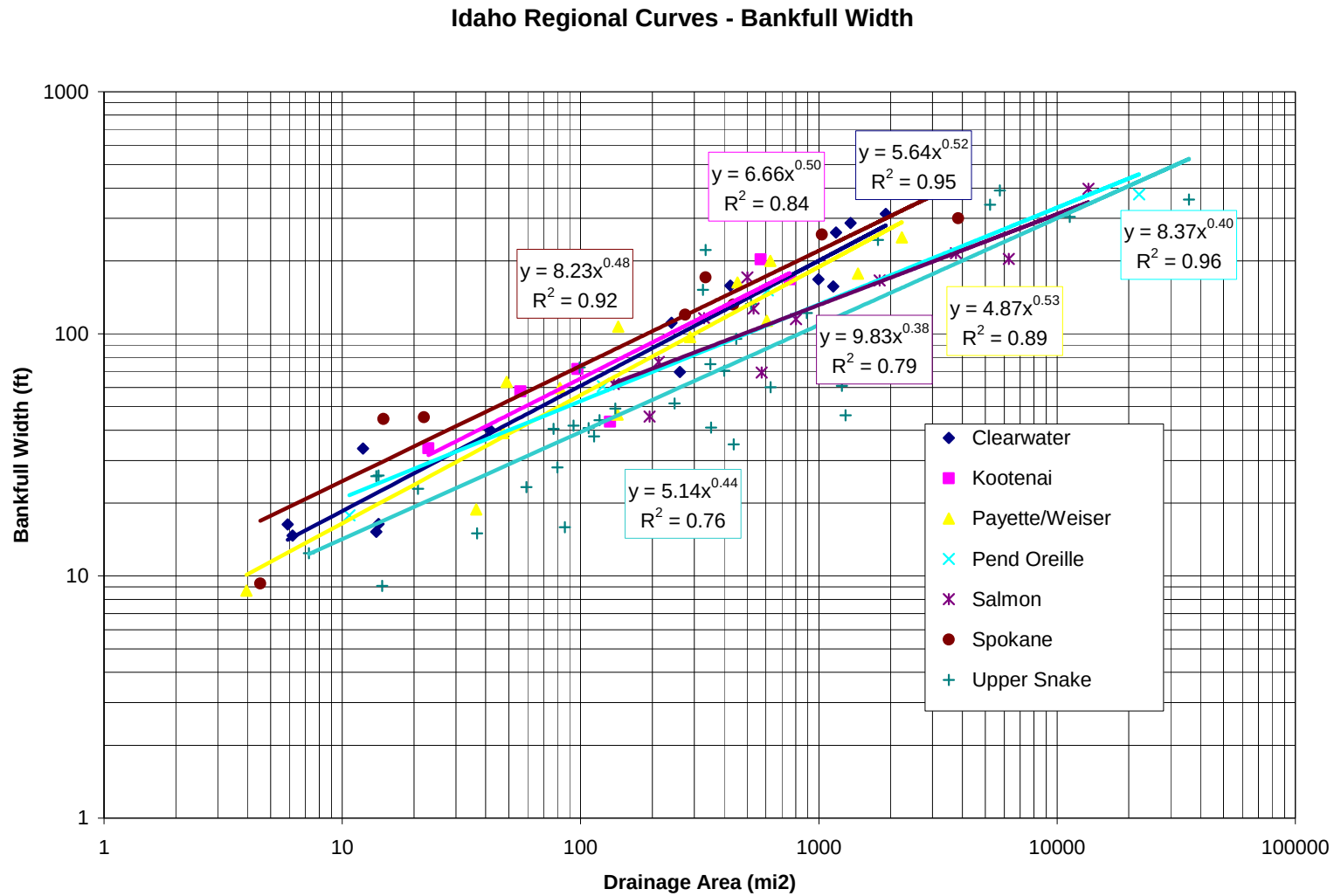
* Averages for groupings of subreaches from Golder (2003).

Pend Oreille Lake Tributaries Temperature TMDL

November 2007

Location	area (sq mi)	PendOreille (m)	Existing (m)
Grouse Creek @ mouth	56.1	13	9.5, 22.3
Grouse Creek bl NF	46.8	12	18.4, 20
Grouse Creek bl SF	22.2	9	16.6, 18, 27.6
Grouse Creek ab SF	14.6	7	10.4
NF Grouse Creek @ mouth	15.3	8	6.3, 8.3
1st Tributary to NF Grouse @ mouth	1.53	3	
2nd Tributary to NF Grouse @ mouth	1	3	
Dyree Creek @ mouth	1.94	3	4.2
4th Tributary to NF Grouse @ mouth	2	3	
Gold Creek (Pack) @ mouth	12.7	7	
Gold Creek bl fork @ 2530ft	6.64	5	4.8
Gold Creek bl 1st fork @2680ft	2.63	4	2.1
Rapid Lightning Creek @ mouth	48.3	12	
Rapid Lightning Creek bl Spring	36.1	11	15, 11.5
Rapid Lightning Creek ab Spring	30.3	10	
Rapid Lightning Creek bl Trapper	12.8	7	
Rapid Lightning Creek ab Trapper	6.75	5	6.4
Trout Creek @ mouth	9.69	6	6.4
Trout Creek bl Shertz Creek	3.7	4	
Sand Creek (PO) @ slough	37.3	11	12.5
Sand Creek ab Little Sand	23.5	9	
Sand Creek @ Bronx	14.8	7	6.4
Sand Creek bl Jack Creek	3.6	4	5.1
Trestle Creek @ mouth	19	8	9.4
Trestle Creek bl 2nd trib @ 2770ft	11.9	7	9.6
Trestle Creek ab trib @ 3040ft	5.27	5	6.8
Granite Creek @ mouth	26.6	9	12.1, 8.2
Granite Creek ab Dry/Toms Gulch	8.85	6	8.7
Granite Creek ab Packsaddle Cr.	4.65	5	
Cedar Creek @ mouth	7.46	6	4.2
Cedar Creek ab Canyon Creek	3.04	4	
Gold Creek (PO) @ mouth	21.8	9	7.7, 8.2
Gold Creek ab Kick Bush/Cheer Cr.	17.7	8	8.3
Gold Creek ab W. Gold Cr.	10.4	7	7.7
Gold Creek ab Chloride Gulch	4.74	5	
1st Tributary to Gold Creek @ mouth	0.46	2	
2nd Tributary to Gold Creek @ mouth	0.38	2	
3rd Tributary to Gold Creek @ mouth	1.12	3	
Chloride Gulch @ mouth	4.25	5	
Chloride Gulch ab 1st Tributary	1.46	3	
1st Tributary to Chloride Gulch @ mouth	0.29	2	
2nd Tributary to Chloride Gulch @ mouth	0.83	2	
3rd Tributary to Chloride Gulch @ mouth	0.64	2	
West Gold Creek @ mouth	6.94	6	3.5, 6.5, 5.6, 4.8
West Gold Creek ab 1st Tributary	1.34	3	
1st Tributary to West Gold @ mouth	0.49	2	
2nd Tributary to West Gold @ mouth	0.52	2	
3rd Tributary to West Gold @ mouth	0.71	2	
4th Tributary to West Gold @ mouth	0.83	2	
Kick Bush Creek @ mouth	3.4	4	
Kick Bush Creek ab Cheer Cr.	2.1	3	
Cheer Creek @ mouth	0.76	2	1.9
Upper Cocolalla Creek ab Lake	44.5	12	5.7, 5
Upper Cocolalla Creek @ Careywood	26.7	9	
Upper Cocolalla Creek ab Micro Cr.	3.93	4	3.6
Lower Cocolalla Creek bl Lake	68	14	7.6
Lower Cocolalla Creek ab slough	81.3	15	
Fish Creek @ mouth	9.55	6	7.2
Fish Creek bl fork	8.1	6	
Hoodoo Creek @ mouth	84.3	15	
Hoodoo Creek ab Hoodoo Lake	24	9	9.9
Hoodoo Creek ab 1st lake	3.9	4	

Figure 1. Bankfull Width as a Function of Drainage Area



Design Conditions

Streams examined in this document are scattered throughout a variety of habitats in the Northern Rockies Level III Ecoregion of McGrath et al., 2001. The upper Pack River region is primarily in the Selkirk Mountains Level IV Ecoregion with the highest peaks of mountains extending into the High Northern Rockies Ecoregion (also Level IV). The Selkirk Mountains Ecoregion is a mixed coniferous forest consisting of both Pacific species (grand fir, western redcedar, western hemlock) and Rocky Mountain species (western larch, western white pine, lodgepole pine). The boreal influence is strong in this Ecoregion resulting in subalpine fir-spruce forests extending down to lower elevations. The highest peaks in the High Northern Rockies Ecoregion are characterized by tundra, alpine grasslands, meadows, and scattered forests and krummholz stands of subalpine fir, lodgepole pine, whitebark pine, and alpine larch.

The lower Pack River as well as low elevation streams (Sand Creek, Cocolalla Creek, Hoodoo Creek) are found in the Inland Maritime Foothills and Valleys Level IV Ecoregion (McGrath et al., 2001). Forests typically include western hemlock, western redcedar, grand fir, Douglas fir, ponderosa pine, lodgepole pine, and western larch. Birch, aspen and more deciduous vegetation in general are more prominent on floodplains at these lower elevations.

Tributaries to the lower Pack River (Grouse Creek, North Gold Creek, Rapid Lightning Creek) and Trestle Creek extend up into the Percell-Cabinet-North Bitterroot Mountains Level IV Ecoregion (McGrath et al., 2001). Again, cedar-hemlock-pine forests are common with western spruce-fir forests at higher elevations and birch-aspen hardwoods on wider floodplains.

Granite Creek and 'south' Gold Creek on the lower east and south sides of Pend Oreille Lake are in the Coeur d'Alene Metasedimentary Zone Level IV Ecoregion (McGrath et al., 2001), which contains forests of Douglas fir, grand fir, western redcedar, and western hemlock with mountain hemlock, subalpine fir, Engelmann spruce, and whitebark pine at higher elevations.

The Panhandle National Forest has grouped this wide variety of forests into habitat types which form the basis for eleven vegetation response units (VRUs) that are further explained in Appendix X of this document. These VRUs were used as the basis for developing shade curves used to set target shade levels for the various streams examined. Most streams examined occur in the moderately warm and moderately cool/moist (Group B) assemblage of forests, which include VRUs 4, 5, and 6. Some streams (i.e. the headwaters of the Pack River, Grouse Creek and Trestle Creek) extend into Group C, the cool/wet to moist forests of VRUs 7 and 8, and Group D, cool/moderately dry and cold forests of VRUs 9, 10 and 11. In addition to these forest groups, Appendix X shows shade curves developed for two lower elevation hardwood-conifer mix forests that occur at lower elevation, wider floodplains. The labels for these groups, although identified as Nonforest Group 1 and 2, are perhaps a misnomer because they are a mix of both coniferous and hardwood species and have a substantial tree component.

Target Selection

To determine potential natural vegetation shade targets for the Pend Oreille Lake tributaries, effective shade curves developed for the Panhandle region of Idaho based on VRUs (see Appendix X) were examined. 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. Appendix X provides an explanation of how shade curves were developed for the Panhandle region of Idaho.

Shade Curves

The use of the various shade curves provided in Appendix X is based on an aquatic response unit (ARU) filter (see Table X-3). If the stream order is between 1st and 4th and the gradient is $\geq 3\%$, then one of the Forest Group shade curves is used for that section of stream. The decision on which Forest Group shade curve to use for a particular section of stream depends on the predominant VRUs surrounding the stream in that section. Forest Groups encountered in this analysis include B (Table 2), C (Table 3) and D (Table 4), with Forest Group B predominant. Forest Group A did not occur on any streams in this analysis. Target values in tables result from the averaging of three flow direction-based shade curves, one for each cardinal direction (N-S and E-W) and one for the 45 degree angle (see Appendix X).

Table 2. Shade Targets for Forest Group B Vegetation Type at Various Stream Widths

Forest	1m	2m	3m	4m	5m	6m	7m	8m	9m
Group B - VRUs 4,5,6 0/180	98	97	95	93	90	87	83	78	74
45/135/225/315	98	98	96	93	90	87	82	78	73
90/270	98	98	97	96	94	92	85	78	71
Target (%)	98	98	96	94	91	89	83	78	73

Forest	10m	11m	12m	13m	14m	15m	20m	24m	25m
Group B - VRUs 4,5,6 0/180	70	67	64	61	58	56	46	40	39
45/135/225/315	70	66	63	60	57	54	43	37	36
90/270	65	60	55	51	48	45	35	30	29
Target (%)	68	64	61	57	54	52	41	36	35

Table 3. Shade Targets for Forest Group C Vegetation Type at Various Stream Widths

Forest	1m	2m	3m	4m	5m	6m	7m	8m	9m
Group C - VRUs 7, 8 0/180	98	97	94	91	88	84	79	74	70
45/135/225/315	98	97	95	91	88	84	78	74	69
90/270	98	98	96	95	93	87	79	72	65
Target (%)	98	97	95	92	90	85	79	73	68

Table 4. Shade Targets for Forest Group D Vegetation Type at Various Stream Widths

Forest	1m	2m	3m	4m	5m	6m	7m	8m	9m
Group D - VRUs 9, 10/11 0/180	98	96	92	88	84	79	74	69	65
45/135/225/315	98	96	93	89	85	79	74	69	64
90/270	98	97	96	93	88	80	72	64	58
Target (%)	98	96	94	90	86	79	73	67	62

If stream orders are between 1st and 4th, but the gradient is $< 3\%$, then the stream falls into the Nonforest Group 1 category from the ARU filter (Appendix X, Table X-3). Shade curves developed for this group includes a variety of coniferous and deciduous vegetation (see Table

X-7). Because this is the most common nonforest group used in the analysis, a large number of stream width/target combinations were needed (Table 5).

Table 5. Shade Targets for Nonforest Group 1 Vegetation Type at Various Stream Widths

Non-Forest	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m
Group 1 – hardwoods 01/180		93		75		61		53		47	
45/135/225/315		93		77		64		55		49	
90/270		95		82		69		57		47	
Target (%)	97	94	86	78	72	65	60	55	52	48	45

Non-Forest	12m	13m	14m	15m	16m	17m	18m	19m	20m	21m	22m	45m	60m
Group 1 – hardwoods 01/180	42		38		35		32		30		28		
45/135/225/315	43		39		35		32		30		27		
90/270	39		34		30		27		25		23		
Target (%)	41	39	37	35	33	32	30	29	28	27	26	14	10

When stream orders increase to the 5th and 6th level, streams and their associated floodplains become wider and a second group of nonforest vegetation is needed for describing shade targets. The lower portions of the Pack River and Rapid Lightning Creek fall into this category and Nonforest Group 2 shade targets (Table 6) are applied. Again, vegetation used to develop shade curves for the Nonforest Group 2 includes a variety of coniferous and deciduous species (see Table X-8).

Table 6. Shade Targets for Forest Group B Vegetation Type at Various Stream Widths

Non-Forest	10m	11m	12m	24m
Group 2 - Hardwoods 0/180	41		37	23
45/135/225/315	43		39	23
90/270	44		37	20
Target (%)	43	41	38	22

Monitoring Points

The accuracy of the aerial photo interpretations were field verified with a solar pathfinder at several locations throughout the subbasin (see Figures 3, 6, 9, & 12). Effective shade monitoring can take place on any reach throughout the Pend Oreille Lake subbasin and compared to estimates of existing shade seen on Figures 3, 6, 9, & 12 and described in Tables 7 through 57. 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.

5.2 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 plate collector (under full sun) for a given period of time by the fraction of the solar radiation that is not blocked by shade (i.e. the percent open or 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 near by. In this case, average data from the two stations, Spokane, WA and Kalispell, MT, 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 and when deciduous vegetation is in leaf. Tables 7 through 57 show the PNV shade targets (identified as Target or Potential Shade) and their corresponding potential summer load (in kWh/m²/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).

5.3 Estimates of Existing Pollutant Loads

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading," (Water quality planning and management, 40 CFR § 130.2(I)). An estimate must be made for each point source. Nonpoint sources are typically estimated based on the type of sources (land use) and area (such as a subwatershed), but may be aggregated by type of source or 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 Tables 7 through 57. Like loading capacities (potential loads), existing loads in Tables 7 through 57 are presented on an area basis (kWh/m²/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. The percent reduction shown in the lower right corner of each table represents how much total excess load there is in relation to total existing load.

Table 7. Existing and Potential Solar Loads for the Pack 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)	Pack River Shade Curves
340	0.6	2.2	0.98	0.11	-2.09	1	1	340	748	340	37.4	-710.6	forest group D
1180	0.7	1.65	0.98	0.11	-1.54	2	1	2360	3894	1180	129.8	-3764.2	forest group C
1370	0.4	3.3	0.97	0.165	-3.135	4	2	5480	18084	2740	452.1	-17631.9	
160	0	5.5	0.97	0.165	-5.335	5	2	800	4400	320	52.8	-4347.2	
170	0.6	2.2	0.95	0.275	-1.925	5	3	850	1870	510	140.25	-1729.75	
250	0.4	3.3	0.95	0.275	-3.025	5	3	1250	4125	750	206.25	-3918.75	
250	0.5	2.75	0.96	0.22	-2.53	5	3	1250	3437.5	750	165	-3272.5	forest group B
250	0.6	2.2	0.96	0.22	-1.98	6	3	1500	3300	750	165	-3135	
110	0.4	3.3	0.96	0.22	-3.08	6	3	660	2178	330	72.6	-2105.4	
80	0.6	2.2	0.96	0.22	-1.98	6	3	480	1056	240	52.8	-1003.2	
760	0.4	3.3	0.96	0.22	-3.08	7	3	5320	17556	2280	501.6	-17054.4	
700	0.5	2.75	0.94	0.33	-2.42	8	4	5600	15400	2800	924	-14476	
250	0.4	3.3	0.94	0.33	-2.97	9	4	2250	7425	1000	330	-7095	
380	0.5	2.75	0.94	0.33	-2.42	9	4	3420	9405	1520	501.6	-8903.4	
190	0.4	3.3	0.94	0.33	-2.97	9	4	1710	5643	760	250.8	-5392.2	
610	0.6	2.2	0.91	0.495	-1.705	10	5	6100	13420	3050	1509.75	-11910.25	
310	0.3	3.85	0.91	0.495	-3.355	10	5	3100	11935	1550	767.25	-11167.75	
110	0.1	4.95	0.91	0.495	-4.455	11	5	1210	5989.5	550	272.25	-5717.25	
380	0.5	2.75	0.91	0.495	-2.255	11	5	4180	11495	1900	940.5	-10554.5	
320	0.2	4.4	0.89	0.605	-3.795	11	6	3520	15488	1920	1161.6	-14326.4	
130	0	5.5	0.89	0.605	-4.895	12	6	1560	8580	780	471.9	-8108.1	
140	0.1	4.95	0.89	0.605	-4.345	12	6	1680	8316	840	508.2	-7807.8	
300	0.3	3.85	0.89	0.605	-3.245	12	6	3600	13860	1800	1089	-12771	
170	0.1	4.95	0.89	0.605	-4.345	12	6	2040	10098	1020	617.1	-9480.9	
1990	0	5.5	0.83	0.935	-4.565	14	7	27860	153230	13930	13024.55	-140205.45	
590	0.1	4.95	0.78	1.21	-3.74	18	8	10620	52569	4720	5711.2	-46857.8	
3350	0	5.5	0.73	1.485	-4.015	21	9	70350	386925	30150	44772.75	-342152.25	
1030	0.1	4.95	0.68	1.76	-3.19	22	10	22660	112167	10300	18128	-94039	
220	0	5.5	0.68	1.76	-3.74	22	10	4840	26620	2200	3872	-22748	
1300	0.1	4.95	0.64	1.98	-2.97	22	11	28600	141570	14300	28314	-113256	
130	0.2	4.4	0.64	1.98	-2.42	22	11	2860	12584	1430	2831.4	-9752.6	
1680	0	5.5	0.64	1.98	-3.52	23	11	38640	212520	18480	36590.4	-175929.6	
1610	0.1	4.95	0.41	3.245	-1.705	23	12	37030	183298.5	19320	62693.4	-120605.1	nonforest 1
900	0	5.5	0.39	3.355	-2.145	24	13	21600	118800	11700	39253.5	-79546.5	
390	0.1	4.95	0.39	3.355	-1.595	25	13	9750	48262.5	5070	17009.85	-31252.65	
230	0	5.5	0.39	3.355	-2.145	26	13	5980	32890	2990	10031.45	-22858.55	
620	0.1	4.95	0.37	3.465	-1.485	27	14	16740	82863	8680	30076.2	-52786.8	
1180	0	5.5	0.37	3.465	-2.035	29	14	34220	188210	16520	57241.8	-130968.2	
17090	0	5.5	0.32	3.74	-1.76	32	17	546880	3007840	290530	1086582.2	-1921257.8	
2340	0	5.5	0.28	3.96	-1.54	36	20	84240	463320	46800	185328	-277992	
240	0.1	4.95	0.28	3.96	-0.99	36	20	8640	42768	4800	19008	-23760	
4200	0	5.5	0.27	4.015	-1.485	37	21	155400	854700	88200	354123	-500577	
23370	0	5.5	0.22	4.29	-1.21	37	24	864690	4755795	560880	2406175.2	-2349619.8	nonforest 2
						Total		2,051,860	11,074,635	1,180,680	4,432,086	-6,642,549	-60 % Reduction

Table 8. Existing and Potential Solar Loads for 1st West-side Pack River Tributary.

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)	1st West-side Pack Tributary Shade Curves
310	0.5	2.75	0.98	0.11	-2.64	1	1	310	852.5	310	34.1	-818.4	Forest Group D
150	0.1	4.95	0.98	0.11	-4.84	1	1	150	742.5	150	16.5	-726	Forest Group C
390	0.7	1.65	0.97	0.165	-1.485	2	2	780	1287	780	128.7	-1158.3	
110	0.1	4.95	0.97	0.165	-4.785	2	2	220	1089	220	36.3	-1052.7	
180	0.7	1.65	0.95	0.275	-1.375	3	3	540	891	540	148.5	-742.5	
350	0.5	2.75	0.95	0.275	-2.475	3	3	1050	2887.5	1050	288.75	-2598.75	
						Total		3,050	7,750	3,050	653	-7,097	-92 % Reduction

Table 9. Existing and Potential Solar Loads for Beehive 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)	Beehive Creek Shade Curves
440	0.8	1.1	0.98	0.11	-0.99	1	1	440	484	440	48.4	-435.6	Forest Group C
110	0	5.5	0	5.5	0	50	50	5500	30250	5500	30250	0	water
370	0.8	1.1	0.98	0.11	-0.99	1	1	370	407	370	40.7	-366.3	Forest Group C
590	0.4	3.3	0.98	0.11	-3.19	2	2	1180	3894	1180	129.8	-3764.2	Forest Group B
150	0.7	1.65	0.98	0.11	-1.54	2	2	300	495	300	33	-462	Forest Group B
290	0.8	1.1	0.98	0.11	-0.99	2	2	580	638	580	63.8	-574.2	Forest Group B
50	0.4	3.3	0.98	0.11	-3.19	2	2	100	330	100	11	-319	Forest Group B
						Total		8,470	36,498	8,470	30,577	-5,921	-16 % Reduction

Table 10. Existing and Potential Solar Loads for Slide 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)	Slide Creek Shade Curves
230	0.4	3.3	0.98	0.11	-3.19	1	1	230	759	230	25.3	-733.7	Nonforest Group 1
330	0.8	1.1	0.98	0.11	-0.99	1	1	330	363	330	36.3	-326.7	Forest Group C
800	0.7	1.65	0.97	0.165	-1.485	2	2	1600	2640	1600	264	-2376	
560	0.8	1.1	0.96	0.22	-0.88	3	3	1680	1848	1680	369.6	-1478.4	Forest Group B
850	0.7	1.65	0.96	0.22	-1.43	3	3	2550	4207.5	2550	561	-3646.5	
						Total		6,390	9,818	6,390	1,256	-8,561	-87 % Reduction

Table 11. Existing and Potential Solar Loads for Thor 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)	Thor Creek Shade Curves
930	0.8	1.1	0.98	0.11	-0.99	1	1	930	1023	930	102.3	-920.7	Forest Group C
630	0.7	1.65	0.98	0.11	-1.54	1	1	630	1039.5	630	69.3	-970.2	
140	0.6	2.2	0.97	0.165	-2.035	2	2	280	616	280	46.2	-569.8	
290	0.4	3.3	0.98	0.11	-3.19	2	2	580	1914	580	63.8	-1850.2	Forest Group B
490	0.3	3.85	0.98	0.11	-3.74	2	2	980	3773	980	107.8	-3665.2	
320	0.5	2.75	0.96	0.22	-2.53	3	3	960	2640	960	211.2	-2428.8	
110	0.3	3.85	0.96	0.22	-3.63	3	3	330	1270.5	330	72.6	-1197.9	
630	0.7	1.65	0.96	0.22	-1.43	3	3	1890	3118.5	1890	415.8	-2702.7	
						Total		6,580	15,395	6,580	1,089	-14,306	-93 % Reduction

Table 12. Existing and Potential Solar Loads for Zuni 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)	Zuni Creek Shade Curves
1140	0.7	1.65	0.98	0.11	-1.54	1	1	1140	1881	1140	125.4	-1755.6	Forest Group B
2120	0.7	1.65	0.98	0.11	-1.54	2	2	4240	6996	4240	466.4	-6529.6	
750	0.6	2.2	0.96	0.22	-1.98	3	3	2250	4950	2250	495	-4455	
						Total		7,630	13,827	7,630	1,087	-12,740	-92 % Reduction

Table 13. Existing and Potential Solar Loads for West Branch 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)	West Branch Creek Shade Curves
720	0.9	0.55	0.97	0.165	-0.39	2	2	1440	792	1440	237.6	-554.4	Forest Group C
800	0.9	0.55	0.98	0.11	-0.44	1	1	800	440	800	88	-352	Forest Group D
410	0.8	1.1	0.96	0.22	-0.88	2	2	820	902	820	180.4	-721.6	Forest Group B
680	0.6	2.2	0.96	0.22	-1.98	3	3	2040	4488	2040	448.8	-4039.2	
1650	0.7	1.65	0.96	0.22	-1.43	2	2	3300	5445	3300	726	-4719	Forest Group D
180	0.5	2.75	0.98	0.11	-2.64	2	2	360	990	360	39.6	-950.4	Forest Group B
100	0.7	1.65	0.98	0.11	-1.54	2	2	200	330	200	22	-308	
1290	0.9	0.55	0.98	0.11	-0.44	1	1	1290	709.5	1290	141.9	-567.6	
720	0.8	1.1	0.98	0.11	-0.99	2	2	1440	1584	1440	158.4	-1425.6	
410	0.6	2.2	0.98	0.11	-2.09	2	2	820	1804	820	90.2	-1713.8	
410	0.8	1.1	0.96	0.22	-0.88	3	3	1230	1353	1230	270.6	-1082.4	
510	0.5	2.75	0.96	0.22	-2.53	3	3	1530	4207.5	1530	336.6	-3870.9	
310	0.4	3.3	0.94	0.33	-2.97	4	4	1240	4092	1240	409.2	-3682.8	
430	0.5	2.75	0.94	0.33	-2.42	4	4	1720	4730	1720	567.6	-4162.4	
460	0.6	2.2	0.91	0.495	-1.705	5	5	2300	5060	2300	1138.5	-3921.5	
770	0.2	4.4	0.91	0.495	-3.905	5	5	3850	16940	3850	1905.75	-15034.25	
						Total		24,380	53,867	24,380	6,761	-47,106	-87 % Reduction

Table 14. Existing and Potential Solar Loads for 1st West-side Pack River Tributary Below West Branch.

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)	1st West-side Pack Trib bl W.Branch
2130	0.7	1.65	0.98	0.11	-1.54	1	1	2130	3514.5	2130	234.3	-3280.2	Forest Group C
340	0.8	1.1	0.98	0.11	-0.99	2	2	680	748	680	74.8	-673.2	Forest Group B
								Total	2,810	4,263	2,810	309	-93
													% Reduction

Table 15. Existing and Potential Solar Loads for 1st East-side Pack River Tributary Below West Branch.

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)	1st East-side Pack Trib bl W.Branch
1020	0.7	1.65	0.98	0.11	-1.54	1	1	1020	1683	1020	112.2	-1570.8	Forest Group D
1140	0.8	1.1	0.98	0.11	-0.99	2	2	2280	2508	2280	250.8	-2257.2	Forest Group B
830	0.9	0.55	0.98	0.11	-0.44	2	2	1660	913	1660	182.6	-730.4	
320	0.7	1.65	0.98	0.11	-1.54	2	2	640	1056	640	70.4	-985.6	
								Total	5,600	6,160	5,600	616	-90
													% Reduction

Table 16. Existing and Potential Solar Loads for 2nd East-side Pack River Tributary Below West Branch.

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)	2nd East-side Pack Trib bl W.Branch
2180	0.7	1.65	0.96	0.22	-1.43	2	2	4360	7194	4360	959.2	-6234.8	Forest Group D
920	0.8	1.1	0.96	0.22	-0.88	3	3	2760	3036	2760	607.2	-2428.8	Forest Group B
								Total	7,120	10,230	7,120	1,566	-85
													% Reduction

Table 17. Existing and Potential Solar Loads for McCormick 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)	McCormick Creek
1430	0.4	3.3	0.98	0.11	-3.19	1	1	1430	4719	1430	157.3	-4561.7	forest group B
910	0.5	2.75	0.98	0.11	-2.64	3	2	2730	7507.5	1820	200.2	-7307.3	
370	0.4	3.3	0.98	0.11	-3.19	4	2	1480	4884	740	81.4	-4802.6	
640	0.2	4.4	0.96	0.22	-4.18	5	3	3200	14080	1920	422.4	-13657.6	
140	0	5.5	0.96	0.22	-5.28	6	3	840	4620	420	92.4	-4527.6	
150	0.2	4.4	0.96	0.22	-4.18	6	3	900	3960	450	99	-3861	
190	0.1	4.95	0.96	0.22	-4.73	6	3	1140	5643	570	125.4	-5517.6	
2800	0	5.5	0.91	0.495	-5.005	10	5	28000	154000	14000	6930	-147070	
								Total	39,720	199,414	21,350	8,108	-96
													% Reduction

Table 18. Existing and Potential Solar Loads for 1st Tributary to McCormick 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)	1st Trib to McCormick Creek
970	0.6	2.2	0.98	0.11	-2.09	1	2	970	2134	1940	213.4	-1920.6	Forest Group B
390	0.2	4.4	0.98	0.11	-4.29	3	1	1170	5148	390	42.9	-5105.1	Nonforest Group 1
440	0.5	2.75	0.96	0.22	-2.53	4	2	1760	4840	880	193.6	-4646.4	Forest Group D
370	0.7	1.65	0.98	0.11	-1.54	5	2	1850	3052.5	740	81.4	-2971.1	Forest Group B
440	0.6	2.2	0.96	0.22	-1.98	6	3	2640	5808	1320	290.4	-5517.6	
360	0.4	3.3	0.96	0.22	-3.08	6	3	2160	7128	1080	237.6	-6890.4	
470	0.6	2.2	0.96	0.22	-1.98	6	3	2820	6204	1410	310.2	-5893.8	
						Total		13,370	34,315	7,760	1,370	-32,945	-96 % Reduction

Table 19. Existing and Potential Solar Loads for 2nd Tributary to McCormick 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)	2nd trib to McCormick Creek
600	0.7	1.65	0.98	0.11	-1.54	1	1	600	990	600	66	-924	Forest Group D
320	0.8	1.1	0.98	0.11	-0.99	1	1	320	352	320	35.2	-316.8	
800	0.7	1.65	0.98	0.11	-1.54	2	2	1600	2640	1600	176	-2464	Forest Group B
190	0.6	2.2	0.98	0.11	-2.09	2	2	380	836	380	41.8	-794.2	
300	0.3	3.85	0.98	0.11	-3.74	2	2	600	2310	600	66	-2244	
200	0.7	1.65	0.98	0.11	-1.54	2	2	400	660	400	44	-616	
						Total		3,900	7,788	3,900	429	-7,359	-94 % Reduction

Table 20. Existing and Potential Solar Loads for Gunsight Creek, Tributary to McCormick 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)	Gunsight Creek
1040	0.8	1.1	0.98	0.11	-0.99	1	1	1040	1144	1040	114.4	-1029.6	Forest Group D
960	0.7	1.65	0.96	0.22	-1.43	2	2	1920	3168	1920	422.4	-2745.6	
290	0.4	3.3	0.96	0.22	-3.08	3	3	870	2871	870	191.4	-2679.6	Forest Group B
730	0.1	4.95	0.96	0.22	-4.73	3	3	2190	10840.5	2190	481.8	-10358.7	
						Total		6,020	18,024	6,020	1,210	-16,814	-93 % Reduction

Table 21. Existing and Potential Solar Loads for 4th Tributary to McCormick 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)	4th Trib to McCormick Creek
1890	0.7	1.65	0.98	0.11	-1.54	1	1	1890	3118.5	1890	207.9	-2910.6	Forest Group D
						Total		1,890	3,119	1,890	208	-2,911	-93 % Reduction

Table 22. Existing and Potential Solar Loads for 1st East-side Pack River Tributary Below McCormick 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)	1st East-side Pack Trib bl McCormick
1540	0.7	1.65	0.98	0.11	-1.54	1	1	1540	2541	1540	169.4	-2371.6	Forest Group B
890	0.8	1.1	0.98	0.11	-0.99	2	2	1780	1958	1780	195.8	-1762.2	
						Total		3,320	4,499	3,320	365	-4,134	-92 % Reduction

Table 23. Existing and Potential Solar Loads for Torrent 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)	Torrent Creek Shade Curves
340	0.8	1.1	0.98	0.11	-0.99	1	1	340	374	340	37.4	-336.6	Forest Group B
1890	0.6	2.2	0.98	0.11	-2.09	2	2	3780	8316	3780	415.8	-7900.2	
						Total		4,120	8,690	4,120	453	-8,237	-95 % Reduction

Table 24. Existing and Potential Solar Loads for Zee 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)	Zee Creek Shade Curves
720	0.9	0.55	0.98	0.11	-0.44	1	1	720	396	720	79.2	-316.8	Forest Group B
1260	0.8	1.1	0.98	0.11	-0.99	2	2	2520	2772	2520	277.2	-2494.8	
						Total		3,240	3,168	3,240	356	-2,812	-89 % Reduction

Table 25. Existing and Potential Solar Loads for Youngs 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)	Youngs Creek Shade Curves
910	0.7	1.65	0.98	0.11	-1.54	1	1	910	1501.5	910	100.1	-1401.4	Forest Group C
1220	0.8	1.1	0.98	0.11	-0.99	2	2	2440	2684	2440	268.4	-2415.6	Forest Group B
1660	0.7	1.65	0.96	0.22	-1.43	3	3	4980	8217	4980	1095.6	-7121.4	
						Total		8,330	12,403	8,330	1,464	-10,938	-88 % Reduction

Table 26. Existing and Potential Solar Loads for Homestead 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)	Homestead Creek Shade Curves
840	0.7	1.65	0.98	0.11	-1.54	1	1	840	1386	840	92.4	-1293.6	Forest Group C
1090	0.8	1.1	0.98	0.11	-0.99	2	2	2180	2398	2180	239.8	-2158.2	Forest Group B
780	0.7	1.65	0.98	0.11	-1.54	1	1	780	1287	780	85.8	-1201.2	
250	0.8	1.1	0.98	0.11	-0.99	2	1	500	550	250	27.5	-522.5	
510	0.6	2.2	0.98	0.11	-2.09	4	2	2040	4488	1020	112.2	-4375.8	
1080	0.4	3.3	0.96	0.22	-3.08	7	3	7560	24948	3240	712.8	-24235.2	
1070	0.3	3.85	0.94	0.33	-3.52	7	4	7490	28836.5	4280	1412.4	-27424.1	
210	0.7	1.65	0.94	0.33	-1.32	7	4	1470	2425.5	840	277.2	-2148.3	
							Total	22,860	66,319	13,430	2,960	-63,359	-96
													% Reduction

Table 27. Existing and Potential Solar Loads for 1st East-side Pack River Tributary Below Homestead 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)	1st East-side Pack Trib bl Homestead
1990	0.9	0.55	0.98	0.11	-0.44	2	2	3980	2189	3980	437.8	-1751.2	Forest Group B
							Total	3,980	2,189	3,980	438	-1,751	-80
												% Reduction	

Table 28. Existing and Potential Solar Loads for 1st West-side Pack River Tributary Below Homestead 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)	1st West-side Pack Trib bl Homestead
600	0.8	1.1	0.98	0.11	-0.99	1	1	600	660	600	66	-594	Forest Group B
2110	0.6	2.2	0.98	0.11	-2.09	2	2	4220	9284	4220	464.2	-8819.8	
							Total	4,820	9,944	4,820	530	-9,414	-95
													% Reduction

Table 29. Existing and Potential Solar Loads for 2nd East-side Pack River Tributary Below Homestead 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)	2nd East-side Pack Trib bl Homestead
1340	0.9	0.55	0.98	0.11	-0.44	1	1	1340	737	1340	147.4	-589.6	Forest Group B
390	0.7	1.65	0.98	0.11	-1.54	1	1	390	643.5	390	42.9	-600.6	
130	0.6	2.2	0.98	0.11	-2.09	1	1	130	286	130	14.3	-271.7	
							Total	1,860	1,667	1,860	205	-1,462	
													-88 % Reduction

Table 30. Existing and Potential Solar Loads for Jeru 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)	Jeru Creek Shade Curves
750	0.3	3.85	0.98	0.11	-3.74	1	1	750	2887.5	750	82.5	-2805	forest group B
530	0.5	2.75	0.98	0.11	-2.64	2	2	1060	2915	1060	116.6	-2798.4	
1040	0.7	1.65	0.96	0.22	-1.43	3	3	3120	5148	3120	686.4	-4461.6	
920	0.8	1.1	0.94	0.33	-0.77	4	4	3680	4048	3680	1214.4	-2833.6	
200	0.7	1.65	0.94	0.33	-1.32	5	4	1000	1650	800	264	-1386	
850	0.8	1.1	0.91	0.495	-0.605	6	5	5100	5610	4250	2103.75	-3506.25	
650	0.7	1.65	0.91	0.495	-1.155	7	5	4550	7507.5	3250	1608.75	-5898.75	
							Total	19,260	29,766	16,910	6,076	-23,690	-80
													% Reduction

Table 31. Existing and Potential Solar Loads for the Forked Tributaries to Jeru 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)	Forked Trib to Jeru Creek
110	0.1	4.95	0.98	0.11	-4.84	1	1	110	544.5	110	12.1	-532.4	forest group B
1240	0.7	1.65	0.98	0.11	-1.54	2	2	2480	4092	2480	272.8	-3819.2	
380	0.5	2.75	0.96	0.22	-2.53	3	3	1140	3135	1140	250.8	-2884.2	
580	0.6	2.2	0.96	0.22	-1.98	3	3	1740	3828	1740	382.8	-3445.2	
640	0.6	2.2	0.98	0.11	-2.09	1	1	640	1408	640	70.4	-1337.6	
890	0.7	1.65	0.98	0.11	-1.54	2	2	1780	2937	1780	195.8	-2741.2	
480	0.6	2.2	0.96	0.22	-1.98	3	3	1440	3168	1440	316.8	-2851.2	
720	0.5	2.75	0.94	0.33	-2.42	4	4	2880	7920	2880	950.4	-6969.6	
140	0.7	1.65	0.94	0.33	-1.32	4	4	560	924	560	184.8	-739.2	
							Total	12,770	27,957	12,770	2,637	-25,320	-91
													% Reduction

Table 32. Existing and Potential Solar Loads for Pearson 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)	Pearson Creek Shade Curves
460	0.9	0.55	0.98	0.11	-0.44	1	1	460	253	460	50.6	-202.4	Forest Group B
340	0.8	1.1	0.98	0.11	-0.99	1	1	340	374	340	37.4	-336.6	
190	0.4	3.3	0.98	0.11	-3.19	1	1	190	627	190	20.9	-606.1	Nonforest Group 1
70	0.1	4.95	0.98	0.11	-4.84	1	1	70	346.5	70	7.7	-338.8	Forest Group B
470	0.6	2.2	0.98	0.11	-2.09	2	2	940	2068	940	103.4	-1964.6	
100	0.1	4.95	0.98	0.11	-4.84	2	2	200	990	200	22	-968	
300	0.7	1.65	0.98	0.11	-1.54	2	2	600	990	600	66	-924	
650	0.6	2.2	0.98	0.11	-2.09	2	2	1300	2860	1300	143	-2717	
750	0.8	1.1	0.96	0.22	-0.88	3	3	2250	2475	2250	495	-1980	
1920	0.9	0.55	0.94	0.33	-0.22	4	4	7680	4224	7680	2534.4	-1689.6	
							Total	14,030	15,208	14,030	3,480	-11,727	-77
													% Reduction

Table 33. Existing and Potential Solar Loads for Martin 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)	Martin Creek Shade Curves
2020	0.9	0.55	0.98	0.11	-0.44	2	2	4040	2222	4040	444.4	-1777.6	Forest Group B
2270	0.9	0.55	0.98	0.11	-0.44	2	2	4540	2497	4540	499.4	-1997.6	
1030	0.9	0.55	0.96	0.22	-0.33	4	3	4120	2266	3090	679.8	-1586.2	
300	0.8	1.1	0.94	0.33	-0.77	5	4	1500	1650	1200	396	-1254	
						Total		14,200	8,635	12,870	2,020	-6,615	-77 % Reduction

Table 34. Existing and Potential Solar Loads for Blane 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)	Blane Creek Shade Curves
990	0.9	0.55	0.98	0.11	-0.44	1	1	990	544.5	990	108.9	-435.6	Forest Group B
790	0.8	1.1	0.98	0.11	-0.99	2	2	1580	1738	1580	173.8	-1564.2	
1890	0.9	0.55	0.98	0.11	-0.44	1	1	1890	1039.5	1890	207.9	-831.6	
490	0.8	1.1	0.98	0.11	-0.99	2	2	980	1078	980	107.8	-970.2	
600	0.8	1.1	0.96	0.22	-0.88	3	3	1800	1980	1800	396	-1584	
110	0.7	1.65	0.96	0.22	-1.43	3	3	330	544.5	330	72.6	-471.9	
						Total		7,570	6,925	7,570	1,067	-5,858	-85 % Reduction

Table 35. Existing and Potential Solar Loads for Lindsey 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)	Lindsey Creek Shade Curves
290	0.8	1.1	0.98	0.11	-0.99	1	1	290	319	290	31.9	-287.1	Forest Group B
1790	0.9	0.55	0.98	0.11	-0.44	2	2	3580	1969	3580	393.8	-1575.2	
620	0.7	1.65	0.98	0.11	-1.54	1	1	620	1023	620	68.2	-954.8	
660	0.8	1.1	0.98	0.11	-0.99	1	1	660	726	660	72.6	-653.4	
1140	0.9	0.55	0.98	0.11	-0.44	2	2	2280	1254	2280	250.8	-1003.2	
670	0.8	1.1	0.98	0.11	-0.99	2	2	1340	1474	1340	147.4	-1326.6	
1480	0.9	0.55	0.96	0.22	-0.33	3	3	4440	2442	4440	976.8	-1465.2	
520	0.8	1.1	0.78	1.21	0.11	4	4	2080	2288	2080	2516.8	228.8	Nonforest Group 1
1290	0.7	1.65	0.78	1.21	-0.44	4	4	5160	8514	5160	6243.6	-2270.4	
						Total		20,450	20,009	20,450	10,702	-9,307	-47 % Reduction

Table 36. Existing and Potential Solar Loads for Hellroaring 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)	Hellroaring Creek Shade Curves
270	0.5	2.75	0.96	0.22	-2.53	3	3	810	2227.5	810	178.2	-2049.3	Hellroaring Creek
590	0.6	2.2	0.96	0.22	-1.98	3	3	1770	3894	1770	389.4	-3504.6	
130	0.4	3.3	0.96	0.22	-3.08	3	3	390	1287	390	85.8	-1201.2	
690	0.7	1.65	0.96	0.22	-1.43	3	3	2070	3415.5	2070	455.4	-2960.1	
170	0.3	3.85	0.94	0.33	-3.52	4	4	680	2618	680	224.4	-2393.6	
350	0.5	2.75	0.94	0.33	-2.42	4	4	1400	3850	1400	462	-3388	
1240	0.6	2.2	0.94	0.33	-1.87	4	4	4960	10912	4960	1636.8	-9275.2	
120	0.5	2.75	0.91	0.495	-2.255	5	5	600	1650	600	297	-1353	
160	0.6	2.2	0.91	0.495	-1.705	5	5	800	1760	800	396	-1364	
250	0.5	2.75	0.91	0.495	-2.255	5	5	1250	3437.5	1250	618.75	-2818.75	
120	0.6	2.2	0.91	0.495	-1.705	5	5	600	1320	600	297	-1023	
160	0.7	1.65	0.91	0.495	-1.155	5	5	800	1320	800	396	-924	
240	0.5	2.75	0.91	0.495	-2.255	5	5	1200	3300	1200	594	-2706	
290	0.6	2.2	0.91	0.495	-1.705	5	5	1450	3190	1450	717.75	-2472.25	
570	0.5	2.75	0.91	0.495	-2.255	5	5	2850	7837.5	2850	1410.75	-6426.75	
1680	0.7	1.65	0.89	0.605	-1.045	6	6	10080	16632	10080	6098.4	-10533.6	
500	0.6	2.2	0.83	0.935	-1.265	7	7	3500	7700	3500	3272.5	-4427.5	
400	0.4	3.3	0.83	0.935	-2.365	7	7	2800	9240	2800	2618	-6622	
180	0.1	4.95	0.6	2.2	-2.75	7	7	1260	6237	1260	2772	-3465	Nonforest Group 1
150	0	5.5	0.6	2.2	-3.3	7	7	1050	5775	1050	2310	-3465	
80	0.1	4.95	0.6	2.2	-2.75	7	7	560	2772	560	1232	-1540	
200	0	5.5	0.6	2.2	-3.3	7	7	1400	7700	1400	3080	-4620	
						Total		42,280	108,075	42,280	29,542	-78,533	-73 % Reduction

Table 37. Existing and Potential Solar Loads for the Forked Tributaries to Hellroaring 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)	Upper and Lower Forks to Hellroaring
1780	0.7	1.65	0.98	0.11	-1.54	2	2	3560	5874	3560	391.6	-5482.4	Forest Group B
200	0.9	0.55	0.98	0.11	-0.44	1	1	200	110	200	22	-88	Forest Group C
800	0.7	1.65	0.98	0.11	-1.54	2	2	1600	2640	1600	176	-2464	Forest Group B
730	0.8	1.1	0.96	0.22	-0.88	3	3	2190	2409	2190	481.8	-1927.2	
170	0.7	1.65	0.96	0.22	-1.43	3	3	510	841.5	510	112.2	-729.3	
						Total		8,060	11,875	8,060	1,184	-10,691	-90 % Reduction

Table 38. Existing and Potential Solar Loads for 3rd Tributary to Hellroaring 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)	3rd Trib to Hellroaring Creek
1030	0.7	1.65	0.98	0.11	-1.54	1	1	1030	1699.5	1030	113.3	-1586.2	
1030	0.8	1.1	0.98	0.11	-0.99	2	2	2060	2266	2060	226.6	-2039.4	
430	0.9	0.55	0.96	0.22	-0.33	3	3	1290	709.5	1290	283.8	-425.7	
330	0.8	1.1	0.96	0.22	-0.88	3	3	990	1089	990	217.8	-871.2	
320	0.9	0.55	0.94	0.33	-0.22	4	4	1280	704	1280	422.4	-281.6	
						Total		6,650	6,468	6,650	1,264	-5,204	-80 % Reduction

Table 39. Existing and Potential Solar Loads for 4th Tributary to Hellroaring 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)	4th Trib to Hellroaring Creek
1090	0.8	1.1	0.98	0.11	-0.99	1	1	1090	1199	1090	119.9	-1079.1	
590	0.9	0.55	0.98	0.11	-0.44	2	2	1180	649	1180	129.8	-519.2	
160	0.7	1.65	0.96	0.22	-1.43	3	3	480	792	480	105.6	-686.4	
140	0.9	0.55	0.96	0.22	-0.33	3	3	420	231	420	92.4	-138.6	
						Total		3,170	2,871	3,170	448	-2,423	-84 % Reduction

Table 40. Existing and Potential Solar Loads for Grouse 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)	Grouse Creek Shade Curves
670	0.9	0.55	0.98	0.11	-0.44	1	1	670	368.5	670	73.7	-294.8	forest group D
150	0.8	1.1	0.98	0.11	-0.99	2	1	300	330	150	16.5	-313.5	
2590	0.9	0.55	0.98	0.11	-0.44	4	2	10360	5698	5180	569.8	-5128.2	forest group B
410	0.7	1.65	0.96	0.22	-1.43	7	3	2870	4735.5	1230	270.6	-4464.9	
3510	0.9	0.55	0.94	0.33	-0.22	11	4	38610	21235.5	14040	4633.2	-16602.3	
260	0.7	1.65	0.91	0.495	-1.155	12	5	3120	5148	1300	643.5	-4504.5	
350	0.8	1.1	0.91	0.495	-0.605	12	5	4200	4620	1750	866.25	-3753.75	
360	0.7	1.65	0.91	0.495	-1.155	13	5	4680	7722	1800	891	-6831	
270	0.8	1.1	0.91	0.495	-0.605	13	5	3510	3861	1350	668.25	-3192.75	
540	0.6	2.2	0.91	0.495	-1.705	14	5	7560	16632	2700	1336.5	-15295.5	
330	0.5	2.75	0.89	0.605	-2.145	15	6	4950	13612.5	1980	1197.9	-12414.6	
210	0.4	3.3	0.89	0.605	-2.695	15	6	3150	10395	1260	762.3	-9632.7	
510	0.5	2.75	0.89	0.605	-2.145	16	6	8160	22440	3060	1851.3	-20588.7	nonforest group 1
180	0.6	2.2	0.65	1.925	-0.275	17	6	3060	6732	1080	2079	-4653	
690	0.8	1.1	0.6	2.2	1.1	18	7	12420	13662	4830	10626	-3036	
180	0.6	2.2	0.6	2.2	0	19	7	3420	7524	1260	2772	-4752	
260	0.7	1.65	0.6	2.2	0.55	19	7	4940	8151	1820	4004	-4147	
530	0.6	2.2	0.6	2.2	0	20	7	10600	23320	3710	8162	-15158	
500	0.5	2.75	0.52	2.64	-0.11	21	9	10500	28875	4500	11880	-16995	
130	0.3	3.85	0.52	2.64	-1.21	20	9	2600	10010	1170	3088.8	-6921.2	
660	0.6	2.2	0.52	2.64	0.44	20	9	13200	29040	5940	15681.6	-13358.4	
360	0.2	4.4	0.52	2.64	-1.76	20	9	7200	31680	3240	8553.6	-23126.4	
430	0	5.5	0.52	2.64	-2.86	20	9	8600	47300	3870	10216.8	-37083.2	
650	0.2	4.4	0.48	2.86	-1.54	20	10	13000	57200	6500	18590	-38610	
130	0	5.5	0.48	2.86	-2.64	20	10	2600	14300	1300	3718	-10582	
350	0.1	4.95	0.48	2.86	-2.09	20	10	7000	34650	3500	10010	-24640	
280	0.4	3.3	0.48	2.86	-0.44	20	10	5600	18480	2800	8008	-10472	
140	0.1	4.95	0.48	2.86	-2.09	20	10	2800	13860	1400	4004	-9856	
430	0.5	2.75	0.48	2.86	0.11	20	10	8600	23650	4300	12298	-11352	
350	0.1	4.95	0.45	3.025	-1.925	20	11	7000	34650	3850	11646.25	-23003.75	
550	0.6	2.2	0.45	3.025	0.825	19	11	10450	22990	6050	18301.25	-4688.75	
1010	0.4	3.3	0.45	3.025	-0.275	19	11	19190	63327	11110	33607.75	-29719.25	
1280	0.2	4.4	0.41	3.245	-1.155	19	12	24320	107008	15360	49843.2	-57164.8	
880	0.1	4.95	0.41	3.245	-1.705	19	12	16720	82764	10560	34267.2	-48496.8	
400	0	5.5	0.41	3.245	-2.255	19	12	7600	41800	4800	15576	-26224	
570	0.1	4.95	0.41	3.245	-1.705	18	12	10260	50787	6840	22195.8	-28591.2	
670	0.5	2.75	0.41	3.245	0.495	18	12	12060	33165	8040	26089.8	-7075.2	
640	0.6	2.2	0.41	3.245	1.045	18	12	11520	25344	7680	24921.6	-422.4	
730	0.4	3.3	0.41	3.245	-0.055	18	12	13140	43362	8760	28426.2	-14935.8	
260	0.3	3.85	0.41	3.245	-0.605	18	12	4680	18018	3120	10124.4	-7893.6	
700	0.2	4.4	0.41	3.245	-1.155	18	12	12600	55440	8400	27258	-28182	
210	0.3	3.85	0.41	3.245	-0.605	18	12	3780	14553	2520	8177.4	-6375.6	
590	0.2	4.4	0.41	3.245	-1.155	18	12	10620	46728	7080	22974.6	-23753.4	
2870	0.1	4.95	0.39	3.355	-1.595	17	13	48790	241510.5	37310	125175.05	-116335.45	
270	0	5.5	0.39	3.355	-2.145	17	13	4590	25245	3510	11776.05	-13468.95	
260	0.1	4.95	0.39	3.355	-1.595	17	13	4420	21879	3380	11339.9	-10539.1	
3810	0	5.5	0.39	3.355	-2.145	16	13	60960	335280	49530	166173.15	-169106.85	
180	0.1	4.95	0.39	3.355	-1.595	16	13	2880	14256	2340	7850.7	-6405.3	
770	0	5.5	0.39	3.355	-2.145	16	13	12320	67760	10010	33583.55	-34176.45	
						Total		506,180	1,831,099	297,940	836,780	-994,318	-54 % Reduction

Table 41. Existing and Potential Solar Loads for the North Fork Grouse Creek and its Tributaries.

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)	NF Grouse Creek Shade Curves	Tributaries
390	0.9	0.55	0.98	0.11	-0.44	1	1	390	214.5	390	42.9	-171.6	forest group D	1st
1300	0.8	1.1	0.96	0.22	-0.88	2	2	2600	2860	2600	572	-2288		
1120	0.9	0.55	0.96	0.22	-0.33	3	3	3360	1848	3360	739.2	-1108.8	forest group B	
2120	0.9	0.55	0.96	0.22	-0.33	3	3	6360	3498	6360	1399.2	-2098.8		2nd
3620	0.9	0.55	0.96	0.22	-0.33	3	3	10860	5973	10860	2389.2	-3583.8		Dyree
3480	0.9	0.55	0.96	0.22	-0.33	3	3	10440	5742	10440	2296.8	-3445.2		4th
530	0.9	0.55	0.98	0.11	-0.44	1	1	530	291.5	530	58.3	-233.2		main
2020	0.9	0.55	0.98	0.11	-0.44	2	2	4040	2222	4040	444.4	-1777.6		
2480	0.9	0.55	0.96	0.22	-0.33	3	3	7440	4092	7440	1636.8	-2455.2		
2700	0.9	0.55	0.94	0.33	-0.22	4	4	10800	5940	10800	3564	-2376		
320	0.8	1.1	0.72	1.54	0.44	5	5	1600	1760	1600	2464	704	nonforest group 1	
510	0.9	0.55	0.72	1.54	0.99	5	5	2550	1402.5	2550	3927	2524.5		
490	0.8	1.1	0.72	1.54	0.44	5	5	2450	2695	2450	3773	1078		
200	0.7	1.65	0.65	1.925	0.275	6	6	1200	1980	1200	2310	330		
660	0.5	2.75	0.65	1.925	-0.825	6	6	3960	10890	3960	7623	-3267		
1070	0.6	2.2	0.65	1.925	-0.275	6	6	6420	14124	6420	12358.5	-1765.5		
1270	0.7	1.65	0.6	2.2	0.55	7	7	8890	14668.5	8890	19558	4889.5		
970	0.6	2.2	0.55	2.475	0.275	8	8	7760	17072	7760	19206	2134		
580	0.5	2.75	0.55	2.475	-0.275	8	8	4640	12760	4640	11484	-1276		
						Total		96,290	110,033	96,290	95,846	-14,187	-13	% Reduction

Table 42. Existing and Potential Solar Loads for North Gold 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)	North Gold Creek Shade Curves	
3170	0.9	0.55	0.98	0.11	-0.44	1	1	3170	1743.5	3170	348.7	-1394.8	forest group B	
270	0.1	4.95	0.94	0.33	-4.62	2	2	540	2673	540	178.2	-2494.8	nonforest group 1	
1180	0.7	1.65	0.94	0.33	-1.32	2	2	2360	3894	2360	778.8	-3115.2		
650	0.5	2.75	0.86	0.77	-1.98	3	3	1950	5362.5	1950	1501.5	-3861		
440	0.3	3.85	0.86	0.77	-3.08	3	3	1320	5082	1320	1016.4	-4065.6		
650	0.1	4.95	0.78	1.21	-3.74	4	4	2600	12870	2600	3146	-9724		
430	0.3	3.85	0.78	1.21	-2.64	4	4	1720	6622	1720	2081.2	-4540.8		
320	0.2	4.4	0.72	1.54	-2.86	5	5	1600	7040	1600	2464	-4576		
440	0.1	4.95	0.72	1.54	-3.41	5	5	2200	10890	2200	3388	-7502		
210	0.4	3.3	0.72	1.54	-1.76	5	5	1050	3465	1050	1617	-1848		
1950	0.7	1.65	0.65	1.925	0.275	6	6	11700	19305	11700	22522.5	3217.5		
900	0.8	1.1	0.65	1.925	0.825	6	6	5400	5940	5400	10395	4455		
370	0.5	2.75	0.65	1.925	-0.825	6	6	2220	6105	2220	4273.5	-1831.5		
160	0.4	3.3	0.65	1.925	-1.375	6	6	960	3168	960	1848	-1320		
240	0.5	2.75	0.6	2.2	-0.55	7	7	1680	4620	1680	3696	-924		
120	0.3	3.85	0.6	2.2	-1.65	7	7	840	3234	840	1848	-1386		
960	0.5	2.75	0.6	2.2	-0.55	7	7	6720	18480	6720	14784	-3696		
480	0.2	4.4	0.6	2.2	-2.2	7	7	3360	14784	3360	7392	-7392		
300	0.1	4.95	0.6	2.2	-2.75	7	7	2100	10395	2100	4620	-5775		
						Total		53,490	145,673	53,490	87,899	-57,774	-40	% Reduction

Table 43. Existing and Potential Solar Loads for Rapid Lightning 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)	Rapid Lightning Creek Shade Curves
670	0.7	1.65	0.65	1.925	0.275	7	6	4690	7738.5	4020	7738.5	-2.72848E-12	nonforest group 1
230	0.6	2.2	0.6	2.2	0	7	7	1610	3542	1610	3542	0	
1020	0.7	1.65	0.6	2.2	0.55	8	7	8160	13464	7140	15708	2244	
70	0.4	3.3	0.6	2.2	-1.1	9	7	630	2079	490	1078	-1001	
380	0.5	2.75	0.55	2.475	-0.275	9	8	3420	9405	3040	7524	-1881	
650	0.3	3.85	0.55	2.475	-1.375	9	8	5850	22522.5	5200	12870	-9652.5	
350	0.4	3.3	0.55	2.475	-0.825	10	8	3500	11550	2800	6930	-4620	
200	0.3	3.85	0.55	2.475	-1.375	10	8	2000	7700	1600	3960	-3740	
480	0.5	2.75	0.52	2.64	-0.11	10	9	4800	13200	4320	11404.8	-1795.2	
1360	0.3	3.85	0.52	2.64	-1.21	11	9	14960	57596	12240	32313.6	-25282.4	
250	0.1	4.95	0.43	3.135	-1.815	12	10	3000	14850	2500	7837.5	-7012.5	nonforest group 2
720	0.3	3.85	0.43	3.135	-0.715	12	10	8640	33264	7200	22572	-10692	
1130	0	5.5	0.41	3.245	-2.255	13	11	14690	80795	12430	40335.35	-40459.65	
990	0.4	3.3	0.41	3.245	-0.055	13	11	12870	42471	10890	35338.05	-7132.95	
610	0.1	4.95	0.41	3.245	-1.705	13	11	7930	39253.5	6710	21773.95	-17479.55	
310	0.3	3.85	0.41	3.245	-0.605	13	11	4030	15515.5	3410	11065.45	-4450.05	
180	0.2	4.4	0.41	3.245	-1.155	13	11	2340	10296	1980	6425.1	-3870.9	
450	0.3	3.85	0.38	3.41	-0.44	14	12	6300	24255	5400	18414	-5841	
130	0.2	4.4	0.38	3.41	-0.99	14	12	1820	8008	1560	5319.6	-2688.4	
380	0.3	3.85	0.38	3.41	-0.44	14	12	5320	20482	4560	15549.6	-4932.4	
140	0.2	4.4	0.38	3.41	-0.99	14	12	1960	8624	1680	5728.8	-2895.2	
430	0.4	3.3	0.38	3.41	0.11	14	12	6020	19866	5160	17595.6	-2270.4	
190	0.2	4.4	0.38	3.41	-0.99	14	12	2660	11704	2280	7774.8	-3929.2	
180	0.3	3.85	0.38	3.41	-0.44	14	12	2520	9702	2160	7365.6	-2336.4	
140	0.2	4.4	0.38	3.41	-0.99	14	12	1960	8624	1680	5728.8	-2895.2	
1310	0	5.5	0.38	3.41	-2.09	14	12	18340	100870	15720	53605.2	-47264.8	
						Total		150,020	597,377	127,780	385,498	-211,879	-35 % Reduction

Table 44. 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)	Trout Creek Shade Curves
1330	0.9	0.55	0.98	0.11	-0.44	1	1	1330	731.5	1330	146.3	-585.2	forest group B
400	0.8	1.1	0.98	0.11	-0.99	2	2	800	880	800	88	-792	
710	0.9	0.55	0.98	0.11	-0.44	2	2	1420	781	1420	156.2	-624.8	
400	0.9	0.55	0.86	0.77	0.22	3	3	1200	660	1200	924	264	nonforest group 1
2190	0.8	1.1	0.94	0.33	-0.77	4	4	8760	9636	8760	2890.8	-6745.2	forest group B
2400	0.9	0.55	0.91	0.495	-0.055	5	5	12000	6600	12000	5940	-660	nonforest group 1
370	0.8	1.1	0.65	1.925	0.825	6	6	2220	2442	2220	4273.5	1831.5	
						Total		27,730	21,731	27,730	14,419	-7,312	-34 % Reduction

Table 45. Existing and Potential Solar Loads for Trestle 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)	Trestle Creek Shade Curves
610	0.8	1.1	0.98	0.11	-0.99	1	1	610	671	610	67.1	-603.9	forest group C
1490	0.7	1.65	0.97	0.165	-1.485	3	2	4470	7375.5	2980	491.7	-6883.8	
530	0.8	1.1	0.96	0.22	-0.88	4	3	2120	2332	1590	349.8	-1982.2	forest group B
10190	0.9	0.55	0.91	0.495	-0.055	7	5	71330	39231.5	50950	25220.25	-14011.25	
660	0.7	1.65	0.55	2.475	0.825	9	8	5940	9801	5280	13068	3267	nonforest group 1
550	0.6	2.2	0.55	2.475	0.275	9	8	4950	10890	4400	10890	-1.81899E-12	
						Total		89,420	70,301	65,810	50,087	-20,214	-29 % Reduction

Table 46. 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)	Sand Creek (PO) Shade Curves
440	0.6	2.2	0.98	0.11	-2.09	1	1	440	968	440	48.4	-919.6	nonforest group 1
70	0.1	4.95	0.98	0.11	-4.84	1	1	70	346.5	70	7.7	-338.8	
690	0	5.5	0.94	0.33	-5.17	2	2	1380	7590	1380	455.4	-7134.6	
360	0.1	4.95	0.86	0.77	-4.18	3	3	1080	5346	1080	831.6	-4514.4	
400	0.2	4.4	0.86	0.77	-3.63	3	3	1200	5280	1200	924	-4356	
1140	0.1	4.95	0.78	1.21	-3.74	4	4	4560	22572	4560	5517.6	-17054.4	
90	0.2	4.4	0.72	1.54	-2.86	5	5	450	1980	450	693	-1287	
120	0.1	4.95	0.72	1.54	-3.41	5	5	600	2970	600	924	-2046	
150	0.2	4.4	0.72	1.54	-2.86	5	5	750	3300	750	1155	-2145	
150	0.4	3.3	0.72	1.54	-1.76	5	5	750	2475	750	1155	-1320	
80	0.3	3.85	0.72	1.54	-2.31	5	5	400	1540	400	616	-924	
290	0.4	3.3	0.72	1.54	-1.76	5	5	1450	4785	1450	2233	-2552	
220	0.5	2.75	0.72	1.54	-1.21	5	5	1100	3025	1100	1694	-1331	
430	0.4	3.3	0.65	1.925	-1.375	6	6	2580	8514	2580	4966.5	-3547.5	
610	0.2	4.4	0.65	1.925	-2.475	6	6	3660	16104	3660	7045.5	-9058.5	
380	0	5.5	0.6	2.2	-3.3	7	7	2660	14630	2660	5852	-8778	
60	0.1	4.95	0.6	2.2	-2.75	7	7	420	2079	420	924	-1155	
160	0.4	3.3	0.6	2.2	-1.1	7	7	1120	3696	1120	2464	-1232	
510	0.5	2.75	0.6	2.2	-0.55	7	7	3570	9817.5	3570	7854	-1963.5	
360	0	5.5	0.55	2.475	-3.025	8	8	2880	15840	2880	7128	-8712	
990	0.1	4.95	0.55	2.475	-2.475	9	8	8910	44104.5	7920	19602	-24502.5	
1910	0	5.5	0.52	2.64	-2.86	11	9	21010	115555	17190	45381.6	-70173.4	
770	0.2	4.4	0.52	2.64	-1.76	12	9	9240	40656	6930	18295.2	-22360.8	
140	0	5.5	0.48	2.86	-2.64	13	10	1820	10010	1400	4004	-6006	
380	0.1	4.95	0.45	3.025	-1.925	13	11	4940	24453	4180	12644.5	-11808.5	
1090	0	5.5	0.41	3.245	-2.255	16	12	17440	95920	13080	42444.6	-53475.4	
						Total		94,480	463,557	81,820	194,861	-268,696	-58 % Reduction

Table 47. Existing and Potential Solar Loads for Granite 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)	Granite Creek Shade Curves
340	0.8	1.1	0.98	0.11	-0.99	1	1	340	374	340	37.4	-336.6	forest group B
1410	0.9	0.55	0.98	0.11	-0.44	2	2	2820	1551	2820	310.2	-1240.8	
2550	0.8	1.1	0.96	0.22	-0.88	3	3	7650	8415	7650	1683	-6732	
2060	0.9	0.55	0.91	0.495	-0.055	5	5	10300	5665	10300	5098.5	-566.5	nonforest group 1
1930	0.8	1.1	0.65	1.925	0.825	6	6	11580	12738	11580	22291.5	9553.5	
320	0.7	1.65	0.65	1.925	0.275	7	6	2240	3696	1920	3696	-1.36424E-12	
1590	0.9	0.55	0.65	1.925	1.375	8	6	12720	6996	9540	18364.5	11368.5	forest group B
2230	0.7	1.65	0.83	0.935	-0.715	9	7	20070	33115.5	15610	14595.35	-18520.15	
1150	0.5	2.75	0.55	2.475	-0.275	10	8	11500	31625	9200	22770	-8855	
410	0.6	2.2	0.55	2.475	0.275	10	8	4100	9020	3280	8118	-902	nonforest group 1
870	0.7	1.65	0.52	2.64	0.99	10	9	8700	14355	7830	20671.2	6316.2	
380	0.6	2.2	0.52	2.64	0.44	10	9	3800	8360	3420	9028.8	668.8	
290	0.8	1.1	0.52	2.64	1.54	10	9	2900	3190	2610	6890.4	3700.4	-4
						Total		98,720	139,101	86,100	133,555	-5,546	% Reduction

Table 48. Existing and Potential Solar Loads for Cedar 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)	Cedar Creek Shade Curves
180	0.9	0.55	0.98	0.11	-0.44	1	1	180	99	180	19.8	-79.2	forest group B
150	0.8	1.1	0.98	0.11	-0.99	1	1	150	165	150	16.5	-148.5	
230	0.9	0.55	0.98	0.11	-0.44	1	1	230	126.5	230	25.3	-101.2	
250	0.4	3.3	0.98	0.11	-3.19	1	1	250	825	250	27.5	-797.5	
210	0.7	1.65	0.98	0.11	-1.54	1	1	210	346.5	210	23.1	-323.4	
350	0.9	0.55	0.98	0.11	-0.44	1	1	350	192.5	350	38.5	-154	
110	0.8	1.1	0.98	0.11	-0.99	2	2	220	242	220	24.2	-217.8	
470	0.9	0.55	0.98	0.11	-0.44	2	2	940	517	940	103.4	-413.6	
310	0.4	3.3	0.98	0.11	-3.19	2	2	620	2046	620	68.2	-1977.8	
670	0.8	1.1	0.98	0.11	-0.99	2	2	1340	1474	1340	147.4	-1326.6	
90	0.5	2.75	0.96	0.22	-2.53	3	3	270	742.5	270	59.4	-683.1	nonforest group 1
100	0.5	2.75	0.86	0.77	-1.98	3	3	300	825	300	231	-594	
460	0.9	0.55	0.86	0.77	0.22	3	3	1380	759	1380	1062.6	303.6	
370	0.7	1.65	0.86	0.77	-0.88	3	3	1110	1831.5	1110	854.7	-976.8	
250	0.4	3.3	0.86	0.77	-2.53	3	3	750	2475	750	577.5	-1897.5	
1530	0.7	1.65	0.78	1.21	-0.44	4	4	6120	10098	6120	7405.2	-2692.8	
220	0.6	2.2	0.72	1.54	-0.66	5	5	1100	2420	1100	1694	-726	
400	0.4	3.3	0.72	1.54	-1.76	5	5	2000	6600	2000	3080	-3520	
100	0.7	1.65	0.72	1.54	-0.11	5	5	500	825	500	770	-55	
400	0.9	0.55	0.72	1.54	0.99	5	5	2000	1100	2000	3080	1980	
							Total	20,020	33,710	20,020	19,308	-14,401	-43
													% Reduction

Table 49. Existing and Potential Solar Loads for 'South' Gold 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)	Gold Creek (PO) Shade Curves
350	0.7	1.65	0.98	0.11	-1.54	1	1	350	577.5	350	38.5	-539	forest group B
1940	0.9	0.55	0.98	0.11	-0.44	2	2	3880	2134	3880	426.8	-1707.2	
400	0.3	3.85	0.96	0.22	-3.63	3	3	1200	4620	1200	264	-4356	
940	0.9	0.55	0.94	0.33	-0.22	4	4	3760	2068	3760	1240.8	-827.2	
1550	0.8	1.1	0.91	0.495	-0.605	5	5	7750	8525	7750	3836.25	-4688.75	
1080	0.7	1.65	0.65	1.925	0.275	6	6	6480	10692	6480	12474	1782	nonforest group 1
220	0.8	1.1	0.65	1.925	0.825	6	6	1320	1452	1320	2541	1089	forest group B
410	0.7	1.65	0.83	0.935	-0.715	7	7	2870	4735.5	2870	2683.45	-2052.05	
670	0.8	1.1	0.83	0.935	-0.165	7	7	4690	5159	4690	4385.15	-773.85	
710	0.7	1.65	0.83	0.935	-0.715	7	7	4970	8200.5	4970	4646.95	-3553.55	nonforest group 1
450	0.6	2.2	0.55	2.475	0.275	8	8	3600	7920	3600	8910	990	
170	0.4	3.3	0.55	2.475	-0.825	8	8	1360	4488	1360	3366	-1122	
130	0.1	4.95	0.55	2.475	-2.475	8	8	1040	5148	1040	2574	-2574	
370	0.7	1.65	0.55	2.475	0.825	8	8	2960	4884	2960	7326	2442	
560	0.5	2.75	0.55	2.475	-0.275	8	8	4480	12320	4480	11088	-1232	
						Total		50,710	82,924	50,710	65,801	-17,123	-21 % Reduction

Table 50. Existing and Potential Solar Loads for Upper Tributaries to Gold 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)	Tribes to Gold Creek (PO) Shade Curves	Tributaries
290	0.7	1.65	0.98	0.11	-1.54	1	1	290	478.5	290	31.9	-446.6	forest group B	1st
1460	0.9	0.55	0.98	0.11	-0.44	2	2	2920	1606	2920	321.2	-1284.8		
130	0.8	1.1	0.98	0.11	-0.99	2	2	260	286	260	28.6	-257.4		
180	0.7	1.65	0.98	0.11	-1.54	1	1	180	297	180	19.8	-277.2		2nd
370	0.9	0.55	0.98	0.11	-0.44	1	1	370	203.5	370	40.7	-162.8		
370	0.7	1.65	0.98	0.11	-1.54	2	2	740	1221	740	81.4	-1139.6		
680	0.8	1.1	0.98	0.11	-0.99	2	2	1360	1496	1360	149.6	-1346.4		3rd
350	0.9	0.55	0.98	0.11	-0.44	1	1	350	192.5	350	38.5	-154		
950	0.8	1.1	0.98	0.11	-0.99	2	2	1900	2090	1900	209	-1881		
920	0.9	0.55	0.96	0.22	-0.33	3	3	2760	1518	2760	607.2	-910.8		
						Total		11,130	9,389	11,130	1,528	-7,861	-84 % Reduction	

Table 51. Existing and Potential Solar Loads for Chloride Gulch and Tributaries.

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)	Chloride Gulch Shade Curves	Tributaries
1580	0.9	0.55	0.98	0.11	-0.44	2	2	3160	1738	3160	347.6	-1390.4	forest group B	1st
310	0.9	0.55	0.98	0.11	-0.44	1	1	310	170.5	310	34.1	-136.4	forest group B	2nd
400	0.8	1.1	0.98	0.11	-0.99	1	1	400	440	400	44	-396		
360	0.9	0.55	0.98	0.11	-0.44	1	1	360	198	360	39.6	-158.4		
1080	0.8	1.1	0.98	0.11	-0.99	2	2	2160	2376	2160	237.6	-2138.4		
270	0.9	0.55	0.98	0.11	-0.44	1	1	270	148.5	270	29.7	-118.8	forest group B	3rd
210	0.8	1.1	0.98	0.11	-0.99	1	1	210	231	210	23.1	-207.9		
470	0.7	1.65	0.98	0.11	-1.54	1	1	470	775.5	470	51.7	-723.8		
1750	0.9	0.55	0.98	0.11	-0.44	2	2	3500	1925	3500	385	-1540		
350	0.8	1.1	0.94	0.33	-0.77	2	2	700	770	700	231	-539	nonforest group 1	main
390	0.7	1.65	0.98	0.11	-1.54	1	1	390	643.5	390	42.9	-600.6	forest group B	
580	0.9	0.55	0.98	0.11	-0.44	2	2	1160	638	1160	127.6	-510.4	nonforest group 1	
140	0.1	4.95	0.98	0.11	-4.84	2	2	280	1386	280	30.8	-1355.2		
1560	0.9	0.55	0.86	0.77	0.22	3	3	4680	2574	4680	3603.6	1029.6		
830	0.8	1.1	0.78	1.21	0.11	4	4	3320	3652	3320	4017.2	365.2	forest group B	
280	0.6	2.2	0.94	0.33	-1.87	4	4	1120	2464	1120	369.6	-2094.4		
250	0.7	1.65	0.91	0.495	-1.155	5	5	1250	2062.5	1250	618.75	-1443.75		
340	0.6	2.2	0.91	0.495	-1.705	5	5	1700	3740	1700	841.5	-2898.5		
280	0.7	1.65	0.91	0.495	-1.155	5	5	1400	2310	1400	693	-1617	-58 % Reduction	
							Total	26,840	28,243	26,840	11,768	-16,474		

Table 52. Existing and Potential Solar Loads for West Gold Creek and Tributaries.

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)	West Gold Creek Shade Curves	Tributaries
1610	0.9	0.55	0.98	0.11	-0.44	2	2	3220	1771	3220	354.2	-1416.8	forest group B	1st
170	0.9	0.55	0.98	0.11	-0.44	1	1	170	93.5	170	18.7	-74.8		2nd
170	0.5	2.75	0.98	0.11	-2.64	1	1	170	467.5	170	18.7	-448.8		
1470	0.9	0.55	0.98	0.11	-0.44	2	2	2940	1617	2940	323.4	-1293.6		
350	0.9	0.55	0.98	0.11	-0.44	1	1	350	192.5	350	38.5	-154	3rd	
440	0.7	1.65	0.98	0.11	-1.54	1	1	440	726	440	48.4	-677.6		
970	0.9	0.55	0.98	0.11	-0.44	2	2	1940	1067	1940	213.4	-853.6		
90	0.7	1.65	0.98	0.11	-1.54	1	1	90	148.5	90	9.9	-138.6		
1810	0.9	0.55	0.98	0.11	-0.44	2	2	3620	1991	3620	398.2	-1592.8	4th	
990	0.9	0.55	0.98	0.11	-0.44	1	1	990	544.5	990	108.9	-435.6		
380	0.6	2.2	0.98	0.11	-2.09	1	1	380	836	380	41.8	-794.2		
1180	0.9	0.55	0.98	0.11	-0.44	2	2	2360	1298	2360	259.6	-1038.4		
280	0.8	1.1	0.94	0.33	-0.77	2	2	560	616	560	184.8	-431.2	nonforest group 1	
740	0.8	1.1	0.86	0.77	-0.33	3	3	2220	2442	2220	1709.4	-732.6		
870	0.8	1.1	0.96	0.22	-0.88	3	3	2610	2871	2610	574.2	-2296.8		
300	0.7	1.65	0.78	1.21	-0.44	4	4	1200	1980	1200	1452	-528	forest group B	
700	0.8	1.1	0.94	0.33	-0.77	4	4	2800	3080	2800	924	-2156	nonforest group 1	
170	0.7	1.65	0.94	0.33	-1.32	4	4	680	1122	680	224.4	-897.6	forest group B	
1310	0.8	1.1	0.91	0.495	-0.605	5	5	6550	7205	6550	3242.25	-3962.75	-61 % Reduction	
810	0.7	1.65	0.89	0.605	-1.045	6	6	4860	8019	4860	2940.3	-5078.7		
690	0.9	0.55	0.89	0.605	0.055	6	6	4140	2277	4140	2504.7	227.7		
							Total	42,290	40,365	42,290	15,590	-24,775		

Table 53. Existing and Potential Solar Loads for Kick Bush and Cheer Creeks.

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)	Kick Bush & Cheer Creeks Shade Curves
3790	0.9	0.55	0.98	0.11	-0.44	2	2	7580	4169	7580	833.8	-3335.2	forest group B
2710	0.9	0.55	0.98	0.11	-0.44	2	2	5420	2981	5420	596.2	-2384.8	
960	0.9	0.55	0.94	0.33	-0.22	4	4	3840	2112	3840	1267.2	-844.8	
						Total		16,840	9,262	16,840	2,697	-6,565	-71 % Reduction

Table 54. Existing and Potential Solar Loads for Upper Cocolalla 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)	Upper Cocolalla Creek Shade Curves
940	0.9	0.55	0.98	0.11	-0.44	1	1	940	517	940	103.4	-413.6	forest group B
410	0.8	1.1	0.98	0.11	-0.99	1	1	410	451	410	45.1	-405.9	
250	0.7	1.65	0.98	0.11	-1.54	2	2	500	825	500	55	-770	
350	0.8	1.1	0.98	0.11	-0.99	2	2	700	770	700	77	-693	
220	0.8	1.1	0.94	0.33	-0.77	2	2	440	484	440	145.2	-338.8	nonforest group 1
280	0.9	0.55	0.94	0.33	-0.22	2	2	560	308	560	184.8	-123.2	
340	0.8	1.1	0.94	0.33	-0.77	2	2	680	748	680	224.4	-523.6	
700	0.8	1.1	0.96	0.22	-0.88	3	3	2100	2310	2100	462	-1848	
600	0.7	1.65	0.96	0.22	-1.43	3	3	1800	2970	1800	396	-2574	forest group B
890	0.8	1.1	0.94	0.33	-0.77	4	4	3560	3916	3560	1174.8	-2741.2	
360	0.7	1.65	0.78	1.21	-0.44	4	4	1440	2376	1440	1742.4	-633.6	
930	0.8	1.1	0.72	1.54	0.44	5	5	4650	5115	4650	7161	2046	
400	0.7	1.65	0.72	1.54	-0.11	5	5	2000	3300	2000	3080	-220	nonforest group 1
570	0.4	3.3	0.72	1.54	-1.76	5	5	2850	9405	2850	4389	-5016	
290	0.5	2.75	0.65	1.925	-0.825	6	6	1740	4785	1740	3349.5	-1435.5	
580	0.2	4.4	0.65	1.925	-2.475	6	6	3480	15312	3480	6699	-8613	
90	0.1	4.95	0.65	1.925	-3.025	6	6	540	2673	540	1039.5	-1633.5	
150	0.3	3.85	0.65	1.925	-1.925	6	6	900	3465	900	1732.5	-1732.5	
320	0.1	4.95	0.65	1.925	-3.025	6	6	1920	9504	1920	3696	-5808	
240	0.6	2.2	0.65	1.925	-0.275	6	6	1440	3168	1440	2772	-396	
360	0.4	3.3	0.65	1.925	-1.375	6	6	2160	7128	2160	4158	-2970	
760	0.1	4.95	0.6	2.2	-2.75	7	7	5320	26334	5320	11704	-14630	
180	0.5	2.75	0.6	2.2	-0.55	7	7	1260	3465	1260	2772	-693	
230	0.3	3.85	0.6	2.2	-1.65	7	7	1610	6198.5	1610	3542	-2656.5	
270	0.5	2.75	0.6	2.2	-0.55	7	7	1890	5197.5	1890	4158	-1039.5	
180	0.3	3.85	0.6	2.2	-1.65	7	7	1260	4851	1260	2772	-2079	
120	0.2	4.4	0.6	2.2	-2.2	7	7	840	3696	840	1848	-1848	
1390	0.7	1.65	0.55	2.475	0.825	8	8	11120	18348	11120	27522	9174	
2300	0.6	2.2	0.55	2.475	0.275	8	8	18400	40480	18400	45540	5060	
170	0.5	2.75	0.52	2.64	-0.11	9	9	1530	4207.5	1530	4039.2	-168.3	
160	0.4	3.3	0.52	2.64	-0.66	9	9	1440	4752	1440	3801.6	-950.4	
650	0.5	2.75	0.52	2.64	-0.11	9	9	5850	16087.5	5850	15444	-643.5	
150	0.4	3.3	0.52	2.64	-0.66	9	9	1350	4455	1350	3564	-891	
190	0.5	2.75	0.52	2.64	-0.11	9	9	1710	4702.5	1710	4514.4	-188.1	
30	0.9	0.55	0.52	2.64	2.09	9	9	270	148.5	270	712.8	564.3	
20	0.4	3.3	0.52	2.64	-0.66	9	9	180	594	180	475.2	-118.8	
30	0.9	0.55	0.52	2.64	2.09	9	9	270	148.5	270	712.8	564.3	
360	0.4	3.3	0.52	2.64	-0.66	9	9	3240	10692	3240	8553.6	-2138.4	
190	0.2	4.4	0.52	2.64	-1.76	9	9	1710	7524	1710	4514.4	-3009.6	
180	0.5	2.75	0.52	2.64	-0.11	9	9	1620	4455	1620	4276.8	-178.2	
130	0.3	3.85	0.52	2.64	-1.21	9	9	1170	4504.5	1170	3088.8	-1415.7	
220	0.1	4.95	0.52	2.64	-2.31	9	9	1980	9801	1980	5227.2	-4573.8	
800	0.3	3.85	0.48	2.86	-0.99	10	10	8000	30800	8000	22880	-7920	
150	0.4	3.3	0.48	2.86	-0.44	10	10	1500	4950	1500	4290	-660	
360	0.3	3.85	0.48	2.86	-0.99	10	10	3600	13860	3600	10296	-3564	
30	0.9	0.55	0.48	2.86	2.31	10	10	300	165	300	858	693	
30	0.3	3.85	0.48	2.86	-0.99	10	10	300	1155	300	858	-297	
30	0.9	0.55	0.48	2.86	2.31	10	10	300	165	300	858	693	
220	0.3	3.85	0.48	2.86	-0.99	10	10	2200	8470	2200	6292	-2178	
260	0.5	2.75	0.48	2.86	0.11	10	10	2600	7150	2600	7436	286	
350	0.1	4.95	0.48	2.86	-2.09	10	10	3500	17325	3500	10010	-7315	
220	0.2	4.4	0.48	2.86	-1.54	10	10	2200	9680	2200	6292	-3388	
470	0.5	2.75	0.45	3.025	0.275	11	11	5170	14217.5	5170	15639.25	1421.75	
410	0.4	3.3	0.45	3.025	-0.275	11	11	4510	14883	4510	13642.75	-1240.25	
410	0.3	3.85	0.45	3.025	-0.825	11	11	4510	17363.5	4510	13642.75	-3720.75	
390	0	5.5	0.45	3.025	-2.475	11	11	4290	23595	4290	12977.25	-10617.75	
200	0.3	3.85	0.45	3.025	-0.825	11	11	2200	8470	2200	6655	-1815	
210	0.1	4.95	0.45	3.025	-1.925	11	11	2310	11434.5	2310	6987.75	-4446.75	
340	0	5.5	0.45	3.025	-2.475	11	11	3740	20570	3740	11313.5	-9256.5	
640	0.2	4.4	0.41	3.245	-1.155	12	12	7680	33792	7680	24921.6	-8870.4	
480	0.1	4.95	0.41	3.245	-1.705	12	12	5760	28512	5760	18691.2	-9820.8	
290	0.2	4.4	0.41	3.245	-1.155	12	12	3480	15312	3480	11292.6	-4019.4	
810	0	5.5	0.41	3.245	-2.255	12	12	9720	53460	9720	31541.4	-21918.6	
20	0.9	0.55	0.41	3.245	2.695	12	12	240	132	240	778.8	646.8	
20	0.6	2.2	0.41	3.245	1.045	12	12	240	528	240	778.8	250.8	
20	0.9	0.55	0.41	3.245	2.695	12	12	240	132	240	778.8	646.8	
140	0.6	2.2	0.65	1.925	-0.275	6	6	840	1848	840	1617	-231	
200	0.1	4.95	0.65	1.925	-3.025	6	6	1200	5940	1200	2310	-3630	
Total								179,460	604,082	179,460	445,108	-158,974	

-26
% Reduction

Table 55. Existing and Potential Solar Loads for Fish 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)	Fish Creek Shade Curves
510	0.6	2.2	0.65	1.925	-0.28	6	6	3060	6732	3060	5890.5	-841.5	nonforest group 1
450	0.8	1.1	0.65	1.925	0.83	6	6	2700	2970	2700	5197.5	2227.5	
1000	0.8	1.1	0.89	0.605	-0.495	6	6	6000	6600	6000	3630	-2970	forest group B
540	0.8	1.1	0.65	1.925	0.825	7	6	3780	4158	3240	6237	2079	nonforest group 1
330	0.5	2.75	0.65	1.925	-0.825	7	6	2310	6352.5	1980	3811.5	-2541	
250	0.1	4.95	0.65	1.925	-3.025	7	6	1750	8662.5	1500	2887.5	-5775	
470	0.3	3.85	0.65	1.925	-1.925	7	6	3290	12666.5	2820	5428.5	-7238	
260	0.6	2.2	0.65	1.925	-0.275	7	6	1820	4004	1560	3003	-1001	
						Total		24,710	52,146	22,860	36,086	-16,060	-31 % Reduction

Table 56. Existing and Potential Solar Loads for Lower Cocolalla 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)	Lower Cocolalla Creek Shade Curves
3860	0	5.5	0	5.5	0	1000	1000	3,860,000	21,230,000	3,860,000	21,230,000	0	Cocolalla Lake
340	0.1	4.95	0.55	2.475	-2.48	8	8	2,720	13,464	2,720	6,732	-6,732	nonforest group 1
590	0.2	4.4	0.55	2.475	-1.925	8	8	4,720	20,768	4,720	11,682	-9,086	
480	0.5	2.75	0.55	2.475	-0.275	8	8	3,840	10,560	3,840	9,504	-1,056	
310	0.1	4.95	0.55	2.475	-2.475	8	8	2,480	12,276	2,480	6,138	-6,138	
380	0.4	3.3	0.55	2.475	-0.825	8	8	3,040	10,032	3,040	7,524	-2,508	
430	0.2	4.4	0.55	2.475	-1.925	8	8	3,440	15,136	3,440	8,514	-6,622	
200	0.5	2.75	0.55	2.475	-0.275	8	8	1,600	4,400	1,600	3,960	-440	
160	0.2	4.4	0.55	2.475	-1.925	8	8	1,280	5,632	1,280	3,168	-2,464	
280	0.7	1.65	0.55	2.475	0.825	8	8	2,240	3,696	2,240	5,544	1,848	
130	0.1	4.95	0.55	2.475	-2.475	8	8	1,040	5,148	1,040	2,574	-2,574	
340	0.7	1.65	0.55	2.475	0.825	8	8	2,720	4,488	2,720	6,732	2,244	
160	0.1	4.95	0.55	2.475	-2.475	8	8	1,280	6,336	1,280	3,168	-3,168	
120	0.9	0.55	0.52	2.64	2.09	9	9	1,080	594	1,080	2,851	2,257	
150	0.5	2.75	0.52	2.64	-0.11	9	9	1,350	3,713	1,350	3,564	-149	
280	0.9	0.55	0.52	2.64	2.09	9	9	2,520	1,386	2,520	6,653	5,267	
140	0.4	3.3	0.52	2.64	-0.66	9	9	1,260	4,158	1,260	3,326	-832	
290	0.2	4.4	0.52	2.64	-1.76	9	9	2,610	11,484	2,610	6,890	-4,594	
						Subtotal		3,899,220	21,363,271	3,899,220	21,328,525	-34,746	above Round Lake
440	0	5.5	0	5.5	0	500	500	220,000	1,210,000	220,000	1,210,000	0	Round Lake
760	0.3	3.85	0.52	2.64	-1.21	9	9	6,840	26,334	6,840	18,058	-8,276	nonforest group 1
160	0.1	4.95	0.52	2.64	-2.31	9	9	1,440	7,128	1,440	3,802	-3,326	
220	0.4	3.3	0.52	2.64	-0.66	9	9	1,980	6,534	1,980	5,227	-1,307	
220	0.6	2.2	0.52	2.64	0.44	9	9	1,980	4,356	1,980	5,227	871	
140	0.4	3.3	0.52	2.64	-0.66	9	9	1,260	4,158	1,260	3,326	-832	
750	0.7	1.65	0.52	2.64	0.99	9	9	6,750	11,138	6,750	17,820	6,682	
700	0.4	3.3	0.52	2.64	-0.66	9	9	6,300	20,790	6,300	16,632	-4,158	
60	0.2	4.4	0.52	2.64	-1.76	9	9	540	2,376	540	1,426	-950	
4700	0	5.5	0	5.5	0	175	175	822,500	4,523,750	822,500	4,523,750	0	water
						Subtotal		1,069,590	5,816,564	1,069,590	5,805,268	-11,296	
						Total		4,968,810	27,179,834	4,968,810	27,133,792	-46,042	-0.17 % reduction

Table 57. Existing and Potential Solar Loads for Hoodoo 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)	Hoodoo Creek Shade Curves
330	0.6	2.2	0.98	0.11	-2.09	1	1	330	726	330	36.3	-689.7	forest group B
270	0.8	1.1	0.98	0.11	-0.99	1	1	270	297	270	29.7	-267.3	
220	0.4	3.3	0.98	0.11	-3.19	1	1	220	726	220	24.2	-701.8	nonforest group 1
1710	0.1	4.95	0.94	0.33	-4.62	2	2	3420	16929	3420	1128.6	-15800.4	
1600	0	5.5	0.86	0.77	-4.73	3	3	4800	26400	4800	3696	-22704	
760	0.2	4.4	0.78	1.21	-3.19	4	4	3040	13376	3040	3678.4	-9697.6	
1320	0	5.5	0.72	1.54	-3.96	5	5	6600	36300	6600	10164	-26136	
870	0.1	4.95	0.65	1.925	-3.025	6	6	5220	25839	5220	10048.5	-15790.5	
690	0.3	3.85	0.6	2.2	-1.65	7	7	4830	18595.5	4830	10626	-7969.5	
110	0.1	4.95	0.6	2.2	-2.75	7	7	770	3811.5	770	1694	-2117.5	
210	0.3	3.85	0.6	2.2	-1.65	7	7	1470	5659.5	1470	3234	-2425.5	
80	0.1	4.95	0.6	2.2	-2.75	7	7	560	2772	560	1232	-1540	
1540	0	5.5	0.55	2.475	-3.025	8	8	12320	67760	12320	30492	-37268	
100	0.1	4.95	0.52	2.64	-2.31	9	9	900	4455	900	2376	-2079	
480	0	5.5	0.52	2.64	-2.86	9	9	4320	23760	4320	11404.8	-12355.2	
							Subtotal	49,070	247,407	49,070	89,865	-157,542	above Hoodoo Lake
1360	0	5.5	0	5.5	0	230	230	312800	1720400	312800	1720400	0	water
2980	0	5.5	0.48	2.86	-2.64	10	10	29800	163900	29800	85228	-78672	
320	0.1	4.95	0.45	3.025	-1.925	11	11	3520	17424	3520	10648	-6776	
9300	0	5.5	0.39	3.355	-2.145	13	13	120900	664950	120900	405619.5	-259330.5	
350	0.4	3.3	0.37	3.465	0.165	14	14	4900	16170	4900	16978.5	808.5	
490	0.7	1.65	0.35	3.575	1.925	15	15	7350	12127.5	7350	26276.25	14148.75	
190	0.3	3.85	0.35	3.575	-0.275	15	15	2850	10972.5	2850	10188.75	-783.75	
120	0.4	3.3	0.35	3.575	0.275	15	15	1800	5940	1800	6435	495	
200	0.3	3.85	0.35	3.575	-0.275	15	15	3000	11550	3000	10725	-825	
110	0.2	4.4	0.35	3.575	-0.825	15	15	1650	7260	1650	5898.75	-1361.25	
70	0.3	3.85	0.35	3.575	-0.275	15	15	1050	4042.5	1050	3753.75	-288.75	
70	0.2	4.4	0.35	3.575	-0.825	15	15	1050	4620	1050	3753.75	-866.25	
150	0.3	3.85	0.35	3.575	-0.275	15	15	2250	8662.5	2250	8043.75	-618.75	
120	0.2	4.4	0.35	3.575	-0.825	15	15	1800	7920	1800	6435	-1485	
80	0.3	3.85	0.35	3.575	-0.275	15	15	1200	4620	1200	4290	-330	
480	0.2	4.4	0.35	3.575	-0.825	15	15	7200	31680	7200	25740	-5940	
390	0.8	1.1	0.35	3.575	2.475	15	15	5850	6435	5850	20913.75	14478.75	
50	0.6	2.2	0.35	3.575	1.375	15	15	750	1650	750	2681.25	1031.25	
							Subtotal	509,720	2,700,324	509,720	2,374,009	-326,315	
							Total	558,790	2,947,731	558,790	2,463,874	-483,857	

-16
% Reduction

Figure 2. Target Shade for the Pend Oreille Subbasin.

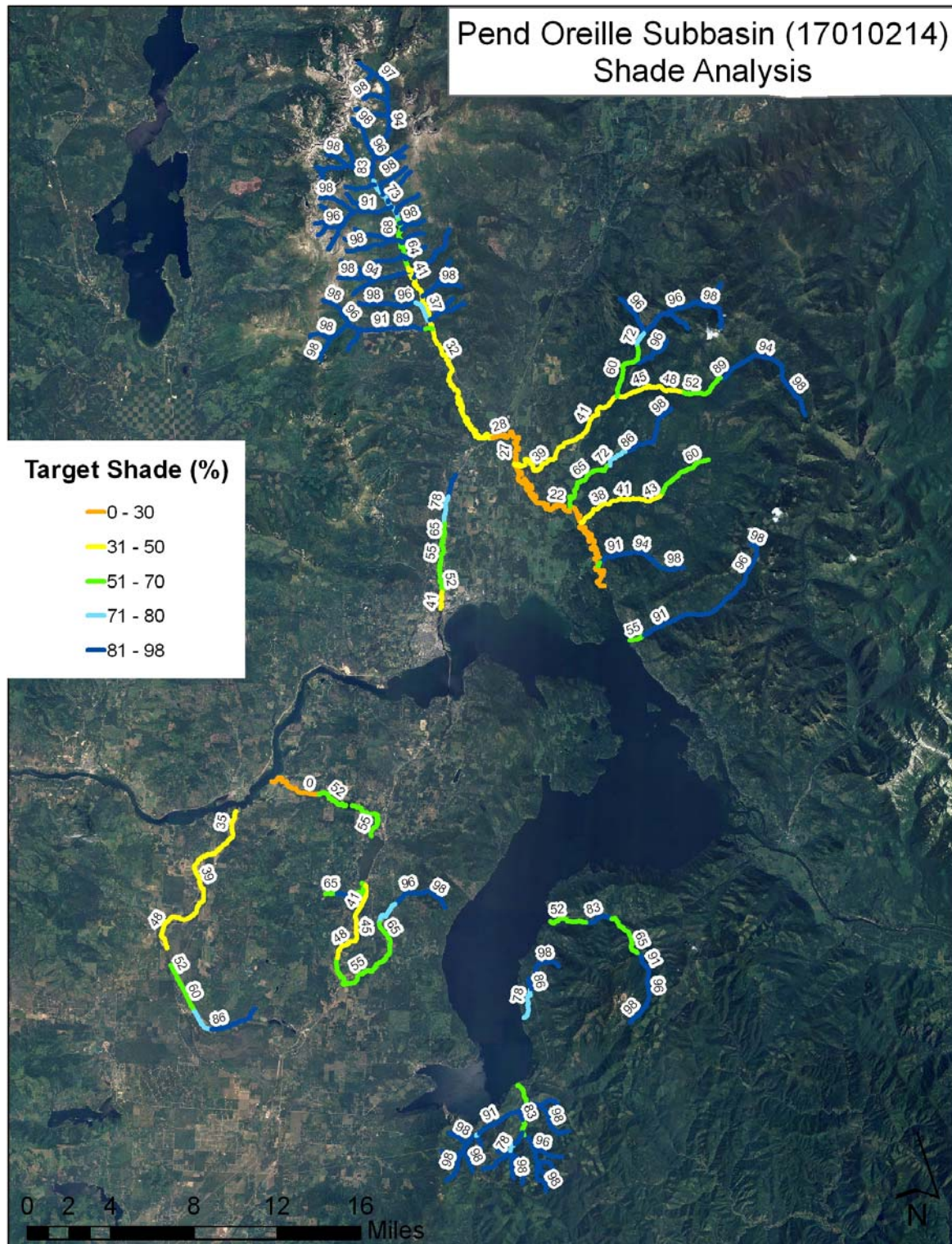


Figure 3. Existing Shade Estimated for Pend Oreille Subbasin by Aerial Photo Interpretation.

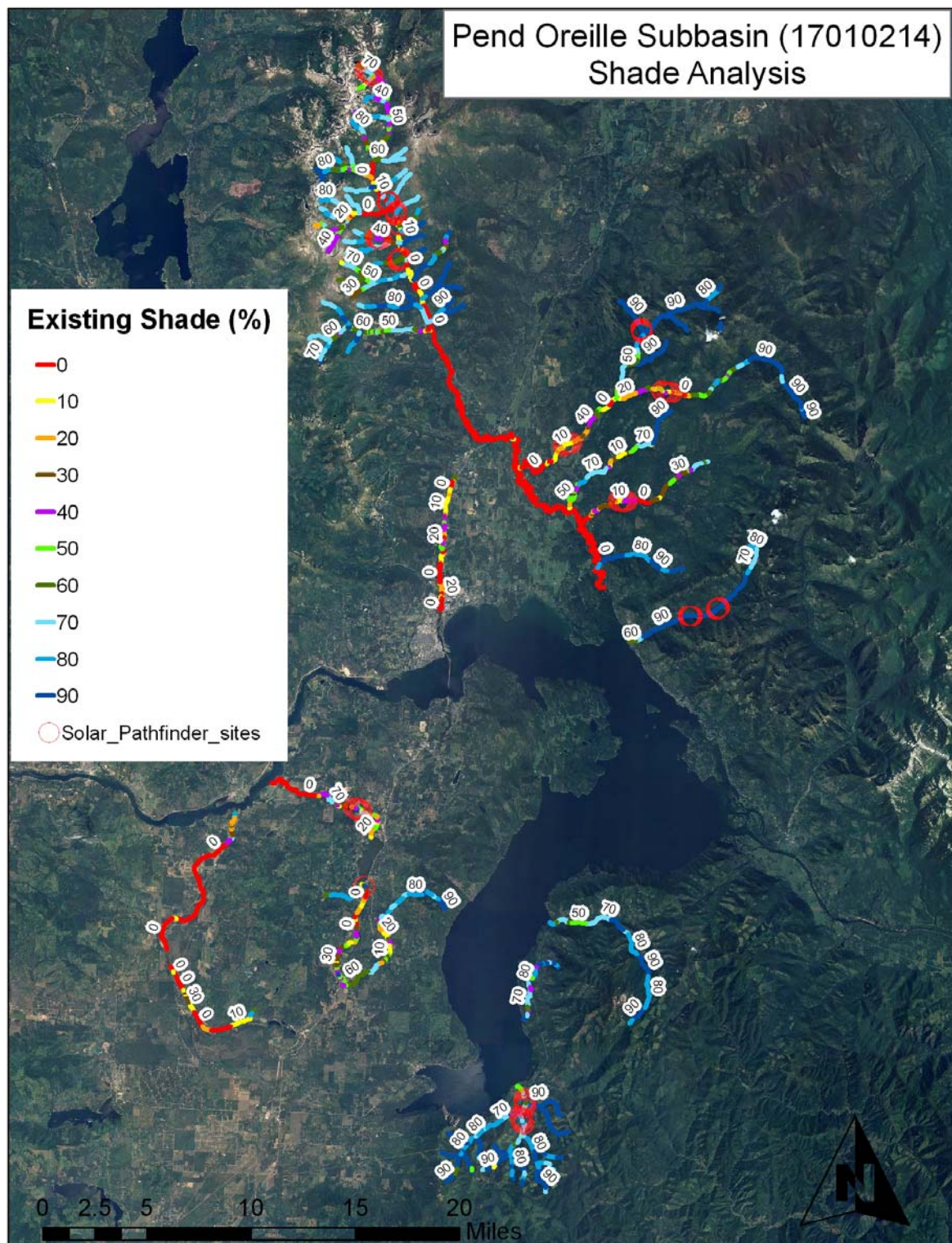


Figure 4. Lack of Shade (Difference Between Existing and Target) for the Pend Oreille Subbasin.

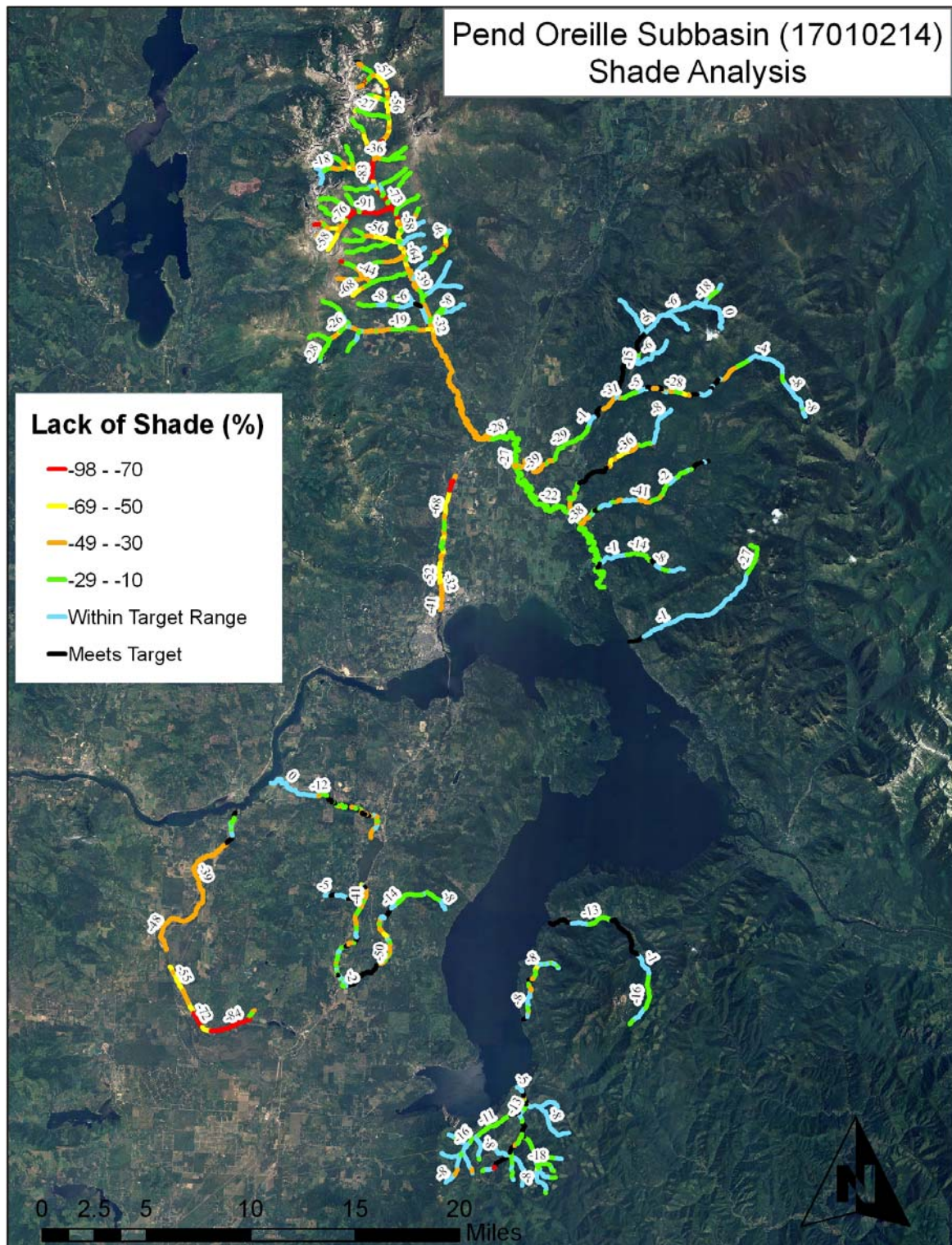


Figure 5. Target Shade for the Upper Pack River.

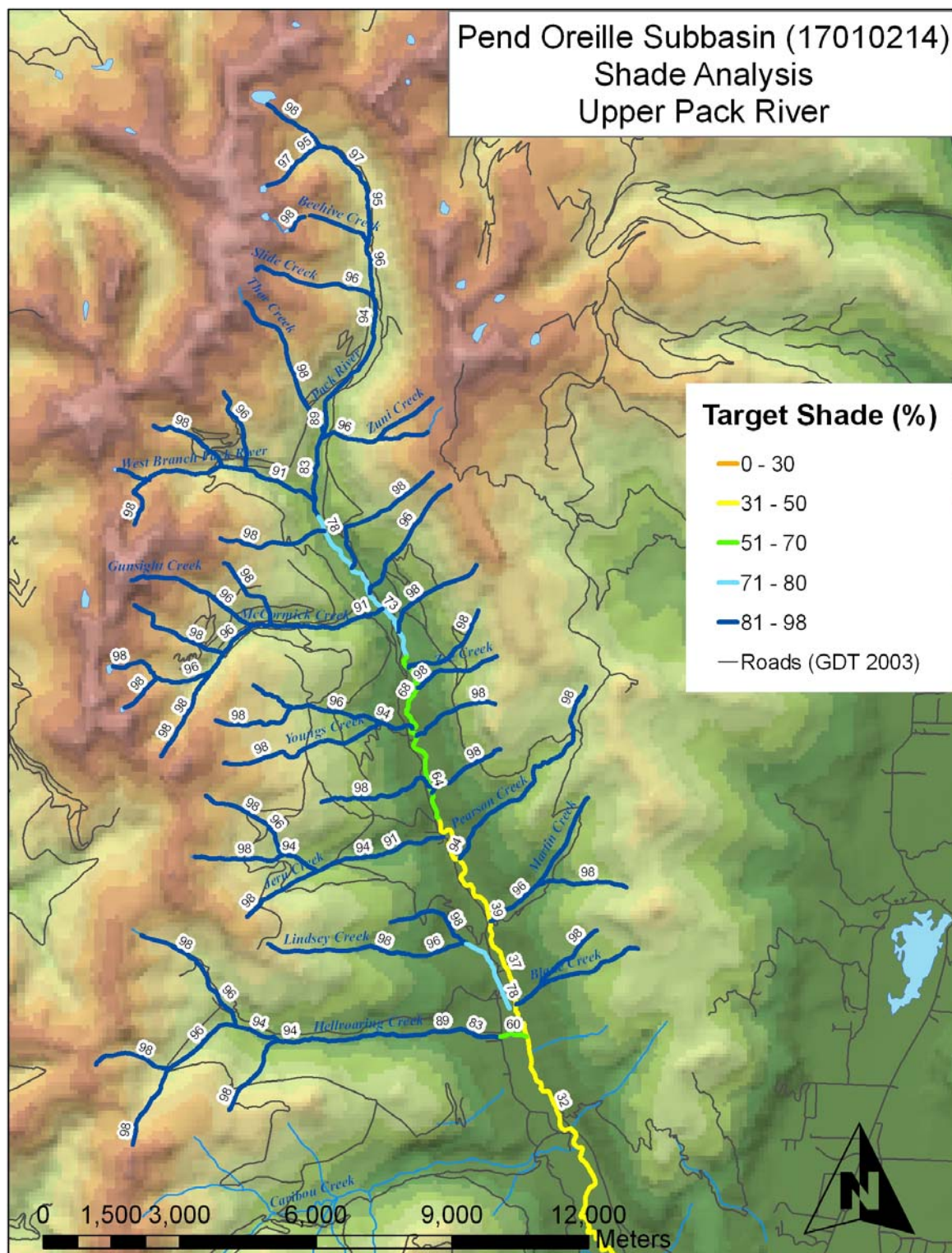


Figure 6. Existing Shade Estimated for the Upper Pack River by Aerial Photo Interpretation.

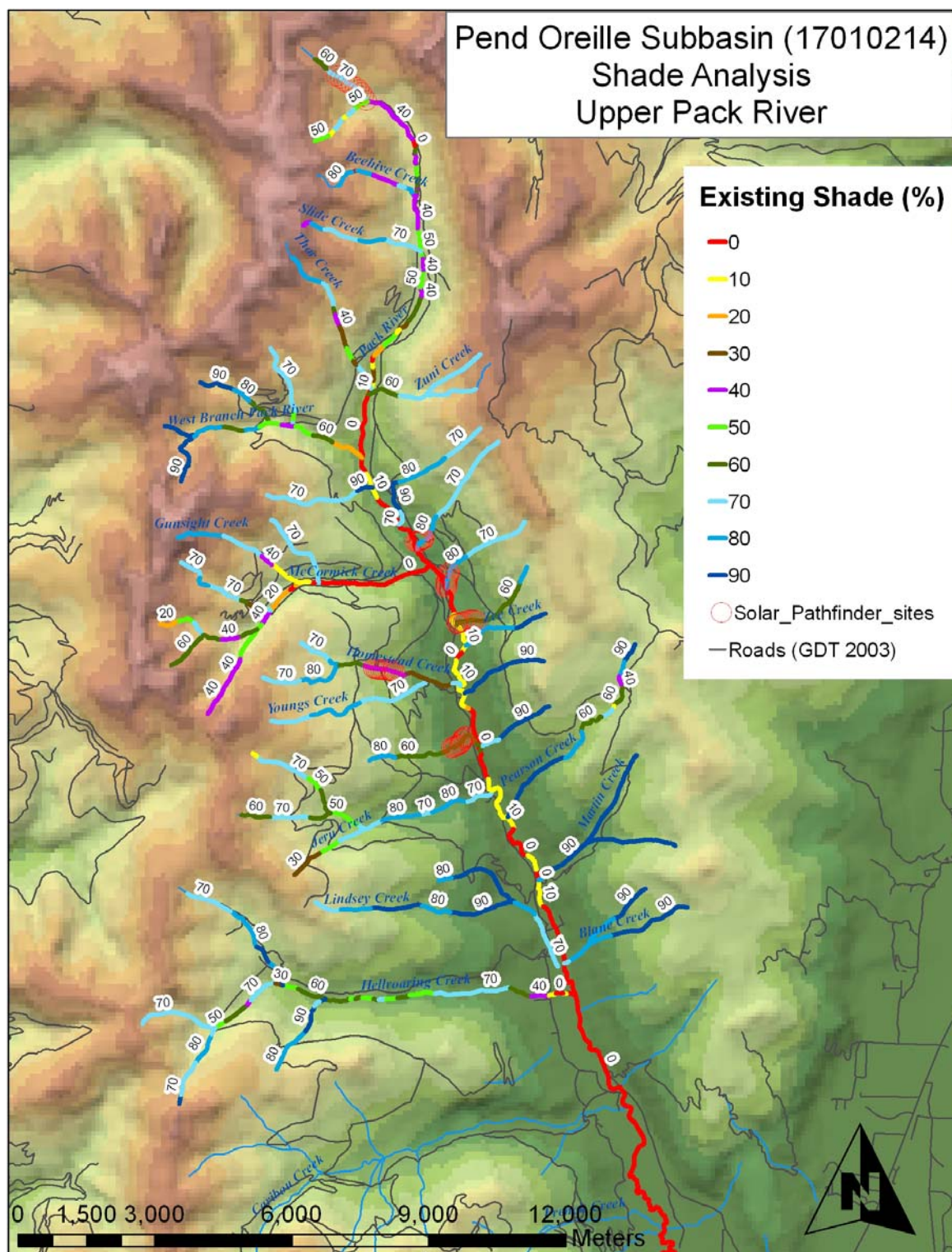


Figure 7. Lack of Shade (Difference Between Existing and Target) for the Upper Pack River.

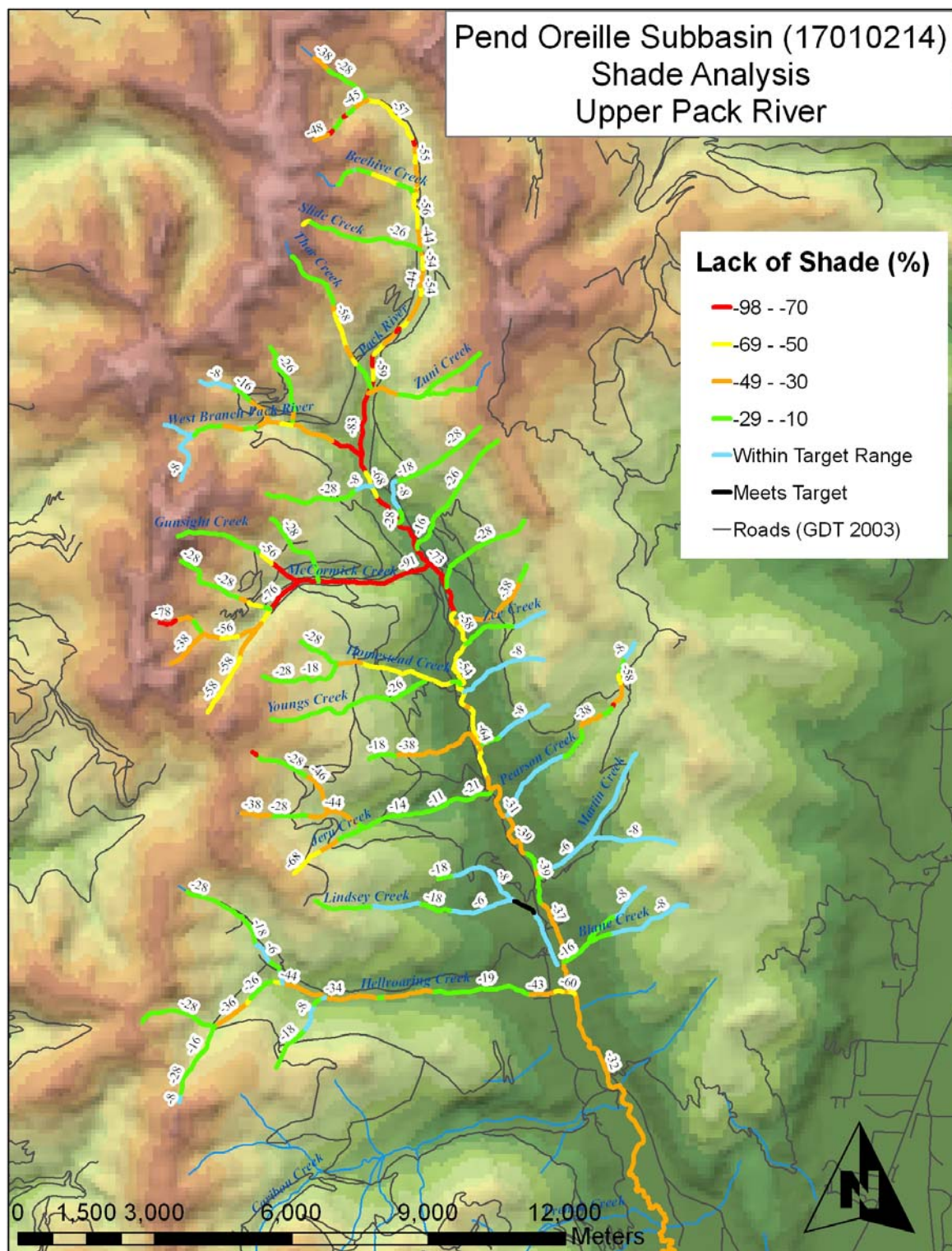


Figure 8. Target Shade for the Lower Pack River.

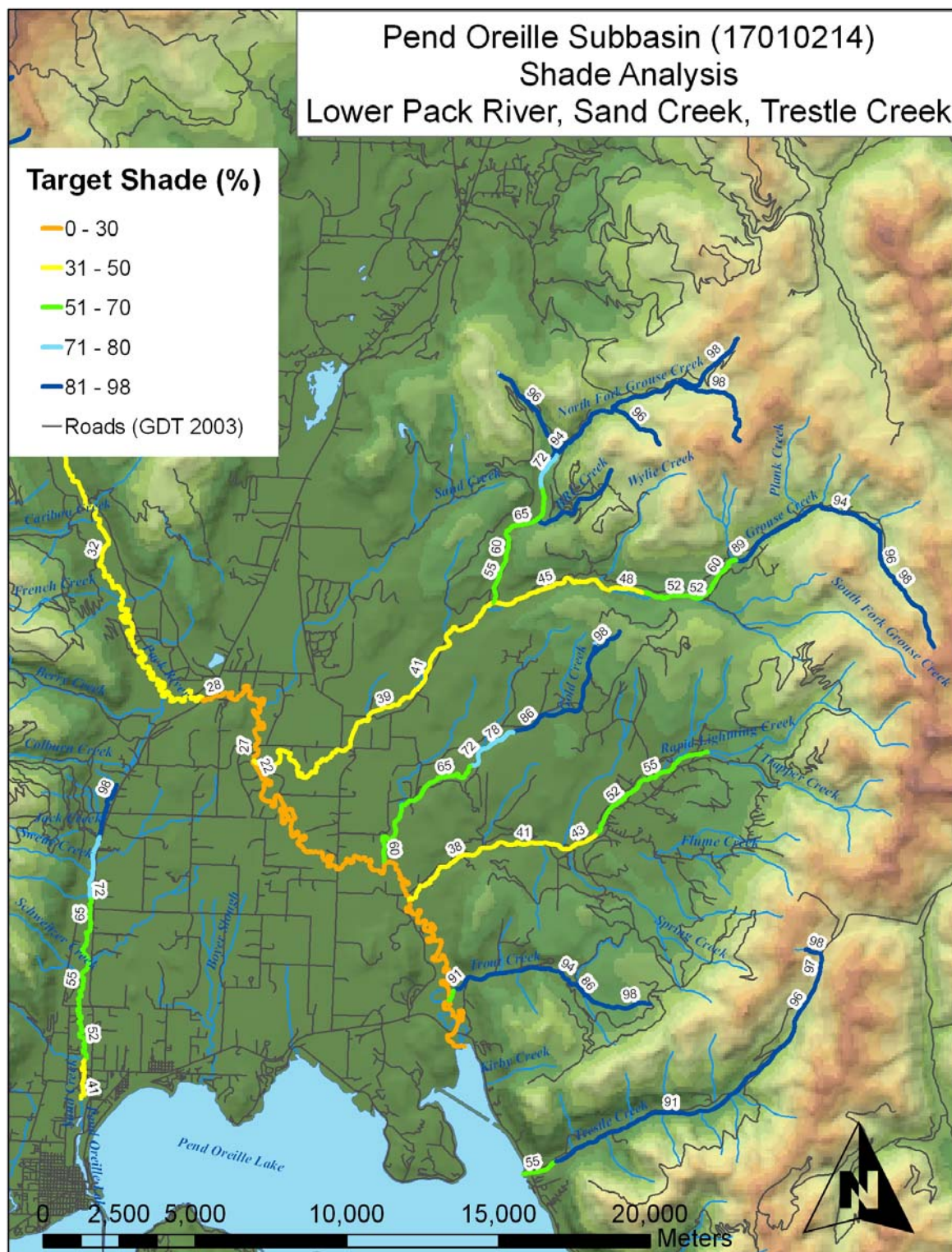


Figure 9. Existing Shade Estimated for the Lower Pack River by Aerial Photo Interpretation.

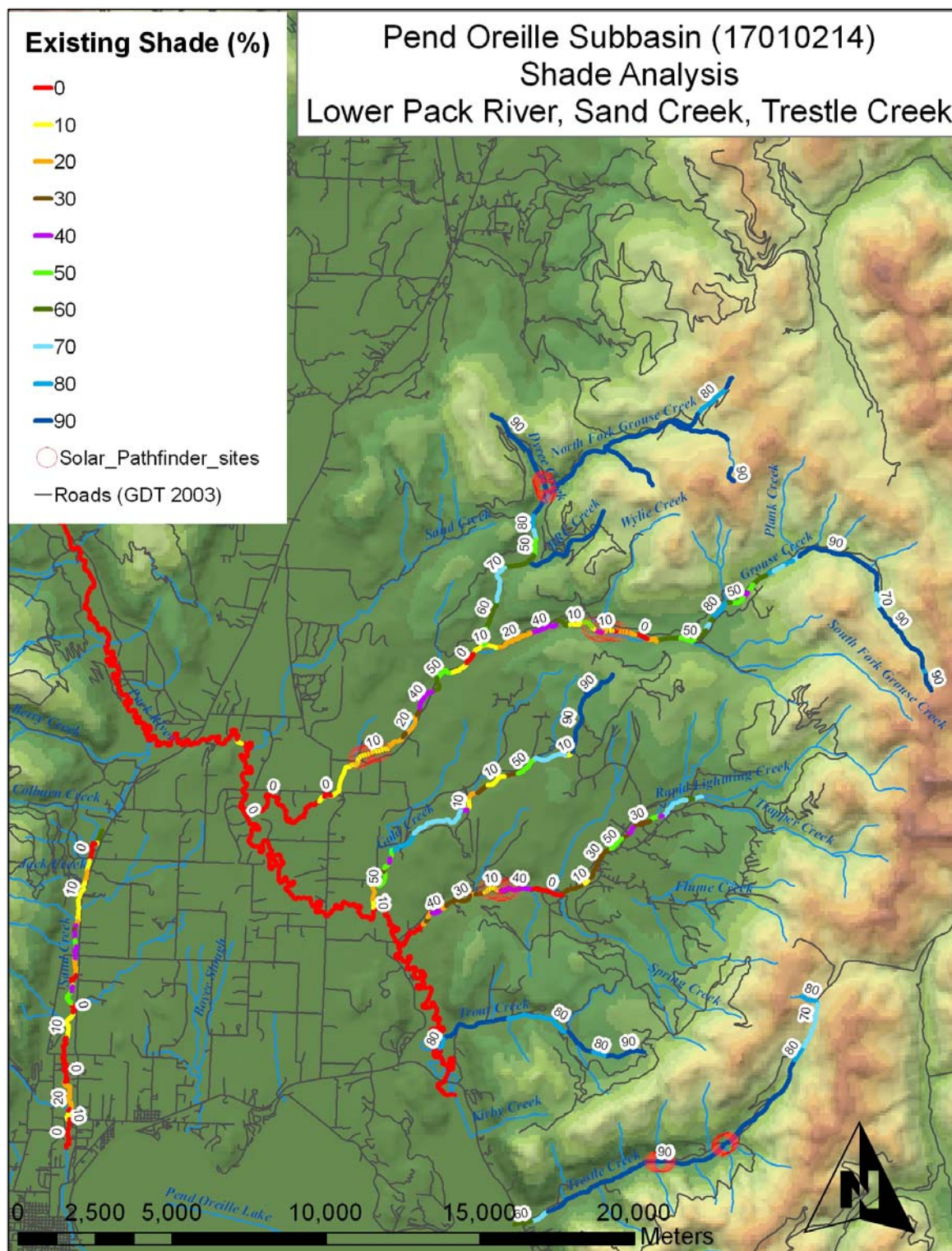


Figure 10. Lack of Shade (Difference Between Existing and Target) for the Lower Pack River.

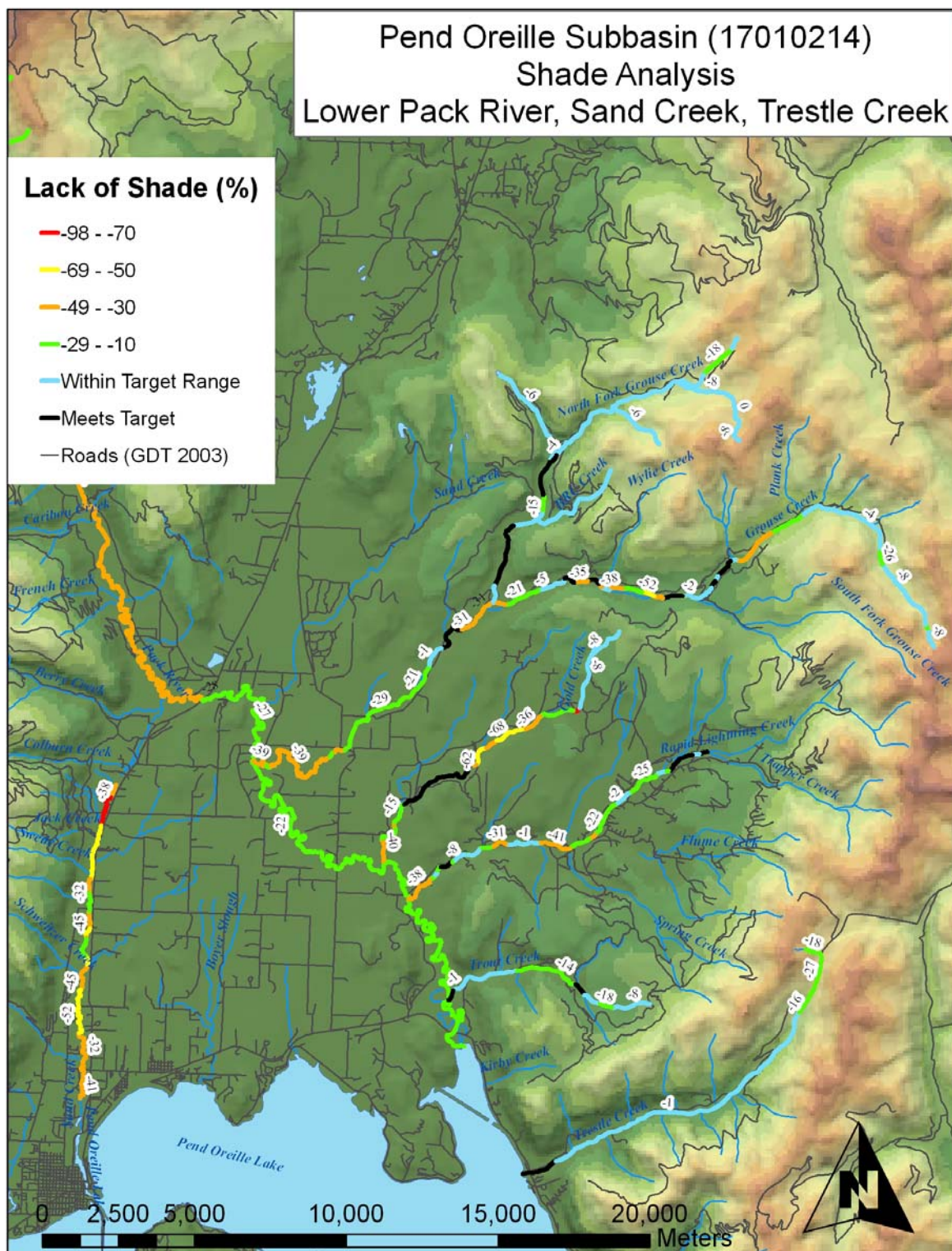


Figure 11. Target Shade for the Lower Pend Oreille Tributaries.

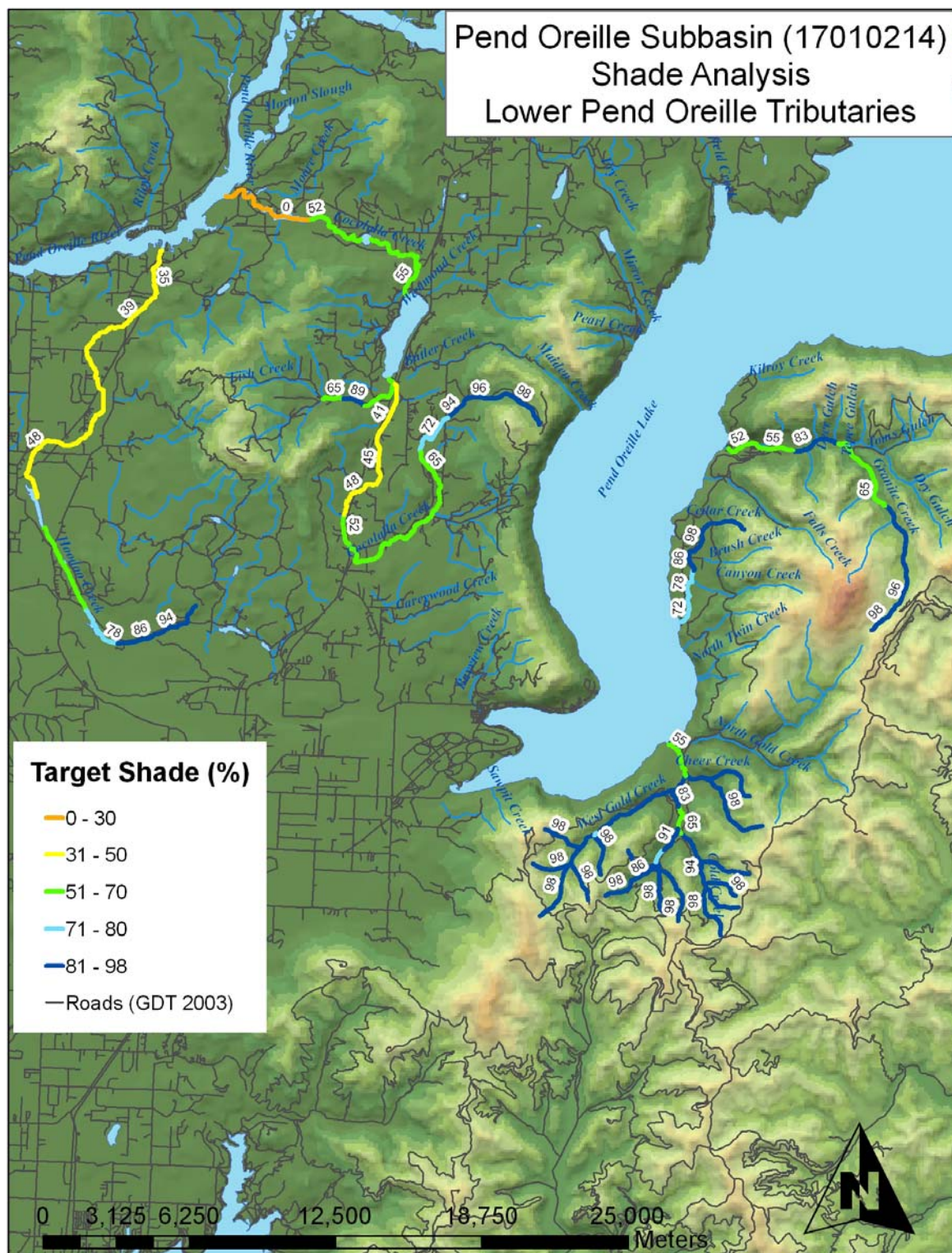


Figure 12. Existing Shade Estimated for the Lower Pend Oreille Tributaries by Aerial Photo Interpretation.

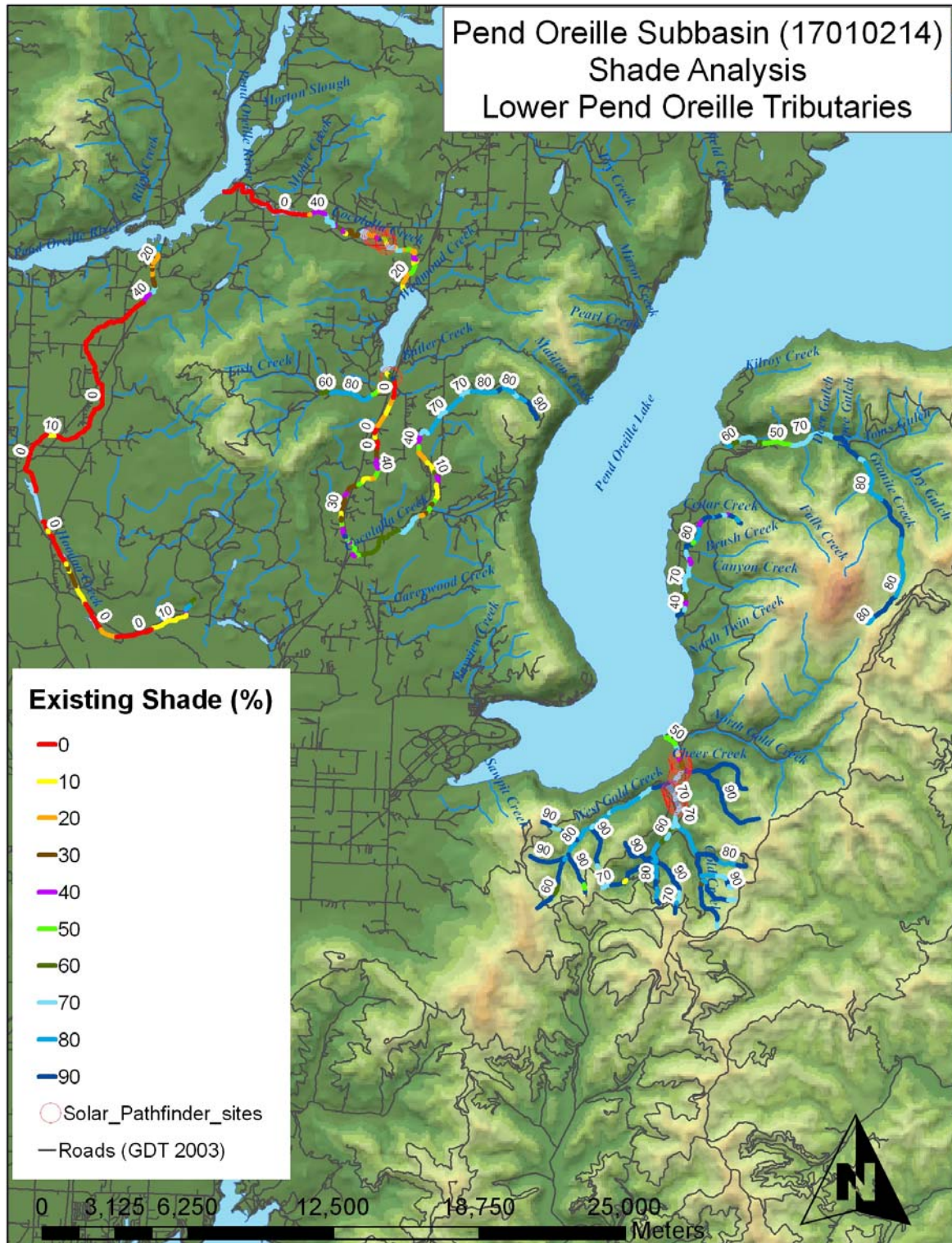
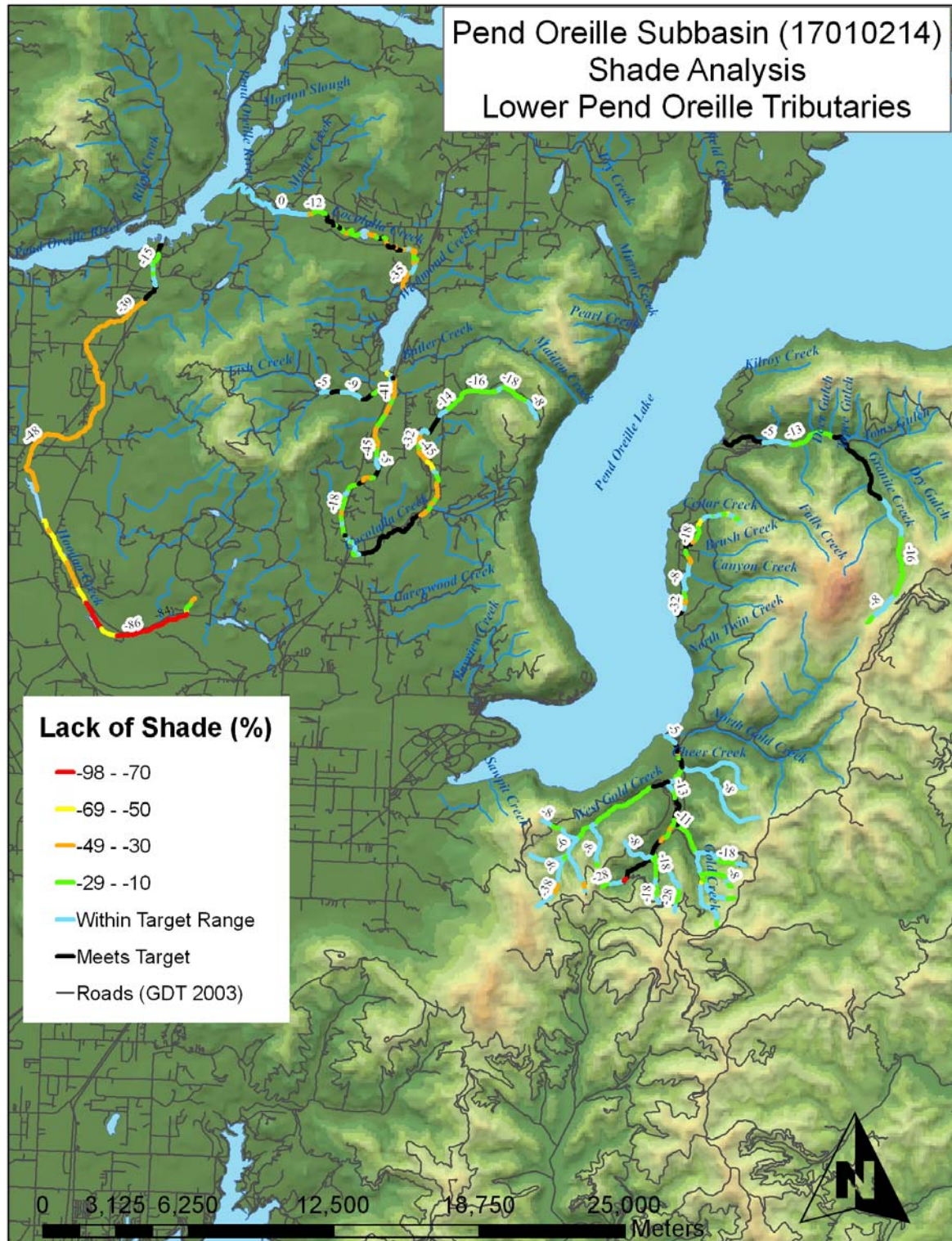


Figure 13. Lack of Shade (Difference Between Existing and Target) for the Lower Pend Oreille Tributaries.



5.4 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, in order 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. Tables 7 through 57 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.

Tables 58, 59 and 60 show the excess heat load (kWh/day) experienced by each water body examined and the percent reduction necessary to bring that water body back to target load levels. 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. Tables 58, 59 and 60 list the tributaries in order of their excess loads highest to lowest. Therefore, large tributaries tend to be listed first and small tributaries are listed last.

A certain amount of excess load and hence percent reduction is created by the Method Difference (MD) inherent in the loading analysis. Because existing shade is reported as a 10% class level and target shade is a unique integer, there is always 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 is attributed to the MD. In reality, existing shade may be somewhere within that interval. Thus, existing shade could be 81% or 82% or 83%, etc. We calculated loadings for all streams with existing shade levels matching the 10% class interval of the corresponding targets and presented those loading tables in Appendix C (see Tables C-2 through C-52). The excess loads generated by this slight (<10%) difference between existing and target levels is presented parenthetically in Tables 58, 59 and 60. Hence, the Pack River for example has an excess load of over 6.6 million kWh/day, but 201,741 kWh/day portion of that excess load may result from the MD. Likewise, the excess load of 6.6 million kWh/day in this example is 60% of the total load representing the percent reduction needed to achieve target loads. If the potential MD excess load (201,741 kWh/day) is subtracted from the 6.6 million and a new percent reduction calculated, then the reduction would be 58%. Hence, the range of possible percent reductions varies from 58% to 60% for the Pack River. All streams are treated accordingly and each has a range of percent reductions in the last column of the tables.

Table 58. Excess Solar Loads and Percent Reductions for the Pack River and Upper Pack River Tributaries. (MD = Method Difference, explained in text)

Water Body	Excess Load (kWh/day)	Percent Reduction
Pack River, source to mouth	6,642,549 (201,741 MD)	58 – 60
McCormick Creek	191,305 (3,634 MD)	94 – 96
Hellroaring Creek	78,533 (9,766 MD)	64 – 73
West Branch Creek	47,106 (6,648 MD)	75 – 87
1 st Tributary to McCormick	32,945 (2,899 MD)	88 – 96
Homestead Creek	63,359 (4,426 MD)	89 – 96
Forked Tributaries to Jeru	25,320 (4,387 MD)	75 – 91
Jeru Creek	23,690 (3,224 MD)	69 – 80
Gunsight Creek	16,814 (2,101 MD)	82 – 93
Thor Creek	14,306 (2,530 MD)	76 – 93
Zuni Creek	12,740 (3,110 MD)	70 – 92
Pearson Creek	11,727 (4,236 MD)	49 – 77
Youngs Creek	10,938 (3,117 MD)	63 – 88
Forked Tributaries to Hellroaring Creek	10,691 (3,249 MD)	63 – 90
Lindsey Creek	9,307 (8,510 MD)	4 – 47
2 nd East-side Pack Trib below West Branch	8,664 (2,350 MD)	62 – 85
Slide Creek	8,561 (2,258 MD)	64 – 87
2 nd Trib to McCormick Creek	7,359 (1,716 MD)	72 – 94
1 st West-side Pack Tributary	7,097 (1,025 MD)	78 – 92
Martin Creek	6,615 (5,059 MD)	18 – 77
Beehive Creek	5,921 (1,307 MD)	13 – 16
Blane Creek	5,858 (3,097 MD)	40 – 85
1 st East-side Pack Trib below West Branch	5,544 (2,464 MD)	50 – 90
3 rd Trib to Hellroaring Creek	5,204 (2,394 MD)	43 – 80
1 st East-side Pack Trib below McCormick Creek	4,134 (1,461 MD)	59 – 92
1 st West-side Pack Trib below West Branch	3,953 (1,236 MD)	64 – 93
4 th Trib to McCormick Creek	2,911 (832 MD)	67 – 93
Zee Creek	2,812 (1,426 MD)	44 – 89
1 st West-side Pack Trib below Homestead Creek	9,414 (2,121 MD)	73 – 95
4 th Trib to Hellroaring Creek	2,423 (1,296 MD)	39 – 84
Torrent Creek	8,237 (1,813 MD)	74 – 95
1 st East-side Pack Trib below Homestead Creek	1,751 (1,751 MD)	0 – 80
2 nd East-side Pack Trib below Homestead Creek	1,462 (818 MD)	39 – 88

The Pack River is a much larger water body than any of the other streams listed in Table 58. However, the relationship between the Pack River excess load and its MD excess load suggests that the river has a major thermal pollution problem resulting from over widening of the channel in lower reaches (Table 7) and a loss of riparian shade in upper reaches (Figure 7). Many of the tributaries to the upper Pack River are small streams, and even though they have very high percent reductions in Table 58, the MD excess load is likewise substantial, resulting in wider range of possible reductions. McCormick Creek and Hellroaring Creek are two of the largest tributaries examined in the upper Pack River watershed. These two streams have excess loads considerably larger than their MD loads (Table 58). The range of percent reductions is also at the high end for these two streams. Practically all streams in the upper Pack River watershed had excess loads greater than MD loads to some degree, presumably because of large impacts from the 1967 wildfire, the scar from which is still very visible. Lindsey Creek and the 1st east-side Pack River tributary below Homestead Creek are examples of existing shade at or near the same class interval as target shade. Thus, their excess loads and MD excess loads are similar or the same. This produces very large ranges in percent reductions (from 0 to 80% for tributary below Homestead Creek) on these small streams.

Table 59. Excess Solar Loads and Percent Reductions for Lower Pack River Tributaries, Sand Creek, and Trestle Creek. (MD = Method Difference, explained in text)

Water Body	Excess Load (kWh/day)	Percent Reduction
Grouse Creek	994,318 (83,672 MD)	50 – 54
Sand Creek	268,696 (13,716 MD)	55 – 58
Rapid Lightning Creek	211,879 (27,640 MD)	31 – 35
North Gold Creek	57,774 (11,123 MD)	32 – 40
Trestle Creek	20,214 (7,405 MD)	18 – 29
North Fork Grouse Creek	14,187 (25,429 MD)	0 – 13
Trout Creek	7,312 (5,156 MD)	10 – 34

Tributaries to the lower Pack River presented in Table 59 show lower ranges of percent reductions typical of much larger streams with larger surface areas naturally exposed to solar radiation. However, most of these streams are impacted by excess solar loading, considerably higher than their MD loading. The NF Grouse Creek appears to be a watershed in very good shape with excess loads within MD limits. Figure 10 shows that the NF Grouse Creek largely is within the same existing shade class as the targets.

Table 60 shows that most streams examined in the lower Pend Oreille Lake region exceed MOS loadings, with the exception of Granite Creek and the Kick Bush Gulch/Cheer Creek section of the 'South' Gold Creek watershed. Although Lower Cocolalla Creek has an excess load over three times higher than its MD excess load, the percent reductions needed are very small because lake surface area was included in the loading analysis (Table 56). Cocolalla Lake, Round Lake and the lower slough area were all included in the loading

analysis generating very high solar loads, however, these lake loads were considered natural and no excess load resulted from these water bodies.

Table 60. Excess Solar Loads and Percent Reductions for Lower Pend Oreille Tributaries. (MD = Method Difference, explained in text)

Water Body	Excess Load (kWh/day)	Percent Reduction
Hoodoo Creek	483,857 (96,365 MD)	13 – 16
Upper Cocolalla Creek	158,974 (39,360 MD)	20 – 26
Lower Cocolalla Creek	46,042 (12,310 MD)	0.05 – 0.17
West Gold Creek	24,776 (15,161 MD)	24 – 61
‘South’ Gold Creek	17,123 (11,419 MD)	7 – 21
Chloride Gulch	16,474 (9,220 MD)	26 – 58
Fish Creek	16,060 (7,607 MD)	16 – 31
Cedar Creek	14,401 (6,542 MD)	23 – 43
Upper Tribs to Gold Creek	7,861 (4,594 MD)	35 – 84
Kick Bush & Cheer Creeks	6,565 (6,565 MD)	0 – 71
Granite Creek	5,546 (18,350 MD)	0 – 4

Wasteload Allocation

There are three known NPDES permitted point sources in the affected watershed, however, none discharge to a listed stream or any other stream examined in this heat loading analysis. 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).

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. The difference between shade targets as specific integers and existing shade as 10% class intervals provides a method difference discussed in the loading analysis. Although the loading analysis used in this TMDL involves gross estimations that are likely to have large variances, there are no load allocations that may benefit or suffer from that variance.

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 June when spring salmonids spawning is occurring, July and August when maximum temperatures exceed cold water aquatic life criteria, and September during fall salmonids spawning. 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.

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.

5.5 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.

Time Frame

Twenty years has been allotted to reach PNV shade levels after implementation actions have been completed.

Approach

TMDLs will be implemented through continuation of ongoing pollution control activities in the watershed. The designated WAG, DMAs, and other appropriate public process participants are expected to:

- Develop best management practices (BMPs) to achieve load allocations.
- Give reasonable assurance that management measures will meet load allocations 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 a monitoring plan to determine if BMPs are being implemented, if individual BMPs are effective, if load allocations and waste load allocations are being met and whether or not water quality standards are being met.

The designated management agencies will recommend specific control actions and will then submit the implementation plan to DEQ. DEQ will act as a repository for approved implementation plans and conduct 5-year reviews of progress toward TMDL goals.

Responsible Parties

In addition to the designated management agencies, the public, through the WAG and other equivalent process or organizations, will be provided with opportunities to be involved in developing the implementation plan to the maximum extent practical.

Monitoring Strategy

Monitoring will be conducted using the DEQ-approved monitoring procedure at the time of sampling.

Pollutant Trading

Pollutant trading (aka water quality trading) is a contractual agreement to exchange pollution reductions between two parties. Pollutant trading is a business-like way of helping to solve water quality problems by focusing on cost effective, local solutions to problems caused by pollutant discharges to surface waters. Pollutant trading is voluntary. Parties trade only if both are better off as a result of the trade. Trading allows parties to decide how to best reduce pollutant loadings within the limits of certain requirements. The appeal of trading emerges when pollutant sources face substantially different pollutant reduction costs. Typically, a party facing relatively high pollutant reduction costs compensates another party to achieve an equivalent, though less costly, pollutant reduction.

Pollutant trading is recognized in Idaho's Water Quality Standards at IDAPA 58.01.02.054.06. Currently, the Department of Environmental Quality's policy is to allow for pollutant trading as a means to meet total maximum daily loads (TMDLs) thus restoring water quality limited water bodies to compliance with water quality standards. The Pollutant Trading Guidance document sets forth the procedures to be followed for pollutant trading.

Trading Components

The major components of pollutant trading are trading parties (buyers and sellers) and credits (the commodity being bought and sold). Additionally, ratios are used to ensure environmental equivalency of trades on water bodies covered by a TMDL. All trading activity must be recorded in the trading database through the Idaho Clean Water Cooperative, Inc.

Both point and nonpoint sources may create marketable credits. Credits are a reduction of a pollutant beyond a level set by a TMDL. Point sources create credits by reducing pollutant discharges below NPDES effluent limits which are set initially by the waste load allocation. Nonpoint sources create credits by implementing approved best management practices (BMPs) that reduce the amount of pollutant run-off. Nonpoint sources must follow specific design, maintenance, and monitoring requirements for that BMP, apply discounts to credits generated if required, and provide a water quality contribution to ensure a net environmental benefit. The water quality contribution also ensures the reduction (the marketable credit), is surplus to the reductions the TMDL assumes the nonpoint source is achieving to meet the water quality goals of the TMDL.

Watershed specific Environmental Protection

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

Trading Framework

In order for pollutant trading to be authorized it must be specifically mentioned within a TMDL document. After adoption of an EPA approved TMDL, DEQ in concert with the Watershed Advisory Group (WAG) must develop a pollutant trading framework document as part of an implementation plan for the watershed that is the subject of the TMDL. The elements of a trading document are described in DEQ's Pollutant Trading Guidance (currently November 2003 Draft) available on the DEQ website at http://www.deq.idaho.gov/water/prog_issues/waste_water/pollutant_trading/pollutant_trading_guidance_entire.pdf. As of this writing the only two watersheds that have yet developed a pollutant trading framework are the Lower Boise River watershed and the Upper Snake Rock/Mid Snake TMDL watershed.

5.6 Conclusions

Nineteen water bodies were listed for temperature problems in the Pend Oreille Lake subbasin. This TMDL examined the relationship between existing shade levels on streams and shade targets developed from vegetation typing in the region. Existing and target shade levels were converted to solar loads for an analysis of excess loading to streams.

Most streams examined in this TMDL had excess solar loads greater than that created by the Method Difference (difference between existing shade as a 10%-class interval and target shade as a specific integer). Notably, the Pack River and several of its larger tributaries (Grouse Creek, Rapid Lightning Creek, McCormick Creek, and Hellroaring Creek) had high excess loads with percent reductions needed to achieve target levels in the neighborhood of 30% to 90%. Hoodoo Creek and upper Cocolalla Creek also had high excess loads, however their percent reductions needed were generally less than 30%.

Several streams stood out as having excess loads less than what you would expect from having the existing shade at the same 10% class-interval as the target shade (Method Difference excess load). These streams (North Fork Grouse Creek and Granite Creek) are recommended for delisting from the 303d list for temperature (Table 61).

Table 61. Summary of Assessment Outcomes.

Water Body Segment/ AU	Pollutant	TMDL(s) Completed	Recommended Changes to §303(d) List	Justification
Pack River/ ID17010214PN031_04 ID17010214PN039_03 ID17010214PN039_04 ID17010214PN041_02 ID17010214PN041_03	Temperature	Yes	n.a.	Existing Shade
Rapid Lightning Creek/ ID17010214PN033_03	Temperature	Yes	n.a.	Existing Shade
North Gold Creek/ ID17010214PN034_02	Temperature	Yes	n.a.	Existing Shade
Grouse Creek/ ID17010214PN035_03 ID17010214PN036_02 ID17010214PN036_03	Temperature	Yes	n.a.	Existing Shade

NF Grouse Creek/ ID17010214PN037_02	Temperature	Yes	delist	Existing Shade
Trout Creek/ ID17010214PN032_02	Temperature	Yes	n.a.	Existing Shade
Hellroaring Creek/ ID17010214PN044_02	Temperature	Yes	n.a.	Existing Shade
Jeru Creek/ ID17010214PN043_02	Temperature	Yes	n.a.	Existing Shade
McCormick Creek/ ID17010214PN042_02	Temperature	Yes	n.a.	Existing Shade
Sand Creek/ ID17010214PN048_03 ID17010214PN049_02 ID17010214PN049_03	Temperature	Yes	n.a.	Existing Shade
Upper Cocolalla Creek/ ID17010214PN014_02 ID17010214PN014_03 ID17010214PN014_04	Temperature	Yes	n.a.	Existing Shade
Lower Cocolalla Creek/ ID17010214PN012_04	Temperature	Yes	n.a.	Existing Shade
Fish Creek/ ID17010214PN015_03	Temperature	Yes	n.a.	Existing Shade
Hoodoo Creek/ ID17010214PN003_02a ID17010214PN003_02	Temperature	Yes	n.a.	Existing Shade
Granite Creek/ ID17010214PN027_02 ID17010214PN027_03	Temperature	Yes	delist	Existing Shade
Cedar Creek/ ID17010214PN026_02	Temperature	Yes	n.a.	Existing Shade
'South' Gold Creek watershed (incls Chloride Gulch & West Gold)/ ID17010214PN021_02 ID17010214PN021_03 ID17010214PN022_02 ID17010214PN023_02 ID17010214PN023_03 ID17010214PN024_02	Temperature	Yes	n.a.	Existing Shade
Trestle Creek/ ID17010214PN030_02	Temperature	Yes	n.a.	Existing Shade

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GIS Coverages

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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.

Acre-foot

A volume of water that would cover an acre to a depth of one foot. Often used to quantify reservoir storage and the annual discharge of large rivers.

Adsorption

The adhesion of one substance to the surface of another. Clays, for example, can adsorb phosphorus and organic molecules

Aeration

A process by which water becomes charged with air directly from the atmosphere. Dissolved gases, such as oxygen, are then available for reactions in water.

Aerobic

Describes life, processes, or conditions that require the presence of oxygen.

Adfluvial

Describes fish whose life history involves seasonal migration from lakes to streams for spawning.

Adjunct

In the context of water quality, adjunct refers to areas directly adjacent to focal or refuge habitats that have been degraded by human or natural disturbances and do not presently support high diversity or abundance of native species.

Alevin	A newly hatched, incompletely developed fish (usually a salmonid) still in nest or inactive on the bottom of a water body, living off stored yolk.
Algae	Non-vascular (without water-conducting tissue) aquatic plants that occur as single cells, colonies, or filaments.
Alluvium	Unconsolidated recent stream deposition.
Ambient	General conditions in the environment (Armantrout 1998). In the context of water quality, ambient waters are those representative of general conditions, not associated with episodic perturbations or specific disturbances such as a wastewater outfall (EPA 1996).
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.
Anaerobic	Describes the processes that occur in the absence of molecular oxygen and describes the condition of water that is devoid of molecular oxygen.
Anoxia	The condition of oxygen absence or deficiency.
Anthropogenic	Relating to, or resulting from, the influence of human beings on nature.
Anti-Degradation	Refers to the U.S. Environmental Protection Agency's interpretation of the Clean Water Act goal that states and tribes maintain, as well as restore, water quality. This applies to waters that meet or are of higher water quality than required by state standards. State rules provide that the quality of those high quality waters may be lowered only to allow important social or economic development and only after adequate public participation (IDAPA 58.01.02.051). In all cases, the existing beneficial uses must be maintained. State rules further define lowered water quality to be 1) a measurable change, 2) a change adverse to a use, and 3) a change in a pollutant relevant to the water's uses (IDAPA 58.01.02.003.61).

Aquatic	Occurring, growing, or living in water.
Aquifer	An underground, water-bearing layer or stratum of permeable rock, sand, or gravel capable of yielding of water to wells or springs.
Assemblage (aquatic)	An association of interacting populations of organisms in a given water body; for example, a fish assemblage or a benthic macroinvertebrate assemblage (also see Community) (EPA 1996).
Assessment Database (ADB)	The ADB is a relational database application designed for the U.S. Environmental Protection Agency for tracking water quality assessment data, such as use attainment and causes and sources of impairment. States need to track this information and many other types of assessment data for thousands of water bodies and integrate it into meaningful reports. The ADB is designed to make this process accurate, straightforward, and user-friendly for participating states, territories, tribes, and basin commissions.
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.
Assimilative Capacity	The ability to process or dissipate pollutants without ill effect to beneficial uses.
Autotrophic	An organism is considered autotrophic if it uses carbon dioxide as its main source of carbon. This most commonly happens through photosynthesis.
Batholith	A large body of intrusive igneous rock that has more than 40 square miles of surface exposure and no known floor. A batholith usually consists of coarse-grained rocks such as granite.
Bedload	Material (generally sand-sized or larger sediment) that is carried along the streambed by rolling or bouncing.

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

Benthic

Pertaining to or living on or in the bottom sediments of a water body

Benthic Organic Matter.

The organic matter on the bottom of a water body.

Benthos

Organisms living in and on the bottom sediments of lakes and streams. Originally, the term meant the lake bottom, but it is now applied almost uniformly to the animals associated with the lake and stream bottoms.

Best Management Practices (BMPs)

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

Best Professional Judgment

A conclusion and/or interpretation derived by a trained and/or technically competent individual by applying interpretation and synthesizing information.

Biochemical Oxygen Demand (BOD)

The amount of dissolved oxygen used by organisms during the decomposition (respiration) of organic matter, expressed as mass of oxygen per volume of water, over some specified period of time.

Biological Integrity

1) The condition of an aquatic community inhabiting unimpaired water bodies of a specified habitat as measured by an evaluation of multiple attributes of the aquatic biota (EPA 1996). 2) The ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to the natural habitats of a region (Karr 1991).

Biomass	The weight of biological matter. Standing crop is the amount of biomass (e.g., fish or algae) in a body of water at a given time. Often expressed as grams per square meter.
Biota	The animal and plant life of a given region.
Biotic	A term applied to the living components of an area.
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.
Coliform Bacteria	A group of bacteria predominantly inhabiting the intestines of humans and animals but also found in soil. Coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms (also see Fecal Coliform Bacteria, <i>E. Coli</i> , and Pathogens).
Colluvium	Material transported to a site by gravity.
Community	A group of interacting organisms living together in a given place.
Conductivity	The ability of an aqueous solution to carry electric current, expressed in micro (μ) mhos/centimeter at 25 °C. Conductivity is affected by dissolved solids and is used as an indirect measure of total dissolved solids in a water sample.
Cretaceous	The final period of the Mesozoic era (after the Jurassic and before the Tertiary period of the Cenozoic era), thought to have covered the span of time between 135 and 65 million years ago.
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.

Cubic Feet per Second

A unit of measure for the rate of flow or discharge of water. One cubic foot per second is the rate of flow of a stream with a cross-section of one square foot flowing at a mean velocity of one foot per second. At a steady rate, once cubic foot per second is equal to 448.8 gallons per minute and 10,984 acre-feet per day.

Cultural Eutrophication

The process of eutrophication that has been accelerated by human-caused influences. Usually seen as an increase in nutrient loading (also see Eutrophication).

Culturally Induced Erosion

Erosion caused by increased runoff or wind action due to the work of humans in deforestation, cultivation of the land, overgrazing, and disturbance of natural drainages; the excess of erosion over the normal for an area (also see Erosion).

Debris Torrent

The sudden down slope movement of soil, rock, and vegetation on steep slopes, often caused by saturation from heavy rains.

Decomposition

The breakdown of organic molecules (e.g., sugar) to inorganic molecules (e.g., carbon dioxide and water) through biological and nonbiological processes.

Depth Fines

Percent by weight of particles of small size within a vertical core of volume of a streambed or lake bottom sediment. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 6.5 millimeters depending on the observer and methodology used. The depth sampled varies but is typically about one foot (30 centimeters).

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.

E. coli

Short for *Escherichia coli*, *E. coli* are a group of bacteria that are a subspecies of coliform bacteria. Most *E. coli* are essential to the healthy life of all warm-blooded animals, including humans, but their presence in water is often indicative of fecal contamination. *E. coli* are used by the state of Idaho as the indicator for the presence of pathogenic microorganisms.

Ecology

The scientific study of relationships between organisms and their environment; also defined as the study of the structure and function of nature.

Ecological Indicator

A characteristic of an ecosystem that is related to, or derived from, a measure of a biotic or abiotic variable that can provide quantitative information on ecological structure and function. An indicator can contribute to a measure of integrity and sustainability. Ecological indicators are often used within the multimetric index framework.

Ecological Integrity

The condition of an unimpaired ecosystem as measured by combined chemical, physical (including habitat), and biological attributes (EPA 1996).

Ecosystem

The interacting system of a biological community and its non-living (abiotic) environmental surroundings.

Effluent

A discharge of untreated, partially treated, or treated wastewater into a receiving water body.

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.

Eocene	An epoch of the early Tertiary period, after the Paleocene and before the Oligocene.
Eolian	Windblown, referring to the process of erosion, transport, and deposition of material by the wind.
Ephemeral Stream	A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long continued supply from melting snow or other sources. Its channel is at all times above the water table (American Geological Institute 1962).
Erosion	The wearing away of areas of the earth's surface by water, wind, ice, and other forces.
Eutrophic	From Greek for "well nourished," this describes a highly productive body of water in which nutrients do not limit algal growth. It is typified by high algal densities and low clarity.
Eutrophication	1) Natural process of maturing (aging) in a body of water. 2) The natural and human-influenced process of enrichment with nutrients, especially nitrogen and phosphorus, leading to an increased production of organic matter.
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 <i>Water Quality Standards and Wastewater Treatment Requirements</i> (IDAPA 58.01.02).
Exotic Species	A species that is not native (indigenous) to a region.
Extrapolation	Estimation of unknown values by extending or projecting from known values.
Fauna	Animal life, especially the animals characteristic of a region, period, or special environment.

Fecal Coliform Bacteria

Bacteria found in the intestinal tracts of all warm-blooded animals or mammals. Their presence in water is an indicator of pollution and possible contamination by pathogens (also see Coliform Bacteria, *E. coli*, and Pathogens).

Fecal Streptococci

A species of spherical bacteria including pathogenic strains found in the intestines of warm-blooded animals.

Feedback Loop

In the context of watershed management planning, a feedback loop is a process that provides for tracking progress toward goals and revising actions according to that progress.

Fixed-Location Monitoring

Sampling or measuring environmental conditions continuously or repeatedly at the same location.

Flow

See *Discharge*.

Fluvial

In fisheries, this describes fish whose life history takes place entirely in streams but migrate to smaller streams for spawning.

Focal

Critical areas supporting a mosaic of high quality habitats that sustain a diverse or unusually productive complement of native species.

Fully Supporting

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

Fully Supporting but Threatened

An intermediate assessment category describing water bodies that fully support beneficial uses, but have a declining trend in water quality conditions, which if not addressed, will lead to a “not fully supporting” status.

Geographical Information Systems (GIS)

A georeferenced database.

Geometric Mean	A back-transformed mean of the logarithmically transformed numbers often used to describe highly variable, right-skewed data (a few large values), such as bacterial data.
Grab Sample	A single sample collected at a particular time and place. It may represent the composition of the water in that water column.
Gradient	The slope of the land, water, or streambed surface.
Ground Water	Water found beneath the soil surface saturating the layer in which it is located. Most ground water originates as rainfall, is free to move under the influence of gravity, and usually emerges again as stream flow.
Growth Rate	A measure of how quickly something living will develop and grow, such as the amount of new plant or animal tissue produced per a given unit of time, or number of individuals added to a population.
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.

Impervious

Describes a surface, such as pavement, that water cannot penetrate.

Influent

A tributary stream.

Inorganic

Materials not derived from biological sources.

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.

Intermittent Stream

1) A stream that flows only part of the year, such as when the ground water table is high or when the stream receives water from springs or from surface sources such as melting snow in mountainous areas. The stream ceases to flow above the streambed when losses from evaporation or seepage exceed the available stream flow. 2) A stream that has a period of zero flow for at least one week during most years.

Interstate Waters

Waters that flow across or form part of state or international boundaries, including boundaries with Native American nations.

Irrigation Return Flow

Surface (and subsurface) water that leaves a field following the application of irrigation water and eventually flows into streams.

Key Watershed

A watershed that has been designated in Idaho Governor Batt's *State of Idaho Bull Trout Conservation Plan* (1996) as critical

to the long-term persistence of regionally important trout populations.

Knickpoint

Any interruption or break of slope.

Land Application

A process or activity involving application of wastewater, surface water, or semi-liquid material to the land surface for the purpose of treatment, pollutant removal, or ground water recharge.

Limiting Factor

A chemical or physical condition that determines the growth potential of an organism. This can result in a complete inhibition of growth, but typically results in less than maximum growth rates.

Limnology

The scientific study of fresh water, especially the history, geology, biology, physics, and chemistry of lakes.

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.

Loam

Refers to a soil with a texture resulting from a relative balance of sand, silt, and clay. This balance imparts many desirable characteristics for agricultural use.

Loess

A uniform wind-blown deposit of silty material. Silty soils are among the most highly erodible.

Lotic

An aquatic system with flowing water such as a brook, stream, or river where the net flow of water is from the headwaters to the mouth.

Luxury Consumption

A phenomenon in which sufficient nutrients are available in either the sediments or the water column of a water body, such that aquatic plants take up and store an abundance in excess of the plants' current needs.

Macroinvertebrate

An invertebrate animal (without a backbone) large enough to be seen without magnification and retained by a 500µm mesh (U.S. #30) screen.

Macrophytes

Rooted and floating vascular aquatic plants, commonly referred to as water weeds. These plants usually flower and bear seeds. Some forms, such as duckweed and coontail (*Ceratophyllum* sp.), are free-floating forms not rooted in sediment.

Margin of Safety (MOS)

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

Mass Wasting

A general term for the down slope movement of soil and rock material under the direct influence of gravity.

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.

Median

The middle number in a sequence of numbers. If there is an even number of numbers, the median is the average of the two middle numbers. For example, 4 is the median of 1, 2, 4, 14, 16; 6 is the median of 1, 2, 5, 7, 9, 11

Method Difference (MD)

1) The difference in percent shade that results from comparing existing shade as a 10%-class interval to target shade as a specific integer (e.g. existing shade = 80%, target shade = 86%, MD = 6%). 2) The excess load created by the difference between existing shade as a 10%-class interval and target shade as a specific integer.

Metric	1) A discrete measure of something, such as an ecological indicator (e.g., number of distinct taxon). 2) The metric system of measurement.
Milligrams per Liter (mg/L)	A unit of measure for concentration. In water, it is essentially equivalent to parts per million (ppm).
Million Gallons per Day (MGD)	A unit of measure for the rate of discharge of water, often used to measure flow at wastewater treatment plants. One MGD is equal to 1.547 cubic feet per second.
Miocene	Of, relating to, or being an epoch of, the Tertiary between the Pliocene and the Oligocene periods, or the corresponding system of rocks.
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.
National Pollution Discharge Elimination System (NPDES)	A national program established by the Clean Water Act for permitting point sources of pollution. Discharge of pollution from point sources is not allowed without a permit.
Natural Condition	The condition that exists with little or no anthropogenic influence.
Nitrogen	An element essential to plant growth, and thus is considered a nutrient.
Nodal	Areas that are separated from focal and adjunct habitats, but serve critical life history functions for individual native fish.
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 Attainable

A concept and an assessment category describing water bodies that demonstrate characteristics that make it unlikely that a beneficial use can be attained (e.g., a stream that is dry but designated for salmonid spawning).

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.

Nuisance

Anything that is injurious to the public health or an obstruction to the free use, in the customary manner, of any waters of the state.

Nutrient

Any substance required by living things to grow. An element or its chemical forms essential to life, such as carbon, oxygen, nitrogen, and phosphorus. Commonly refers to those elements in short supply, such as nitrogen and phosphorus, which usually limit growth.

Nutrient Cycling

The flow of nutrients from one component of an ecosystem to another, as when macrophytes die and release nutrients that become available to algae (organic to inorganic phase and return).

Oligotrophic

The Greek term for “poorly nourished.” This describes a body of water in which productivity is low and nutrients are limiting to algal growth, as typified by low algal density and high clarity.

Organic Matter	Compounds manufactured by plants and animals that contain principally carbon.
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Orthophosphate	A form of soluble inorganic phosphorus most readily used for algal growth.
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Oxygen-Demanding Materials	Those materials, mainly organic matter, in a water body that consume oxygen during decomposition.
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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.
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Partitioning	The sharing of limited resources by different races or species; use of different parts of the habitat, or the same habitat at different times. Also the separation of a chemical into two or more phases, such as partitioning of phosphorus between the water column and sediment.
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Pathogens	A small subset of microorganisms (e.g., certain bacteria, viruses, and protozoa) that can cause sickness or death. Direct measurement of pathogen levels in surface water is difficult. Consequently, indicator bacteria that are often associated with pathogens are assessed. <i>E. coli</i> , a type of fecal coliform bacteria, are used by the state of Idaho as the indicator for the presence of pathogenic microorganisms.
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Perennial Stream	A stream that flows year-around in most years.
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Periphyton	Attached microflora (algae and diatoms) growing on the bottom of a water body or on submerged substrates, including larger plants.
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Pesticide	Substances or mixtures of substances intended for preventing, destroying, repelling, or mitigating any pest. Also, any substance or mixture intended for use as a plant regulator, defoliant, or desiccant.
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pH	The negative log ₁₀ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very
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alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.

Phased TMDL

A total maximum daily load (TMDL) that identifies interim load allocations and details further monitoring to gauge the success of management actions in achieving load reduction goals and the effect of actual load reductions on the water quality of a water body. Under a phased TMDL, a refinement of load allocations, wasteload allocations, and the margin of safety is planned at the outset.

Phosphorus

An element essential to plant growth, often in limited supply, and thus considered a nutrient.

Physiochemical

In the context of bioassessment, the term is commonly used to mean the physical and chemical factors of the water column that relate to aquatic biota. Examples in bioassessment usage include saturation of dissolved gases, temperature, pH, conductivity, dissolved or suspended solids, forms of nitrogen, and phosphorus. This term is used interchangeable with the term “physical/chemical.”

Plankton

Microscopic algae (phytoplankton) and animals (zooplankton) that float freely in open water of lakes and oceans.

Point Source

A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable “point” of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.

Pollutant

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

Pollution

A very broad concept that encompasses human-caused changes in the environment 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.

Population	A group of interbreeding organisms occupying a particular space; the number of humans or other living creatures in a designated area.
Pretreatment	The reduction in the amount of pollutants, elimination of certain pollutants, or alteration of the nature of pollutant properties in wastewater prior to, or in lieu of, discharging or otherwise introducing such wastewater into a publicly owned wastewater treatment plant.
Primary Productivity	The rate at which algae and macrophytes fix carbon dioxide using light energy. Commonly measured as milligrams of carbon per square meter per hour.
Protocol	A series of formal steps for conducting a test or survey.
Qualitative	Descriptive of kind, type, or direction.
Quality Assurance (QA)	A program organized and designed to provide accurate and precise results. Included are the selection of proper technical methods, tests, or laboratory procedures; sample collection and preservation; the selection of limits; data evaluation; quality control; and personnel qualifications and training (Rand 1995). The goal of QA is to assure the data provided are of the quality needed and claimed (EPA 1996).
Quality Control (QC)	Routine application of specific actions required to provide information for the quality assurance program. Included are standardization, calibration, and replicate samples (Rand 1995). QC is implemented at the field or bench level (EPA 1996).
Quantitative	Descriptive of size, magnitude, or degree.
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.

Representative Sample

A portion of material or water that is as similar in content and consistency as possible to that in the larger body of material or water being sampled.

Resident

A term that describes fish that do not migrate.

Respiration

A process by which organic matter is oxidized by organisms, including plants, animals, and bacteria. The process converts organic matter to energy, carbon dioxide, water, and lesser constituents.

Riffle

A relatively shallow, gravelly area of a streambed with a locally fast current, recognized by surface choppiness. Also an area of higher streambed gradient and roughness.

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.
Runoff	The portion of rainfall, melted snow, or irrigation water that flows across the surface, through shallow underground zones (interflow), and through ground water to creates streams.
Sediments	Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.
Settleable Solids	The volume of material that settles out of one liter of water in one hour.
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.
Spring	Ground water seeping out of the earth where the water table intersects the ground surface.
Stagnation	The absence of mixing in a water body.
Stenothermal	Unable to tolerate a wide temperature range.
Stratification	A Department of Environmental Quality classification method used to characterize comparable units (also called classes or strata).
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.
Stream Order	Hierarchical ordering of streams based on the degree of branching. A first-order stream is an unforked or unbranched stream. Under Strahler's (1957) system, higher order streams result from the joining of two streams of the same order.

Storm Water Runoff

Rainfall that quickly runs off the land after a storm. In developed watersheds the water flows off roofs and pavement into storm drains that may feed quickly and directly into the stream. The water often carries pollutants picked up from these surfaces.

Stressors

Physical, chemical, or biological entities that can induce adverse effects on ecosystems or human health.

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 Fines

Sediments of small size deposited on the surface of a streambed or lake bottom. The upper size threshold for fine sediment for fisheries purposes varies from 0.8 to 605 millimeters depending on the observer and methodology used. Results are typically expressed as a percentage of observation points with fine sediment.

Surface Runoff

Precipitation, snow melt, or irrigation water in excess of what can infiltrate the soil surface and be stored in small surface depressions; a major transporter of nonpoint source pollutants in rivers, streams, and lakes. Surface runoff is also called overland flow.

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.

Suspended Sediments

Fine material (usually sand size or smaller) that remains suspended by turbulence in the water column until deposited in

areas of weaker current. These sediments cause turbidity and, when deposited, reduce living space within streambed gravels and can cover fish eggs or alevins.

Taxon

Any formal taxonomic unit or category of organisms (e.g., species, genus, family, order). The plural of taxon is taxa (Armantrout 1998).

Tertiary

An interval of geologic time lasting from 66.4 to 1.6 million years ago. It constitutes the first of two periods of the Cenozoic Era, the second being the Quaternary. The Tertiary has five subdivisions, which from oldest to youngest are the Paleocene, Eocene, Oligocene, Miocene, and Pliocene epochs.

Thalweg

The center of a stream's current, where most of the water flows.

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 basis. A TMDL is equal to the load capacity, such that load capacity = margin of safety + natural background + load allocation + wasteload allocation = TMDL. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.

Total Dissolved Solids

Dry weight of all material in solution in a water sample as determined by evaporating and drying filtrate.

Total Suspended Solids (TSS)

The dry weight of material retained on a filter after filtration. Filter pore size and drying temperature can vary. American Public Health Association Standard Methods (Franson et al. 1998) call for using a filter of 2.0 microns or smaller; a 0.45 micron filter is also often used. This method calls for drying at a temperature of 103-105 °C.

Toxic Pollutants

Materials that cause death, disease, or birth defects in organisms that ingest or absorb them. The quantities and exposures necessary to cause these effects can vary widely.

Tributary

A stream feeding into a larger stream or lake.

Trophic State

The level of growth or productivity of a lake as measured by phosphorus content, chlorophyll *a* concentrations, amount (biomass) of aquatic vegetation, algal abundance, and water clarity.

Total Dissolved Solids

Dry weight of all material in solution in a water sample as determined by evaporating and drying filtrate.

Total Suspended Solids (TSS)

The dry weight of material retained on a filter after filtration. Filter pore size and drying temperature can vary. American Public Health Association Standard Methods (Franson et al. 1998) call for using a filter of 2.0 micron or smaller; a 0.45 micron filter is also often used. This method calls for drying at a temperature of 103-105 °C.

Toxic Pollutants

Materials that cause death, disease, or birth defects in organisms that ingest or absorb them. The quantities and exposures necessary to cause these effects can vary widely.

Tributary

A stream feeding into a larger stream or lake.

Trophic State

The level of growth or productivity of a lake as measured by phosphorus content, chlorophyll *a* concentrations, amount (biomass) of aquatic vegetation, algal abundance, and water clarity.

Turbidity

A measure of the extent to which light passing through water is scattered by fine suspended materials. The effect of turbidity depends on the size of the particles (the finer the particles, the greater the effect per unit weight) and the color of the particles.

Vadose Zone

The unsaturated region from the soil surface to the ground water table.

Wasteload Allocation (WLA)

The portion of receiving water's loading capacity that is allocated to one of its existing or future point sources of pollution. Wasteload allocations specify how much pollutant each point source may release to a water body.

Water Body

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

Water Column

Water between the interface with the air at the surface and the interface with the sediment layer at the bottom. The idea derives from a vertical series of measurements (oxygen, temperature, phosphorus) used to characterize water.

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 Limited

A label that describes water bodies for which one or more water quality criterion is not met or beneficial uses are not fully supported. Water quality limited segments may or may not be on a §303(d) list.

Water Quality Limited Segment (WQLS)

Any segment placed on a state's §303(d) list for failure to meet applicable water quality standards, and/or is not expected to meet applicable water quality standards in the period prior to the next list. These segments are also referred to as "§303(d) listed."

Water Quality Management Plan

A state or area-wide waste treatment management plan developed and updated in accordance with the provisions of the Clean Water Act.

Water Quality Modeling

The prediction of the response of some characteristics of lake or stream water based on mathematical relations of input variables such as climate, stream flow, and inflow water quality.

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.

Water Table

The upper surface of ground water; below this point, the soil is saturated with water.

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.

Water Body Identification Number (WBID)

A number that uniquely identifies a water body in Idaho and ties in to the Idaho water quality standards and GIS information.

Wetland

An area that is at least some of the time saturated by surface or ground water so as to support with vegetation adapted to saturated soil conditions. Examples include swamps, bogs, fens, and marshes.

Young of the Year

Young fish born the year captured, evidence of spawning activity.

Appendix A. Unit Conversion Chart

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 = 35.31 cfs	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.

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°C as a daily maximum water temperature,

9°C as a daily average water temperature.

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

Natural Background Provisions

For potential natural vegetation temperature TMDLs, it is assumed that natural temperatures may exceed these criteria during 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°C (IDAPA 58.01.02.401.03.a.v.).

Appendix C. Data Sources and Method Difference Loading Tables

Table C-1. Data sources for the Pend Oreille Lake Tributaries TMDLs.

Water Body	Data Source	Type of Data	When Collected
Pack River, Grouse Creek, Rapid Lightning Creek, Gold Creek, Cocolalla Creek	DEQ CDA Regional Office	Pathfinder effective shade and stream width	Summer 2006, 2007
All 19 TMDL streams	DEQ State Technical Services Office	Aerial Photo Interpretation of existing shade and stream width estimation	Spring-Summer 2006
	DEQ IDASA Database	Temperature	

Table C-2. Method Difference (MD) Solar Loads for the Pack 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)	Pack River Shade Curves
340	0.9	0.55	0.98	0.11	-0.44	1	1	340	187	340	37.4	-149.6	forest group D
1180	0.9	0.55	0.98	0.11	-0.44	1	1	1180	649	1180	129.8	-519.2	forest group C
1370	0.9	0.55	0.97	0.165	-0.385	2	2	2740	1507	2740	452.1	-1054.9	
160	0.9	0.55	0.97	0.165	-0.385	2	2	320	176	320	52.8	-123.2	
170	0.9	0.55	0.95	0.275	-0.275	3	3	510	280.5	510	140.25	-140.25	
250	0.9	0.55	0.95	0.275	-0.275	3	3	750	412.5	750	206.25	-206.25	
250	0.9	0.55	0.96	0.22	-0.33	3	3	750	412.5	750	165	-247.5	forest group B
250	0.9	0.55	0.96	0.22	-0.33	3	3	750	412.5	750	165	-247.5	
110	0.9	0.55	0.96	0.22	-0.33	3	3	330	181.5	330	72.6	-108.9	
80	0.9	0.55	0.96	0.22	-0.33	3	3	240	132	240	52.8	-79.2	
760	0.9	0.55	0.96	0.22	-0.33	3	3	2280	1254	2280	501.6	-752.4	
700	0.9	0.55	0.94	0.33	-0.22	4	4	2800	1540	2800	924	-616	
250	0.9	0.55	0.94	0.33	-0.22	4	4	1000	550	1000	330	-220	
380	0.9	0.55	0.94	0.33	-0.22	4	4	1520	836	1520	501.6	-334.4	
190	0.9	0.55	0.94	0.33	-0.22	4	4	760	418	760	250.8	-167.2	
610	0.9	0.55	0.91	0.495	-0.055	5	5	3050	1677.5	3050	1509.75	-167.75	
310	0.9	0.55	0.91	0.495	-0.055	5	5	1550	852.5	1550	767.25	-85.25	
110	0.9	0.55	0.91	0.495	-0.055	5	5	550	302.5	550	272.25	-30.25	
380	0.9	0.55	0.91	0.495	-0.055	5	5	1900	1045	1900	940.5	-104.5	
320	0.8	1.1	0.89	0.605	-0.495	6	6	1920	2112	1920	1161.6	-950.4	
130	0.8	1.1	0.89	0.605	-0.495	6	6	780	858	780	471.9	-386.1	
140	0.8	1.1	0.89	0.605	-0.495	6	6	840	924	840	508.2	-415.8	
300	0.8	1.1	0.89	0.605	-0.495	6	6	1800	1980	1800	1089	-891	
170	0.8	1.1	0.89	0.605	-0.495	6	6	1020	1122	1020	617.1	-504.9	
1990	0.8	1.1	0.83	0.935	-0.165	7	7	13930	15323	13930	13024.55	-2298.45	
590	0.7	1.65	0.78	1.21	-0.44	8	8	4720	7788	4720	5711.2	-2076.8	
3350	0.7	1.65	0.73	1.485	-0.165	9	9	30150	49747.5	30150	44772.75	-4974.75	
1030	0.6	2.2	0.68	1.76	-0.44	10	10	10300	22660	10300	18128	-4532	
220	0.6	2.2	0.68	1.76	-0.44	10	10	2200	4840	2200	3872	-968	
1300	0.6	2.2	0.64	1.98	-0.22	11	11	14300	31460	14300	28314	-3146	
130	0.6	2.2	0.64	1.98	-0.22	11	11	1430	3146	1430	2831.4	-314.6	
1680	0.6	2.2	0.64	1.98	-0.22	11	11	18480	40656	18480	36590.4	-4065.6	
1610	0.4	3.3	0.41	3.245	-0.055	12	12	19320	63756	19320	62693.4	-1062.6	nonforest 1
900	0.3	3.85	0.39	3.355	-0.495	13	13	11700	45045	11700	39253.5	-5791.5	
390	0.3	3.85	0.39	3.355	-0.495	13	13	5070	19519.5	5070	17009.85	-2509.65	
230	0.3	3.85	0.39	3.355	-0.495	13	13	2990	11511.5	2990	10031.45	-1480.05	
620	0.3	3.85	0.37	3.465	-0.385	14	14	8680	33418	8680	30076.2	-3341.8	
1180	0.3	3.85	0.37	3.465	-0.385	14	14	16520	63602	16520	57241.8	-6360.2	
17090	0.3	3.85	0.32	3.74	-0.11	17	17	290530	1118540.5	290530	1086582.2	-31958.3	
2340	0.2	4.4	0.28	3.96	-0.44	20	20	46800	205920	46800	185328	-20592	
240	0.2	4.4	0.28	3.96	-0.44	20	20	4800	21120	4800	19008	-2112	
4200	0.2	4.4	0.27	4.015	-0.385	21	21	88200	388080	88200	354123	-33957	
23370	0.2	4.4	0.22	4.29	-0.11	24	24	560880	2467872	560880	2406175.2	-61696.8	nonforest 2
						Total		1,180,680	4,633,827	1,180,680	4,432,086	-201,741	

-4
% Reduction

Table C-3. Method Difference (MD) Solar Loads for 1st West-side Pack River Tributary.

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)	1st West-side Pack Tributary Shade Curves
310	0.9	0.55	0.98	0.11	-0.44	1	1	310	170.5	310	34.1	-136.4	Forest Group D
150	0.9	0.55	0.98	0.11	-0.44	1	1	150	82.5	150	16.5	-66	Forest Group C
390	0.9	0.55	0.97	0.165	-0.385	2	2	780	429	780	128.7	-300.3	
110	0.9	0.55	0.97	0.165	-0.385	2	2	220	121	220	36.3	-84.7	
180	0.9	0.55	0.95	0.275	-0.275	3	3	540	297	540	148.5	-148.5	
350	0.9	0.55	0.95	0.275	-0.275	3	3	1050	577.5	1050	288.75	-288.75	
						Total		3,050	1,678	3,050	653	-1,025	-61 % Reduction

Table C-4. Method Difference (MD) Solar Loads for Beehive 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)	Beehive Creek Shade Curves
440	0.9	0.55	0.98	0.11	-0.44	1	1	440	242	440	48.4	-193.6	Forest Group C
110	0	5.5	0	5.5	0	50	50	5500	30250	5500	30250	0	water
370	0.9	0.55	0.98	0.11	-0.44	1	1	370	203.5	370	40.7	-162.8	Forest Group C
590	0.9	0.55	0.98	0.11	-0.44	2	2	1180	649	1180	129.8	-519.2	Forest Group B
150	0.9	0.55	0.98	0.11	-0.44	2	2	300	165	300	33	-132	Forest Group B
290	0.9	0.55	0.98	0.11	-0.44	2	2	580	319	580	63.8	-255.2	Forest Group B
50	0.9	0.55	0.98	0.11	-0.44	2	2	100	55	100	11	-44	Forest Group B
						Total		8,470	31,884	8,470	30,577	-1,307	-4 % Reduction

Table C-5. Method Difference (MD) Solar Loads for Slide 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)	Slide Creek Shade Curves
230	0.9	0.55	0.98	0.11	-0.44	1	1	230	126.5	230	25.3	-101.2	Nonforest Group 1
330	0.9	0.55	0.98	0.11	-0.44	1	1	330	181.5	330	36.3	-145.2	Forest Group C
800	0.9	0.55	0.97	0.165	-0.385	2	2	1600	880	1600	264	-616	
560	0.9	0.55	0.96	0.22	-0.33	3	3	1680	924	1680	369.6	-554.4	Forest Group B
850	0.9	0.55	0.96	0.22	-0.33	3	3	2550	1402.5	2550	561	-841.5	
						Total		6,390	3,515	6,390	1,256	-2,258	-64 % Reduction

Table C-6. Method Difference (MD) Solar Loads for Thor 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)	Thor Creek Shade Curves
930	0.9	0.55	0.98	0.11	-0.44	1	1	930	511.5	930	102.3	-409.2	Forest Group C
630	0.9	0.55	0.98	0.11	-0.44	1	1	630	346.5	630	69.3	-277.2	
140	0.9	0.55	0.97	0.165	-0.385	2	2	280	154	280	46.2	-107.8	
290	0.9	0.55	0.98	0.11	-0.44	2	2	580	319	580	63.8	-255.2	Forest Group B
490	0.9	0.55	0.98	0.11	-0.44	2	2	980	539	980	107.8	-431.2	
320	0.9	0.55	0.96	0.22	-0.33	3	3	960	528	960	211.2	-316.8	
110	0.9	0.55	0.96	0.22	-0.33	3	3	330	181.5	330	72.6	-108.9	
630	0.9	0.55	0.96	0.22	-0.33	3	3	1890	1039.5	1890	415.8	-623.7	
Total								6,580	3,619	6,580	1,089	-2,530	-70 % Reduction

Table C-7. Method Difference (MD) Solar Loads for Zuni 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)	Zuni Creek Shade Curves
1140	0.9	0.55	0.98	0.11	-0.44	1	1	1140	627	1140	125.4	-501.6	Forest Group B
2120	0.9	0.55	0.98	0.11	-0.44	2	2	4240	2332	4240	466.4	-1865.6	
750	0.9	0.55	0.96	0.22	-0.33	3	3	2250	1237.5	2250	495	-742.5	
Total								7,630	4,197	7,630	1,087	-3,110	-74 % Reduction

Table C-8. Method Difference (MD) Solar Loads for West Branch 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)	West Branch Creek Shade Curves
720	0.9	0.55	0.97	0.165	-0.39	2	2	1440	792	1440	237.6	-554.4	Forest Group C
800	0.9	0.55	0.98	0.11	-0.44	1	1	800	440	800	88	-352	Forest Group D
410	0.9	0.55	0.96	0.22	-0.33	2	2	820	451	820	180.4	-270.6	Forest Group B
680	0.9	0.55	0.96	0.22	-0.33	3	3	2040	1122	2040	448.8	-673.2	
1650	0.9	0.55	0.96	0.22	-0.33	2	2	3300	1815	3300	726	-1089	
180	0.9	0.55	0.98	0.11	-0.44	2	2	360	198	360	39.6	-158.4	Forest Group B
100	0.9	0.55	0.98	0.11	-0.44	2	2	200	110	200	22	-88	
1290	0.9	0.55	0.98	0.11	-0.44	1	1	1290	709.5	1290	141.9	-567.6	
720	0.9	0.55	0.98	0.11	-0.44	2	2	1440	792	1440	158.4	-633.6	
410	0.9	0.55	0.98	0.11	-0.44	2	2	820	451	820	90.2	-360.8	
410	0.9	0.55	0.96	0.22	-0.33	3	3	1230	676.5	1230	270.6	-405.9	
510	0.9	0.55	0.96	0.22	-0.33	3	3	1530	841.5	1530	336.6	-504.9	
310	0.9	0.55	0.94	0.33	-0.22	4	4	1240	682	1240	409.2	-272.8	
430	0.9	0.55	0.94	0.33	-0.22	4	4	1720	946	1720	567.6	-378.4	
460	0.9	0.55	0.91	0.495	-0.055	5	5	2300	1265	2300	1138.5	-126.5	
770	0.9	0.55	0.91	0.495	-0.055	5	5	3850	2117.5	3850	1905.75	-211.75	
Total								24,380	13,409	24,380	6,761	-6,648	-50 % Reduction

Table C-9. Method Difference (MD) Solar Loads for 1st West-side Pack River Tributary Below West Branch.

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)	1st West-side Pack Trib bl W.Branch
2130	0.9	0.55	0.98	0.11	-0.44	1	1	2130	1171.5	2130	234.3	-937.2	Forest Group C
340	0.9	0.55	0.98	0.11	-0.44	2	2	680	374	680	74.8	-299.2	Forest Group B
								Total	2,810	2,810	309	-1,236	-80 % Reduction

Table C-10. Method Difference (MD) Solar Loads for 1st East-side Pack River Tributary Below West Branch.

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)	1st East-side Pack Trib bl W.Branch
1020	0.9	0.55	0.98	0.11	-0.44	1	1	1020	561	1020	112.2	-448.8	Forest Group D
1140	0.9	0.55	0.98	0.11	-0.44	2	2	2280	1254	2280	250.8	-1003.2	Forest Group B
830	0.9	0.55	0.98	0.11	-0.44	2	2	1660	913	1660	182.6	-730.4	
320	0.9	0.55	0.98	0.11	-0.44	2	2	640	352	640	70.4	-281.6	
								Total	5,600	5,600	616	-2,464	-80 % Reduction

Table C-11. Method Difference (MD) Solar Loads for 2nd East-side Pack River Tributary Below West Branch.

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)	2nd East-side Pack Trib bl W.Branch
2180	0.9	0.55	0.96	0.22	-0.33	2	2	4360	2398	4360	959.2	-1438.8	Forest Group D
920	0.9	0.55	0.96	0.22	-0.33	3	3	2760	1518	2760	607.2	-910.8	Forest Group B
								Total	7,120	7,120	1,566	-2,350	-60 % Reduction

Table C-12. Method Difference (MD) Solar Loads for McCormick 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)	McCormick Creek
1430	0.9	0.55	0.98	0.11	-0.44	1	1	1430	786.5	1430	157.3	-629.2	forest group B
910	0.9	0.55	0.98	0.11	-0.44	2	2	1820	1001	1820	200.2	-800.8	
370	0.9	0.55	0.98	0.11	-0.44	2	2	740	407	740	81.4	-325.6	
640	0.9	0.55	0.96	0.22	-0.33	3	3	1920	1056	1920	422.4	-633.6	
140	0.9	0.55	0.96	0.22	-0.33	3	3	420	231	420	92.4	-138.6	
150	0.9	0.55	0.96	0.22	-0.33	3	3	450	247.5	450	99	-148.5	
190	0.9	0.55	0.96	0.22	-0.33	3	3	570	313.5	570	125.4	-188.1	
2800	0.9	0.55	0.91	0.495	-0.055	5	5	14000	7700	14000	6930	-770	
								Total	21,350	21,350	8,108	-3,634	-31 % Reduction

Table C-13. Method Difference (MD) Solar Loads for 1st Tributary to McCormick 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)	1st Trib to McCormick Creek
970	0.9	0.55	0.98	0.11	-0.44	2	2	1940	1067	1940	213.4	-853.6	Forest Group B
390	0.9	0.55	0.98	0.11	-0.44	1	1	390	214.5	390	42.9	-171.6	Nonforest Group 1
440	0.9	0.55	0.96	0.22	-0.33	2	2	880	484	880	193.6	-290.4	Forest Group D
370	0.9	0.55	0.98	0.11	-0.44	2	2	740	407	740	81.4	-325.6	Forest Group B
440	0.9	0.55	0.96	0.22	-0.33	3	3	1320	726	1320	290.4	-435.6	
360	0.9	0.55	0.96	0.22	-0.33	3	3	1080	594	1080	237.6	-356.4	
470	0.9	0.55	0.96	0.22	-0.33	3	3	1410	775.5	1410	310.2	-465.3	
							Total	7,760	4,268	7,760	1,370	-2,899	-68
													% Reduction

Table C-14. Method Difference (MD) Solar Loads for 2nd Tributary to McCormick 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)	2nd trib to McCormick Creek
600	0.9	0.55	0.98	0.11	-0.44	1	1	600	330	600	66	-264	Forest Group D
320	0.9	0.55	0.98	0.11	-0.44	1	1	320	176	320	35.2	-140.8	
800	0.9	0.55	0.98	0.11	-0.44	2	2	1600	880	1600	176	-704	Forest Group B
190	0.9	0.55	0.98	0.11	-0.44	2	2	380	209	380	41.8	-167.2	
300	0.9	0.55	0.98	0.11	-0.44	2	2	600	330	600	66	-264	
200	0.9	0.55	0.98	0.11	-0.44	2	2	400	220	400	44	-176	
							Total	3,900	2,145	3,900	429	-1,716	-80 % Reduction

Table C-15. Method Difference (MD) Solar Loads for Gunsight Creek, Tributary to McCormick 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)	Gunsight Creek
1040	0.9	0.55	0.98	0.11	-0.44	1	1	1040	572	1040	114.4	-457.6	Forest Group D
960	0.9	0.55	0.96	0.22	-0.33	2	2	1920	1056	1920	422.4	-633.6	
290	0.9	0.55	0.96	0.22	-0.33	3	3	870	478.5	870	191.4	-287.1	Forest Group B
730	0.9	0.55	0.96	0.22	-0.33	3	3	2190	1204.5	2190	481.8	-722.7	
							Total	6,020	3,311	6,020	1,210	-2,101	-63
													% Reduction

Table C-16. Method Difference (MD) Solar Loads for 4th Tributary to McCormick 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)	4th Trib to McCormick Creek
1890	0.9	0.55	0.98	0.11	-0.44	1	1	1890	1039.5	1890	207.9	-831.6	Forest Group D -80 % Reduction
							Total	1,890	1,040	1,890	208	-832	

Table C-17. Method Difference (MD) Solar Loads for 1st East-side Pack River Tributary Below McCormick 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)	1st East-side Pack Trib bl McCormick
1540	0.9	0.55	0.98	0.11	-0.44	1	1	1540	847	1540	169.4	-677.6	Forest Group B
890	0.9	0.55	0.98	0.11	-0.44	2	2	1780	979	1780	195.8	-783.2	
						Total		3,320	1,826	3,320	365	-1,461	-80 % Reduction

Table C-18. Method Difference (MD) Solar Loads for Torrent 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)	Torrent Creek Shade Curves
340	0.9	0.55	0.98	0.11	-0.44	1	1	340	187	340	37.4	-149.6	Forest Group B
1890	0.9	0.55	0.98	0.11	-0.44	2	2	3780	2079	3780	415.8	-1663.2	
						Total		4,120	2,266	4,120	453	-1,813	-80 % Reduction

Table C-19. Method Difference (MD) Solar Loads for Zee 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)	Zee Creek Shade Curves
720	0.9	0.55	0.98	0.11	-0.44	1	1	720	396	720	79.2	-316.8	Forest Group B
1260	0.9	0.55	0.98	0.11	-0.44	2	2	2520	1386	2520	277.2	-1108.8	
						Total		3,240	1,782	3,240	356	-1,426	-80 % Reduction

Table C-20. Method Difference (MD) Solar Loads for Youngs 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)	Youngs Creek Shade Curves
910	0.9	0.55	0.98	0.11	-0.44	1	1	910	500.5	910	100.1	-400.4	Forest Group C
1220	0.9	0.55	0.98	0.11	-0.44	2	2	2440	1342	2440	268.4	-1073.6	Forest Group B
1660	0.9	0.55	0.96	0.22	-0.33	3	3	4980	2739	4980	1095.6	-1643.4	
						Total		8,330	4,582	8,330	1,464	-3,117	-68 % Reduction

Table C-21. Method Difference (MD) Solar Loads for Homestead 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)	Homestead Creek Shade Curves
840	0.9	0.55	0.98	0.11	-0.44	1	1	840	462	840	92.4	-369.6	Forest Group C
1090	0.9	0.55	0.98	0.11	-0.44	2	2	2180	1199	2180	239.8	-959.2	Forest Group B
780	0.9	0.55	0.98	0.11	-0.44	1	1	780	429	780	85.8	-343.2	
250	0.9	0.55	0.98	0.11	-0.44	1	1	250	137.5	250	27.5	-110	
510	0.9	0.55	0.98	0.11	-0.44	2	2	1020	561	1020	112.2	-448.8	
1080	0.9	0.55	0.96	0.22	-0.33	3	3	3240	1782	3240	712.8	-1069.2	
1070	0.9	0.55	0.94	0.33	-0.22	4	4	4280	2354	4280	1412.4	-941.6	
210	0.9	0.55	0.94	0.33	-0.22	4	4	840	462	840	277.2	-184.8	
						Total		13,430	7,387	13,430	2,960	-4,426	-60 % Reduction

Table C-22. Method Difference (MD) Solar Loads for 1st East-side Pack River Tributary Below Homestead 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)	1st East-side Pack Trib bl Homestead
1990	0.9	0.55	0.98	0.11	-0.44	2	2	3980	2189	3980	437.8	-1751.2	Forest Group B
						Total		3,980	2,189	3,980	438	-1,751	-80 % Reduction

Table C-23. Method Difference (MD) Solar Loads for 1st West-side Pack River Tributary Below Homestead 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)	1st West-side Pack Trib bl Homestead
600	0.9	0.55	0.98	0.11	-0.44	1	1	600	330	600	66	-264	Forest Group B
2110	0.9	0.55	0.98	0.11	-0.44	2	2	4220	2321	4220	464.2	-1856.8	
						Total		4,820	2,651	4,820	530	-2,121	-80 % Reduction

Table C-24. Method Difference (MD) Solar Loads for 2nd East-side Pack River Tributary Below Homestead 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)	2nd East-side Pack Trib bl Homestead
1340	0.9	0.55	0.98	0.11	-0.44	1	1	1340	737	1340	147.4	-589.6	Forest Group B
390	0.9	0.55	0.98	0.11	-0.44	1	1	390	214.5	390	42.9	-171.6	
130	0.9	0.55	0.98	0.11	-0.44	1	1	130	71.5	130	14.3	-57.2	
						Total		1,860	1,023	1,860	205	-818	-80 % Reduction

Table C-25. Method Difference (MD) Solar Loads for Jeru 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)	Jeru Creek Shade Curves forest group B
750	0.9	0.55	0.98	0.11	-0.44	1	1	750	412.5	750	82.5	-330	
530	0.9	0.55	0.98	0.11	-0.44	2	2	1060	583	1060	116.6	-466.4	
1040	0.9	0.55	0.96	0.22	-0.33	3	3	3120	1716	3120	686.4	-1029.6	
920	0.9	0.55	0.94	0.33	-0.22	4	4	3680	2024	3680	1214.4	-809.6	
200	0.9	0.55	0.94	0.33	-0.22	4	4	800	440	800	264	-176	
850	0.9	0.55	0.91	0.495	-0.055	5	5	4250	2337.5	4250	2103.75	-233.75	
650	0.9	0.55	0.91	0.495	-0.055	5	5	3250	1787.5	3250	1608.75	-178.75	
						Total		16,910	9,301	16,910	6,076	-3,224	-35 % Reduction

Table C-26. Method Difference (MD) Solar Loads for the Forked Tributaries to Jeru 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)	Forked Trib to Jeru Creek forest group B
110	0.9	0.55	0.98	0.11	-0.44	1	1	110	60.5	110	12.1	-48.4	
1240	0.9	0.55	0.98	0.11	-0.44	2	2	2480	1364	2480	272.8	-1091.2	
380	0.9	0.55	0.96	0.22	-0.33	3	3	1140	627	1140	250.8	-376.2	
580	0.9	0.55	0.96	0.22	-0.33	3	3	1740	957	1740	382.8	-574.2	
640	0.9	0.55	0.98	0.11	-0.44	1	1	640	352	640	70.4	-281.6	
890	0.9	0.55	0.98	0.11	-0.44	2	2	1780	979	1780	195.8	-783.2	
480	0.9	0.55	0.96	0.22	-0.33	3	3	1440	792	1440	316.8	-475.2	
720	0.9	0.55	0.94	0.33	-0.22	4	4	2880	1584	2880	950.4	-633.6	
140	0.9	0.55	0.94	0.33	-0.22	4	4	560	308	560	184.8	-123.2	
						Total		12,770	7,024	12,770	2,637	-4,387	-62 % Reduction

Table C-27. Method Difference (MD) Solar Loads for Pearson 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)	Pearson Creek Shade Curves
460	0.9	0.55	0.98	0.11	-0.44	1	1	460	253	460	50.6	-202.4	Forest Group B
340	0.9	0.55	0.98	0.11	-0.44	1	1	340	187	340	37.4	-149.6	Nonforest Group 1
190	0.9	0.55	0.98	0.11	-0.44	1	1	190	104.5	190	20.9	-83.6	
70	0.9	0.55	0.98	0.11	-0.44	1	1	70	38.5	70	7.7	-30.8	Forest Group B
470	0.9	0.55	0.98	0.11	-0.44	2	2	940	517	940	103.4	-413.6	
100	0.9	0.55	0.98	0.11	-0.44	2	2	200	110	200	22	-88	
300	0.9	0.55	0.98	0.11	-0.44	2	2	600	330	600	66	-264	
650	0.9	0.55	0.98	0.11	-0.44	2	2	1300	715	1300	143	-572	
750	0.9	0.55	0.96	0.22	-0.33	3	3	2250	1237.5	2250	495	-742.5	
1920	0.9	0.55	0.94	0.33	-0.22	4	4	7680	4224	7680	2534.4	-1689.6	
						Total		14,030	7,717	14,030	3,480	-4,236	-55 % Reduction

Table C-28. Method Difference (MD) Solar Loads for Martin 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)	Martin Creek Shade Curves
2020	0.9	0.55	0.98	0.11	-0.44	2	2	4040	2222	4040	444.4	-1777.6	Forest Group B
2270	0.9	0.55	0.98	0.11	-0.44	2	2	4540	2497	4540	499.4	-1997.6	
1030	0.9	0.55	0.96	0.22	-0.33	3	3	3090	1699.5	3090	679.8	-1019.7	
300	0.9	0.55	0.94	0.33	-0.22	4	4	1200	660	1200	396	-264	
						Total		12,870	7,079	12,870	2,020	-5,059	-71 % Reduction

Table C-29. Method Difference (MD) Solar Loads for Blane 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)	Blane Creek Shade Curves
990	0.9	0.55	0.98	0.11	-0.44	1	1	990	544.5	990	108.9	-435.6	Forest Group B
790	0.9	0.55	0.98	0.11	-0.44	2	2	1580	869	1580	173.8	-695.2	
1890	0.9	0.55	0.98	0.11	-0.44	1	1	1890	1039.5	1890	207.9	-831.6	
490	0.9	0.55	0.98	0.11	-0.44	2	2	980	539	980	107.8	-431.2	
600	0.9	0.55	0.96	0.22	-0.33	3	3	1800	990	1800	396	-594	
110	0.9	0.55	0.96	0.22	-0.33	3	3	330	181.5	330	72.6	-108.9	
						Total		7,570	4,164	7,570	1,067	-3,097	-74 % Reduction

Table C-30. Method Difference (MD) Solar Loads for Lindsey 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)	Lindsey Creek Shade Curves
290	0.9	0.55	0.98	0.11	-0.44	1	1	290	159.5	290	31.9	-127.6	Forest Group B
1790	0.9	0.55	0.98	0.11	-0.44	2	2	3580	1969	3580	393.8	-1575.2	
620	0.9	0.55	0.98	0.11	-0.44	1	1	620	341	620	68.2	-272.8	
660	0.9	0.55	0.98	0.11	-0.44	1	1	660	363	660	72.6	-290.4	
1140	0.9	0.55	0.98	0.11	-0.44	2	2	2280	1254	2280	250.8	-1003.2	
670	0.9	0.55	0.98	0.11	-0.44	2	2	1340	737	1340	147.4	-589.6	
1480	0.9	0.55	0.96	0.22	-0.33	3	3	4440	2442	4440	976.8	-1465.2	
520	0.7	1.65	0.78	1.21	-0.44	4	4	2080	3432	2080	2516.8	-915.2	
1290	0.7	1.65	0.78	1.21	-0.44	4	4	5160	8514	5160	6243.6	-2270.4	Nonforest Group 1
						Total		20,450	19,212	20,450	10,702	-8,510	-44 % Reduction

Table C-31. Method Difference (MD) Solar Loads for Hellroaring 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)	Hellroaring Creek
270	0.9	0.55	0.96	0.22	-0.33	3	3	810	445.5	810	178.2	-267.3	Forest Group B
590	0.9	0.55	0.96	0.22	-0.33	3	3	1770	973.5	1770	389.4	-584.1	
130	0.9	0.55	0.96	0.22	-0.33	3	3	390	214.5	390	85.8	-128.7	
690	0.9	0.55	0.96	0.22	-0.33	3	3	2070	1138.5	2070	455.4	-683.1	
170	0.9	0.55	0.94	0.33	-0.22	4	4	680	374	680	224.4	-149.6	
350	0.9	0.55	0.94	0.33	-0.22	4	4	1400	770	1400	462	-308	
1240	0.9	0.55	0.94	0.33	-0.22	4	4	4960	2728	4960	1636.8	-1091.2	
120	0.9	0.55	0.91	0.495	-0.055	5	5	600	330	600	297	-33	
160	0.9	0.55	0.91	0.495	-0.055	5	5	800	440	800	396	-44	
250	0.9	0.55	0.91	0.495	-0.055	5	5	1250	687.5	1250	618.75	-68.75	
120	0.9	0.55	0.91	0.495	-0.055	5	5	600	330	600	297	-33	
160	0.9	0.55	0.91	0.495	-0.055	5	5	800	440	800	396	-44	
240	0.9	0.55	0.91	0.495	-0.055	5	5	1200	660	1200	594	-66	
290	0.9	0.55	0.91	0.495	-0.055	5	5	1450	797.5	1450	717.75	-79.75	
570	0.9	0.55	0.91	0.495	-0.055	5	5	2850	1567.5	2850	1410.75	-156.75	
1680	0.8	1.1	0.89	0.605	-0.495	6	6	10080	11088	10080	6098.4	-4989.6	
500	0.8	1.1	0.83	0.935	-0.165	7	7	3500	3850	3500	3272.5	-577.5	
400	0.8	1.1	0.83	0.935	-0.165	7	7	2800	3080	2800	2618	-462	
180	0.6	2.2	0.6	2.2	0	7	7	1260	2772	1260	2772	0	Nonforest Group 1
150	0.6	2.2	0.6	2.2	0	7	7	1050	2310	1050	2310	0	
80	0.6	2.2	0.6	2.2	0	7	7	560	1232	560	1232	0	
200	0.6	2.2	0.6	2.2	0	7	7	1400	3080	1400	3080	0	
						Total		42,280	39,309	42,280	29,542	-9,766	-25 % Reduction

Table C-32. Method Difference (MD) Solar Loads for the Forked Tributaries to Hellroaring 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)	Upper and Lower Forks to Hellroaring
1780	0.9	0.55	0.98	0.11	-0.44	2	2	3560	1958	3560	391.6	-1566.4	Forest Group B
200	0.9	0.55	0.98	0.11	-0.44	1	1	200	110	200	22	-88	Forest Group C
800	0.9	0.55	0.98	0.11	-0.44	2	2	1600	880	1600	176	-704	Forest Group B
730	0.9	0.55	0.96	0.22	-0.33	3	3	2190	1204.5	2190	481.8	-722.7	
170	0.9	0.55	0.96	0.22	-0.33	3	3	510	280.5	510	112.2	-168.3	
						Total		8,060	4,433	8,060	1,184	-3,249	-73 % Reduction

Table C-33. Method Difference (MD) Solar Loads for 3rd Tributary to Hellroaring 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)	3rd Trib to Hellroaring Creek
1030	0.9	0.55	0.98	0.11	-0.44	1	1	1030	566.5	1030	113.3	-453.2	
1030	0.9	0.55	0.98	0.11	-0.44	2	2	2060	1133	2060	226.6	-906.4	
430	0.9	0.55	0.96	0.22	-0.33	3	3	1290	709.5	1290	283.8	-425.7	
330	0.9	0.55	0.96	0.22	-0.33	3	3	990	544.5	990	217.8	-326.7	
320	0.9	0.55	0.94	0.33	-0.22	4	4	1280	704	1280	422.4	-281.6	
						Total		6,650	3,658	6,650	1,264	-2,394	-65 % Reduction

Table C-34. Method Difference (MD) Solar Loads for 4th Tributary to Hellroaring 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)	4th Trib to Hellroaring Creek
1090	0.9	0.55	0.98	0.11	-0.44	1	1	1090	599.5	1090	119.9	-479.6	
590	0.9	0.55	0.98	0.11	-0.44	2	2	1180	649	1180	129.8	-519.2	
160	0.9	0.55	0.96	0.22	-0.33	3	3	480	264	480	105.6	-158.4	
140	0.9	0.55	0.96	0.22	-0.33	3	3	420	231	420	92.4	-138.6	
						Total		3,170	1,744	3,170	448	-1,296	-74 % Reduction

Table C-35. Method Difference (MD) Solar Loads for Grouse 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)	Grouse Creek Shade Curves
670	0.9	0.55	0.98	0.11	-0.44	1	1	670	368.5	670	73.7	-294.8	forest group D
150	0.9	0.55	0.98	0.11	-0.44	1	1	150	82.5	150	16.5	-66	
2590	0.9	0.55	0.98	0.11	-0.44	2	2	5180	2849	5180	569.8	-2279.2	forest group B
410	0.9	0.55	0.96	0.22	-0.33	3	3	1230	676.5	1230	270.6	-405.9	
3510	0.9	0.55	0.94	0.33	-0.22	4	4	14040	7722	14040	4633.2	-3088.8	
260	0.9	0.55	0.91	0.495	-0.055	5	5	1300	715	1300	643.5	-71.5	
350	0.9	0.55	0.91	0.495	-0.055	5	5	1750	962.5	1750	866.25	-96.25	
360	0.9	0.55	0.91	0.495	-0.055	5	5	1800	990	1800	891	-99	
270	0.9	0.55	0.91	0.495	-0.055	5	5	1350	742.5	1350	668.25	-74.25	
540	0.9	0.55	0.91	0.495	-0.055	5	5	2700	1485	2700	1336.5	-148.5	
330	0.8	1.1	0.89	0.605	-0.495	6	6	1980	2178	1980	1197.9	-980.1	
210	0.8	1.1	0.89	0.605	-0.495	6	6	1260	1386	1260	762.3	-623.7	
510	0.8	1.1	0.89	0.605	-0.495	6	6	3060	3366	3060	1851.3	-1514.7	
180	0.6	2.2	0.65	1.925	-0.275	6	6	1080	2376	1080	2079	-297	nonforest group 1
690	0.6	2.2	0.6	2.2	0	7	7	4830	10626	4830	10626	0	
180	0.6	2.2	0.6	2.2	0	7	7	1260	2772	1260	2772	0	
260	0.6	2.2	0.6	2.2	0	7	7	1820	4004	1820	4004	0	
530	0.6	2.2	0.6	2.2	0	7	7	3710	8162	3710	8162	0	
500	0.5	2.75	0.52	2.64	-0.11	9	9	4500	12375	4500	11880	-495	
130	0.5	2.75	0.52	2.64	-0.11	9	9	1170	3217.5	1170	3088.8	-128.7	
660	0.5	2.75	0.52	2.64	-0.11	9	9	5940	16335	5940	15681.6	-653.4	
360	0.5	2.75	0.52	2.64	-0.11	9	9	3240	8910	3240	8553.6	-356.4	
430	0.5	2.75	0.52	2.64	-0.11	9	9	3870	10642.5	3870	10216.8	-425.7	
650	0.4	3.3	0.48	2.86	-0.44	10	10	6500	21450	6500	18590	-2860	
130	0.4	3.3	0.48	2.86	-0.44	10	10	1300	4290	1300	3718	-572	
350	0.4	3.3	0.48	2.86	-0.44	10	10	3500	11550	3500	10010	-1540	
280	0.4	3.3	0.48	2.86	-0.44	10	10	2800	9240	2800	8008	-1232	
140	0.4	3.3	0.48	2.86	-0.44	10	10	1400	4620	1400	4004	-616	
430	0.4	3.3	0.48	2.86	-0.44	10	10	4300	14190	4300	12298	-1892	
350	0.4	3.3	0.45	3.025	-0.275	11	11	3850	12705	3850	11646.25	-1058.75	
550	0.4	3.3	0.45	3.025	-0.275	11	11	6050	19965	6050	18301.25	-1663.75	
1010	0.4	3.3	0.45	3.025	-0.275	11	11	11110	36663	11110	33607.75	-3055.25	
1280	0.4	3.3	0.41	3.245	-0.055	12	12	15360	50688	15360	49843.2	-844.8	
880	0.4	3.3	0.41	3.245	-0.055	12	12	10560	34848	10560	34267.2	-580.8	
400	0.4	3.3	0.41	3.245	-0.055	12	12	4800	15840	4800	15576	-264	
570	0.4	3.3	0.41	3.245	-0.055	12	12	6840	22572	6840	22195.8	-376.2	
670	0.4	3.3	0.41	3.245	-0.055	12	12	8040	26532	8040	26089.8	-442.2	
640	0.4	3.3	0.41	3.245	-0.055	12	12	7680	25344	7680	24921.6	-422.4	
730	0.4	3.3	0.41	3.245	-0.055	12	12	8760	28908	8760	28426.2	-481.8	
260	0.4	3.3	0.41	3.245	-0.055	12	12	3120	10296	3120	10124.4	-171.6	
700	0.4	3.3	0.41	3.245	-0.055	12	12	8400	27720	8400	27258	-462	
210	0.4	3.3	0.41	3.245	-0.055	12	12	2520	8316	2520	8177.4	-138.6	
590	0.4	3.3	0.41	3.245	-0.055	12	12	7080	23364	7080	22974.6	-389.4	
2870	0.3	3.85	0.39	3.355	-0.495	13	13	37310	143643.5	37310	125175.05	-18468.45	
270	0.3	3.85	0.39	3.355	-0.495	13	13	3510	13513.5	3510	11776.05	-1737.45	
260	0.3	3.85	0.39	3.355	-0.495	13	13	3380	13013	3380	11339.9	-1673.1	
3810	0.3	3.85	0.39	3.355	-0.495	13	13	49530	190690.5	49530	166173.15	-24517.35	
180	0.3	3.85	0.39	3.355	-0.495	13	13	2340	9009	2340	7850.7	-1158.3	
770	0.3	3.85	0.39	3.355	-0.495	13	13	10010	38538.5	10010	33583.55	-4954.95	
						Total		297,940	920,453	297,940	836,780	-83,672	-9 % Reduction

Table C-36. Method Difference (MD) Solar Loads for the North Fork Grouse Creek and its Tributaries.

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)	NF Grouse Creek Shade Curves
390	0.9	0.55	0.98	0.11	-0.44	1	1	390	214.5	390	42.9	-171.6	forest group D
1300	0.9	0.55	0.96	0.22	-0.33	2	2	2600	1430	2600	572	-858	
1120	0.9	0.55	0.96	0.22	-0.33	3	3	3360	1848	3360	739.2	-1108.8	forest group B
2120	0.9	0.55	0.96	0.22	-0.33	3	3	6360	3498	6360	1399.2	-2098.8	
3620	0.9	0.55	0.96	0.22	-0.33	3	3	10860	5973	10860	2389.2	-3583.8	
3480	0.9	0.55	0.96	0.22	-0.33	3	3	10440	5742	10440	2296.8	-3445.2	
530	0.9	0.55	0.98	0.11	-0.44	1	1	530	291.5	530	58.3	-233.2	
2020	0.9	0.55	0.98	0.11	-0.44	2	2	4040	2222	4040	444.4	-1777.6	
2480	0.9	0.55	0.96	0.22	-0.33	3	3	7440	4092	7440	1636.8	-2455.2	nonforest group 1
2700	0.9	0.55	0.94	0.33	-0.22	4	4	10800	5940	10800	3564	-2376	
320	0.7	1.65	0.72	1.54	-0.11	5	5	1600	2640	1600	2464	-176	
510	0.7	1.65	0.72	1.54	-0.11	5	5	2550	4207.5	2550	3927	-280.5	
490	0.7	1.65	0.72	1.54	-0.11	5	5	2450	4042.5	2450	3773	-269.5	
200	0.6	2.2	0.65	1.925	-0.275	6	6	1200	2640	1200	2310	-330	
660	0.6	2.2	0.65	1.925	-0.275	6	6	3960	8712	3960	7623	-1089	
1070	0.6	2.2	0.65	1.925	-0.275	6	6	6420	14124	6420	12358.5	-1765.5	
1270	0.6	2.2	0.6	2.2	0	7	7	8890	19558	8890	19558	0	
970	0.5	2.75	0.55	2.475	-0.275	8	8	7760	21340	7760	19206	-2134	
580	0.5	2.75	0.55	2.475	-0.275	8	8	4640	12760	4640	11484	-1276	
						Total		96,290	121,275	96,290	95,846	-25,429	-21 % Reduction

Table C-37. Method Difference (MD) Solar Loads for North Gold 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)	Gold Creek Shade Curves
3170	0.9	0.55	0.98	0.11	-0.44	1	1	3170	1743.5	3170	348.7	-1394.8	forest group B
270	0.9	0.55	0.94	0.33	-0.22	2	2	540	297	540	178.2	-118.8	
1180	0.9	0.55	0.94	0.33	-0.22	2	2	2360	1298	2360	778.8	-519.2	nonforest group 1
650	0.8	1.1	0.86	0.77	-0.33	3	3	1950	2145	1950	1501.5	-643.5	
440	0.8	1.1	0.86	0.77	-0.33	3	3	1320	1452	1320	1016.4	-435.6	
650	0.7	1.65	0.78	1.21	-0.44	4	4	2600	4290	2600	3146	-1144	
430	0.7	1.65	0.78	1.21	-0.44	4	4	1720	2838	1720	2081.2	-756.8	
320	0.7	1.65	0.72	1.54	-0.11	5	5	1600	2640	1600	2464	-176	
440	0.7	1.65	0.72	1.54	-0.11	5	5	2200	3630	2200	3388	-242	
210	0.7	1.65	0.72	1.54	-0.11	5	5	1050	1732.5	1050	1617	-115.5	
1950	0.6	2.2	0.65	1.925	-0.275	6	6	11700	25740	11700	22522.5	-3217.5	
900	0.6	2.2	0.65	1.925	-0.275	6	6	5400	11880	5400	10395	-1485	
370	0.6	2.2	0.65	1.925	-0.275	6	6	2220	4884	2220	4273.5	-610.5	
160	0.6	2.2	0.65	1.925	-0.275	6	6	960	2112	960	1848	-264	
240	0.6	2.2	0.6	2.2	0	7	7	1680	3696	1680	3696	0	
120	0.6	2.2	0.6	2.2	0	7	7	840	1848	840	1848	0	
960	0.6	2.2	0.6	2.2	0	7	7	6720	14784	6720	14784	0	
480	0.6	2.2	0.6	2.2	0	7	7	3360	7392	3360	7392	0	
300	0.6	2.2	0.6	2.2	0	7	7	2100	4620	2100	4620	0	
						Total		53,490	99,022	53,490	87,899	-11,123	-11 % Reduction

Table C-38. Method Difference (MD) Solar Loads for Rapid Lightning 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)	Rapid Lightning Creek Shade Curves
670	0.6	2.2	0.65	1.925	-0.275	6	6	4020	8844	4020	7738.5	-1105.5	nonforest group 1
230	0.6	2.2	0.6	2.2	0	7	7	1610	3542	1610	3542	0	
1020	0.6	2.2	0.6	2.2	0	7	7	7140	15708	7140	15708	0	
70	0.6	2.2	0.6	2.2	0	7	7	490	1078	490	1078	0	
380	0.5	2.75	0.55	2.475	-0.275	8	8	3040	8360	3040	7524	-836	
650	0.5	2.75	0.55	2.475	-0.275	8	8	5200	14300	5200	12870	-1430	
350	0.5	2.75	0.55	2.475	-0.275	8	8	2800	7700	2800	6930	-770	
200	0.5	2.75	0.55	2.475	-0.275	8	8	1600	4400	1600	3960	-440	
480	0.5	2.75	0.52	2.64	-0.11	9	9	4320	11880	4320	11404.8	-475.2	
1360	0.5	2.75	0.52	2.64	-0.11	9	9	12240	33660	12240	32313.6	-1346.4	
250	0.4	3.3	0.43	3.135	-0.165	10	10	2500	8250	2500	7837.5	-412.5	nonforest group 2
720	0.4	3.3	0.43	3.135	-0.165	10	10	7200	23760	7200	22572	-1188	
1130	0.4	3.3	0.41	3.245	-0.055	11	11	12430	41019	12430	40335.35	-683.65	
990	0.4	3.3	0.41	3.245	-0.055	11	11	10890	35937	10890	35338.05	-598.95	
610	0.4	3.3	0.41	3.245	-0.055	11	11	6710	22143	6710	21773.95	-369.05	
310	0.4	3.3	0.41	3.245	-0.055	11	11	3410	11253	3410	11065.45	-187.55	
180	0.4	3.3	0.41	3.245	-0.055	11	11	1980	6534	1980	6425.1	-108.9	
450	0.3	3.85	0.38	3.41	-0.44	12	12	5400	20790	5400	18414	-2376	
130	0.3	3.85	0.38	3.41	-0.44	12	12	1560	6006	1560	5319.6	-686.4	
380	0.3	3.85	0.38	3.41	-0.44	12	12	4560	17556	4560	15549.6	-2006.4	
140	0.3	3.85	0.38	3.41	-0.44	12	12	1680	6468	1680	5728.8	-739.2	
430	0.3	3.85	0.38	3.41	-0.44	12	12	5160	19866	5160	17595.6	-2270.4	
190	0.3	3.85	0.38	3.41	-0.44	12	12	2280	8778	2280	7774.8	-1003.2	
180	0.3	3.85	0.38	3.41	-0.44	12	12	2160	8316	2160	7365.6	-950.4	
140	0.3	3.85	0.38	3.41	-0.44	12	12	1680	6468	1680	5728.8	-739.2	
1310	0.3	3.85	0.38	3.41	-0.44	12	12	15720	60522	15720	53605.2	-6916.8	
						Total		127,780	413,138	127,780	385,498	-27,640	-7 % Reduction

Table C-39. Method Difference (MD) 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)	Trout Creek Shade Curves
1330	0.9	0.55	0.98	0.11	-0.44	1	1	1330	731.5	1330	146.3	-585.2	forest group B
400	0.9	0.55	0.98	0.11	-0.44	2	2	800	440	800	88	-352	
710	0.9	0.55	0.98	0.11	-0.44	2	2	1420	781	1420	156.2	-624.8	
400	0.8	1.1	0.86	0.77	-0.33	3	3	1200	1320	1200	924	-396	nonforest group 1
2190	0.9	0.55	0.94	0.33	-0.22	4	4	8760	4818	8760	2890.8	-1927.2	forest group B
2400	0.9	0.55	0.91	0.495	-0.055	5	5	12000	6600	12000	5940	-660	nonforest group 1
370	0.6	2.2	0.65	1.925	-0.275	6	6	2220	4884	2220	4273.5	-610.5	
						Total		27,730	19,575	27,730	14,419	-5,156	-26 % Reduction

Table C-40. Method Difference (MD) Solar Loads for Trestle 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)	Trestle Creek Shade Curves
610	0.9	0.55	0.98	0.11	-0.44	1	1	610	335.5	610	67.1	-268.4	forest group C
1490	0.9	0.55	0.97	0.165	-0.385	2	2	2980	1639	2980	491.7	-1147.3	
530	0.9	0.55	0.96	0.22	-0.33	3	3	1590	874.5	1590	349.8	-524.7	forest group B
10190	0.9	0.55	0.91	0.495	-0.055	5	5	50950	28022.5	50950	25220.25	-2802.25	
660	0.5	2.75	0.55	2.475	-0.275	8	8	5280	14520	5280	13068	-1452	nonforest group 1
550	0.5	2.75	0.55	2.475	-0.275	8	8	4400	12100	4400	10890	-1210	
						Total		65,810	57,492	65,810	50,087	-7,405	-13 % Reduction

Table C-41. Method Difference (MD) 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)	Sand Creek (PO) Shade Curves
440	0.9	0.55	0.98	0.11	-0.44	1	1	440	242	440	48.4	-193.6	nonforest group 1
70	0.9	0.55	0.98	0.11	-0.44	1	1	70	38.5	70	7.7	-30.8	
690	0.9	0.55	0.94	0.33	-0.22	2	2	1380	759	1380	455.4	-303.6	
360	0.8	1.1	0.86	0.77	-0.33	3	3	1080	1188	1080	831.6	-356.4	
400	0.8	1.1	0.86	0.77	-0.33	3	3	1200	1320	1200	924	-396	
1140	0.7	1.65	0.78	1.21	-0.44	4	4	4560	7524	4560	5517.6	-2006.4	
90	0.7	1.65	0.72	1.54	-0.11	5	5	450	742.5	450	693	-49.5	
120	0.7	1.65	0.72	1.54	-0.11	5	5	600	990	600	924	-66	
150	0.7	1.65	0.72	1.54	-0.11	5	5	750	1237.5	750	1155	-82.5	
150	0.7	1.65	0.72	1.54	-0.11	5	5	750	1237.5	750	1155	-82.5	
80	0.7	1.65	0.72	1.54	-0.11	5	5	400	660	400	616	-44	
290	0.7	1.65	0.72	1.54	-0.11	5	5	1450	2392.5	1450	2233	-159.5	
220	0.7	1.65	0.72	1.54	-0.11	5	5	1100	1815	1100	1694	-121	
430	0.6	2.2	0.65	1.925	-0.275	6	6	2580	5676	2580	4966.5	-709.5	
610	0.6	2.2	0.65	1.925	-0.275	6	6	3660	8052	3660	7045.5	-1006.5	
380	0.6	2.2	0.6	2.2	0	7	7	2660	5852	2660	5852	0	
60	0.6	2.2	0.6	2.2	0	7	7	420	924	420	924	0	
160	0.6	2.2	0.6	2.2	0	7	7	1120	2464	1120	2464	0	
510	0.6	2.2	0.6	2.2	0	7	7	3570	7854	3570	7854	0	
360	0.5	2.75	0.55	2.475	-0.275	8	8	2880	7920	2880	7128	-792	
990	0.5	2.75	0.55	2.475	-0.275	8	8	7920	21780	7920	19602	-2178	
1910	0.5	2.75	0.52	2.64	-0.11	9	9	17190	47272.5	17190	45381.6	-1890.9	
770	0.5	2.75	0.52	2.64	-0.11	9	9	6930	19057.5	6930	18295.2	-762.3	
140	0.4	3.3	0.48	2.86	-0.44	10	10	1400	4620	1400	4004	-616	
380	0.4	3.3	0.45	3.025	-0.275	11	11	4180	13794	4180	12644.5	-1149.5	
1090	0.4	3.3	0.41	3.245	-0.055	12	12	13080	43164	13080	42444.6	-719.4	
						Total		81,820	208,577	81,820	194,861	-13,716	-7 % Reduction

Table C-42. Method Difference (MD) Solar Loads for Granite 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)	Granite Creek Shade Curves
340	0.9	0.55	0.98	0.11	-0.44	1	1	340	187	340	37.4	-149.6	forest group B
1410	0.9	0.55	0.98	0.11	-0.44	2	2	2820	1551	2820	310.2	-1240.8	
2550	0.9	0.55	0.96	0.22	-0.33	3	3	7650	4207.5	7650	1683	-2524.5	
2060	0.9	0.55	0.91	0.495	-0.055	5	5	10300	5665	10300	5098.5	-566.5	
1930	0.6	2.2	0.65	1.925	-0.275	6	6	11580	25476	11580	22291.5	-3184.5	nonforest group 1
320	0.6	2.2	0.65	1.925	-0.275	6	6	1920	4224	1920	3696	-528	
1590	0.6	2.2	0.65	1.925	-0.275	6	6	9540	20988	9540	18364.5	-2623.5	
2230	0.8	1.1	0.83	0.935	-0.165	7	7	15610	17171	15610	14595.35	-2575.65	forest group B
1150	0.5	2.75	0.55	2.475	-0.275	8	8	9200	25300	9200	22770	-2530	nonforest group 1
410	0.5	2.75	0.55	2.475	-0.275	8	8	3280	9020	3280	8118	-902	
870	0.5	2.75	0.52	2.64	-0.11	9	9	7830	21532.5	7830	20671.2	-861.3	
380	0.5	2.75	0.52	2.64	-0.11	9	9	3420	9405	3420	9028.8	-376.2	
290	0.5	2.75	0.52	2.64	-0.11	9	9	2610	7177.5	2610	6890.4	-287.1	
						Total		86,100	151,905	86,100	133,555	-18,350	-12 % Reduction

Table C-43. Method Difference (MD) Solar Loads for Cedar 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)	Cedar Creek Shade Curves
180	0.9	0.55	0.98	0.11	-0.44	1	1	180	99	180	19.8	-79.2	forest group B
150	0.9	0.55	0.98	0.11	-0.44	1	1	150	82.5	150	16.5	-66	
230	0.9	0.55	0.98	0.11	-0.44	1	1	230	126.5	230	25.3	-101.2	
250	0.9	0.55	0.98	0.11	-0.44	1	1	250	137.5	250	27.5	-110	
210	0.9	0.55	0.98	0.11	-0.44	1	1	210	115.5	210	23.1	-92.4	
350	0.9	0.55	0.98	0.11	-0.44	1	1	350	192.5	350	38.5	-154	
110	0.9	0.55	0.98	0.11	-0.44	2	2	220	121	220	24.2	-96.8	
470	0.9	0.55	0.98	0.11	-0.44	2	2	940	517	940	103.4	-413.6	
310	0.9	0.55	0.98	0.11	-0.44	2	2	620	341	620	68.2	-272.8	
670	0.9	0.55	0.98	0.11	-0.44	2	2	1340	737	1340	147.4	-589.6	
90	0.9	0.55	0.96	0.22	-0.33	3	3	270	148.5	270	59.4	-89.1	nonforest group 1
100	0.8	1.1	0.86	0.77	-0.33	3	3	300	330	300	231	-99	
460	0.8	1.1	0.86	0.77	-0.33	3	3	1380	1518	1380	1062.6	-455.4	
370	0.8	1.1	0.86	0.77	-0.33	3	3	1110	1221	1110	854.7	-366.3	
250	0.8	1.1	0.86	0.77	-0.33	3	3	750	825	750	577.5	-247.5	
1530	0.7	1.65	0.78	1.21	-0.44	4	4	6120	10098	6120	7405.2	-2692.8	
220	0.7	1.65	0.72	1.54	-0.11	5	5	1100	1815	1100	1694	-121	
400	0.7	1.65	0.72	1.54	-0.11	5	5	2000	3300	2000	3080	-220	
100	0.7	1.65	0.72	1.54	-0.11	5	5	500	825	500	770	-55	
400	0.7	1.65	0.72	1.54	-0.11	5	5	2000	3300	2000	3080	-220	
						Total		20,020	25,850	20,020	19,308	-6,542	-25 % Reduction

Table C-44. Method Difference (MD) Solar Loads for 'South' Gold 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)	Gold Creek (PO) Shade Curves
350	0.9	0.55	0.98	0.11	-0.44	1	1	350	192.5	350	38.5	-154	forest group B
1940	0.9	0.55	0.98	0.11	-0.44	2	2	3880	2134	3880	426.8	-1707.2	
400	0.9	0.55	0.96	0.22	-0.33	3	3	1200	660	1200	264	-396	
940	0.9	0.55	0.94	0.33	-0.22	4	4	3760	2068	3760	1240.8	-827.2	
1550	0.9	0.55	0.91	0.495	-0.055	5	5	7750	4262.5	7750	3836.25	-426.25	
1080	0.6	2.2	0.65	1.925	-0.275	6	6	6480	14256	6480	12474	-1782	nonforest group 1
220	0.6	2.2	0.65	1.925	-0.275	6	6	1320	2904	1320	2541	-363	forest group B
410	0.8	1.1	0.83	0.935	-0.165	7	7	2870	3157	2870	2683.45	-473.55	
670	0.8	1.1	0.83	0.935	-0.165	7	7	4690	5159	4690	4385.15	-773.85	
710	0.8	1.1	0.83	0.935	-0.165	7	7	4970	5467	4970	4646.95	-820.05	
450	0.5	2.75	0.55	2.475	-0.275	8	8	3600	9900	3600	8910	-990	nonforest group 1
170	0.5	2.75	0.55	2.475	-0.275	8	8	1360	3740	1360	3366	-374	nonforest group 1
130	0.5	2.75	0.55	2.475	-0.275	8	8	1040	2860	1040	2574	-286	
370	0.5	2.75	0.55	2.475	-0.275	8	8	2960	8140	2960	7326	-814	
560	0.5	2.75	0.55	2.475	-0.275	8	8	4480	12320	4480	11088	-1232	
						Total		50,710	77,220	50,710	65,801	-11,419	-15 % Reduction

Table C-45. Method Difference (MD) Solar Loads for Upper Tributaries to Gold 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)	Tribes to Gold Creek (PO) Shade Curves
290	0.9	0.55	0.98	0.11	-0.44	1	1	290	159.5	290	31.9	-127.6	forest group B
1460	0.9	0.55	0.98	0.11	-0.44	2	2	2920	1606	2920	321.2	-1284.8	
130	0.9	0.55	0.98	0.11	-0.44	2	2	260	143	260	28.6	-114.4	
180	0.9	0.55	0.98	0.11	-0.44	1	1	180	99	180	19.8	-79.2	
370	0.9	0.55	0.98	0.11	-0.44	1	1	370	203.5	370	40.7	-162.8	
370	0.9	0.55	0.98	0.11	-0.44	2	2	740	407	740	81.4	-325.6	
680	0.9	0.55	0.98	0.11	-0.44	2	2	1360	748	1360	149.6	-598.4	
350	0.9	0.55	0.98	0.11	-0.44	1	1	350	192.5	350	38.5	-154	
950	0.9	0.55	0.98	0.11	-0.44	2	2	1900	1045	1900	209	-836	
920	0.9	0.55	0.96	0.22	-0.33	3	3	2760	1518	2760	607.2	-910.8	
						Total		11,130	6,122	11,130	1,528	-4,594	-75 % Reduction

Table C-46. Method Difference (MD) Solar Loads for Chloride Gulch and Tributaries.

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)	Chloride Gulch Shade Curves
1580	0.9	0.55	0.98	0.11	-0.44	2	2	3160	1738	3160	347.6	-1390.4	forest group B
310	0.9	0.55	0.98	0.11	-0.44	1	1	310	170.5	310	34.1	-136.4	
400	0.9	0.55	0.98	0.11	-0.44	1	1	400	220	400	44	-176	
360	0.9	0.55	0.98	0.11	-0.44	1	1	360	198	360	39.6	-158.4	
1080	0.9	0.55	0.98	0.11	-0.44	2	2	2160	1188	2160	237.6	-950.4	
270	0.9	0.55	0.98	0.11	-0.44	1	1	270	148.5	270	29.7	-118.8	
210	0.9	0.55	0.98	0.11	-0.44	1	1	210	115.5	210	23.1	-92.4	
470	0.9	0.55	0.98	0.11	-0.44	1	1	470	258.5	470	51.7	-206.8	
1750	0.9	0.55	0.98	0.11	-0.44	2	2	3500	1925	3500	385	-1540	
350	0.9	0.55	0.94	0.33	-0.22	2	2	700	385	700	231	-154	nonforest group 1
390	0.9	0.55	0.98	0.11	-0.44	1	1	390	214.5	390	42.9	-171.6	forest group B
580	0.9	0.55	0.98	0.11	-0.44	2	2	1160	638	1160	127.6	-510.4	
140	0.9	0.55	0.98	0.11	-0.44	2	2	280	154	280	30.8	-123.2	
1560	0.8	1.1	0.86	0.77	-0.33	3	3	4680	5148	4680	3603.6	-1544.4	nonforest group 1
830	0.7	1.65	0.78	1.21	-0.44	4	4	3320	5478	3320	4017.2	-1460.8	
280	0.9	0.55	0.94	0.33	-0.22	4	4	1120	616	1120	369.6	-246.4	forest group B
250	0.9	0.55	0.91	0.495	-0.055	5	5	1250	687.5	1250	618.75	-68.75	
340	0.9	0.55	0.91	0.495	-0.055	5	5	1700	935	1700	841.5	-93.5	
280	0.9	0.55	0.91	0.495	-0.055	5	5	1400	770	1400	693	-77	
						Total		26,840	20,988	26,840	11,768	-9,220	-44 % Reduction

Table C-47. Method Difference (MD) Solar Loads for West Gold Creek and Tributaries.

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)	West Gold Creek Shade Curves
1610	0.9	0.55	0.98	0.11	-0.44	2	2	3220	1771	3220	354.2	-1416.8	forest group B
170	0.9	0.55	0.98	0.11	-0.44	1	1	170	93.5	170	18.7	-74.8	
170	0.9	0.55	0.98	0.11	-0.44	1	1	170	93.5	170	18.7	-74.8	
1470	0.9	0.55	0.98	0.11	-0.44	2	2	2940	1617	2940	323.4	-1293.6	
350	0.9	0.55	0.98	0.11	-0.44	1	1	350	192.5	350	38.5	-154	
440	0.9	0.55	0.98	0.11	-0.44	1	1	440	242	440	48.4	-193.6	
970	0.9	0.55	0.98	0.11	-0.44	2	2	1940	1067	1940	213.4	-853.6	
90	0.9	0.55	0.98	0.11	-0.44	1	1	90	49.5	90	9.9	-39.6	
1810	0.9	0.55	0.98	0.11	-0.44	2	2	3620	1991	3620	398.2	-1592.8	
990	0.9	0.55	0.98	0.11	-0.44	1	1	990	544.5	990	108.9	-435.6	
380	0.9	0.55	0.98	0.11	-0.44	1	1	380	209	380	41.8	-167.2	
1180	0.9	0.55	0.98	0.11	-0.44	2	2	2360	1298	2360	259.6	-1038.4	
280	0.9	0.55	0.94	0.33	-0.22	2	2	560	308	560	184.8	-123.2	nonforest group 1
740	0.8	1.1	0.86	0.77	-0.33	3	3	2220	2442	2220	1709.4	-732.6	
870	0.9	0.55	0.96	0.22	-0.33	3	3	2610	1435.5	2610	574.2	-861.3	forest group B
300	0.7	1.65	0.78	1.21	-0.44	4	4	1200	1980	1200	1452	-528	nonforest group 1
700	0.9	0.55	0.94	0.33	-0.22	4	4	2800	1540	2800	924	-616	forest group B
170	0.9	0.55	0.94	0.33	-0.22	4	4	680	374	680	224.4	-149.6	
1310	0.9	0.55	0.91	0.495	-0.055	5	5	6550	3602.5	6550	3242.25	-360.25	
810	0.8	1.1	0.89	0.605	-0.495	6	6	4860	5346	4860	2940.3	-2405.7	
690	0.8	1.1	0.89	0.605	-0.495	6	6	4140	4554	4140	2504.7	-2049.3	
						Total		42,290	30,751	42,290	15,590	-15,161	-49 % Reduction

Table C-48. Method Difference (MD) Solar Loads for Kick Bush and Cheer Creeks.

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)	Kick Bush & Cheer Creeks Shade Curves
3790	0.9	0.55	0.98	0.11	-0.44	2	2	7580	4169	7580	833.8	-3335.2	forest group B
2710	0.9	0.55	0.98	0.11	-0.44	2	2	5420	2981	5420	596.2	-2384.8	
960	0.9	0.55	0.94	0.33	-0.22	4	4	3840	2112	3840	1267.2	-844.8	
						Total		16,840	9,262	16,840	2,697	-6,565	-71 % Reduction

Table C-49. Method Difference (MD) Solar Loads for Upper Cocolalla 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)	Upper Cocolalla Creek Shade Curves
940	0.9	0.55	0.98	0.11	-0.44	1	1	940	517	940	103.4	-413.6	forest group B
410	0.9	0.55	0.98	0.11	-0.44	1	1	410	225.5	410	45.1	-180.4	
250	0.9	0.55	0.98	0.11	-0.44	2	2	500	275	500	55	-220	
350	0.9	0.55	0.98	0.11	-0.44	2	2	700	385	700	77	-308	
220	0.9	0.55	0.94	0.33	-0.22	2	2	440	242	440	145.2	-96.8	nonforest group 1
280	0.9	0.55	0.94	0.33	-0.22	2	2	560	308	560	184.8	-123.2	
340	0.9	0.55	0.94	0.33	-0.22	2	2	680	374	680	224.4	-149.6	
700	0.9	0.55	0.96	0.22	-0.33	3	3	2100	1155	2100	462	-693	
600	0.9	0.55	0.96	0.22	-0.33	3	3	1800	990	1800	396	-594	forest group B
890	0.9	0.55	0.94	0.33	-0.22	4	4	3560	1958	3560	1174.8	-783.2	
360	0.7	1.65	0.78	1.21	-0.44	4	4	1440	2376	1440	1742.4	-633.6	
930	0.7	1.65	0.72	1.54	-0.11	5	5	4650	7672.5	4650	7161	-511.5	
400	0.7	1.65	0.72	1.54	-0.11	5	5	2000	3300	2000	3080	-220	nonforest group 1
570	0.7	1.65	0.72	1.54	-0.11	5	5	2850	4702.5	2850	4389	-313.5	
290	0.6	2.2	0.65	1.925	-0.275	6	6	1740	3828	1740	3349.5	-478.5	
580	0.6	2.2	0.65	1.925	-0.275	6	6	3480	7656	3480	6699	-957	
90	0.6	2.2	0.65	1.925	-0.275	6	6	540	1188	540	1039.5	-148.5	nonforest group 1
150	0.6	2.2	0.65	1.925	-0.275	6	6	900	1980	900	1732.5	-247.5	
320	0.6	2.2	0.65	1.925	-0.275	6	6	1920	4224	1920	3696	-528	
240	0.6	2.2	0.65	1.925	-0.275	6	6	1440	3168	1440	2772	-396	
360	0.6	2.2	0.65	1.925	-0.275	6	6	2160	4752	2160	4158	-594	nonforest group 1
760	0.6	2.2	0.6	2.2	0	7	7	5320	11704	5320	11704	0	
180	0.6	2.2	0.6	2.2	0	7	7	1260	2772	1260	2772	0	
230	0.6	2.2	0.6	2.2	0	7	7	1610	3542	1610	3542	0	
270	0.6	2.2	0.6	2.2	0	7	7	1890	4158	1890	4158	0	nonforest group 1
180	0.6	2.2	0.6	2.2	0	7	7	1260	2772	1260	2772	0	
120	0.6	2.2	0.6	2.2	0	7	7	840	1848	840	1848	0	
1390	0.5	2.75	0.55	2.475	-0.275	8	8	11120	30580	11120	27522	-3058	
2300	0.5	2.75	0.55	2.475	-0.275	8	8	18400	50600	18400	45540	-5060	nonforest group 1
170	0.5	2.75	0.52	2.64	-0.11	9	9	1530	4207.5	1530	4039.2	-168.3	
160	0.5	2.75	0.52	2.64	-0.11	9	9	1440	3960	1440	3801.6	-158.4	
650	0.5	2.75	0.52	2.64	-0.11	9	9	5850	16087.5	5850	15444	-643.5	
150	0.5	2.75	0.52	2.64	-0.11	9	9	1350	3712.5	1350	3564	-148.5	nonforest group 1
190	0.5	2.75	0.52	2.64	-0.11	9	9	1710	4702.5	1710	4514.4	-188.1	
30	0.5	2.75	0.52	2.64	-0.11	9	9	270	742.5	270	712.8	-29.7	
20	0.5	2.75	0.52	2.64	-0.11	9	9	180	495	180	475.2	-19.8	
30	0.5	2.75	0.52	2.64	-0.11	9	9	270	742.5	270	712.8	-29.7	nonforest group 1
360	0.5	2.75	0.52	2.64	-0.11	9	9	3240	8910	3240	8553.6	-356.4	
190	0.5	2.75	0.52	2.64	-0.11	9	9	1710	4702.5	1710	4514.4	-188.1	
180	0.5	2.75	0.52	2.64	-0.11	9	9	1620	4455	1620	4276.8	-178.2	
130	0.5	2.75	0.52	2.64	-0.11	9	9	1170	3217.5	1170	3088.8	-128.7	nonforest group 1
220	0.5	2.75	0.52	2.64	-0.11	9	9	1980	5445	1980	5227.2	-217.8	
800	0.4	3.3	0.48	2.86	-0.44	10	10	8000	26400	8000	22880	-3520	
150	0.4	3.3	0.48	2.86	-0.44	10	10	1500	4950	1500	4290	-660	
360	0.4	3.3	0.48	2.86	-0.44	10	10	3600	11880	3600	10296	-1584	nonforest group 1
30	0.4	3.3	0.48	2.86	-0.44	10	10	300	990	300	858	-132	
30	0.4	3.3	0.48	2.86	-0.44	10	10	300	990	300	858	-132	
30	0.4	3.3	0.48	2.86	-0.44	10	10	300	990	300	858	-132	
220	0.4	3.3	0.48	2.86	-0.44	10	10	2200	7260	2200	6292	-968	nonforest group 1
260	0.4	3.3	0.48	2.86	-0.44	10	10	2600	8580	2600	7436	-1144	
350	0.4	3.3	0.48	2.86	-0.44	10	10	3500	11550	3500	10010	-1540	
220	0.4	3.3	0.48	2.86	-0.44	10	10	2200	7260	2200	6292	-968	
470	0.4	3.3	0.45	3.025	-0.275	11	11	5170	17061	5170	15639.25	-1421.75	nonforest group 1
410	0.4	3.3	0.45	3.025	-0.275	11	11	4510	14883	4510	13642.75	-1240.25	
410	0.4	3.3	0.45	3.025	-0.275	11	11	4510	14883	4510	13642.75	-1240.25	
390	0.4	3.3	0.45	3.025	-0.275	11	11	4290	14157	4290	12977.25	-1179.75	
200	0.4	3.3	0.45	3.025	-0.275	11	11	2200	7260	2200	6655	-605	nonforest group 1
210	0.4	3.3	0.45	3.025	-0.275	11	11	2310	7623	2310	6987.75	-635.25	
340	0.4	3.3	0.45	3.025	-0.275	11	11	3740	12342	3740	11313.5	-1028.5	
640	0.4	3.3	0.41	3.245	-0.055	12	12	7680	25344	7680	24921.6	-422.4	
480	0.4	3.3	0.41	3.245	-0.055	12	12	5760	19008	5760	18691.2	-316.8	nonforest group 1
290	0.4	3.3	0.41	3.245	-0.055	12	12	3480	11484	3480	11292.6	-191.4	
810	0.4	3.3	0.41	3.245	-0.055	12	12	9720	32076	9720	31541.4	-534.6	
20	0.4	3.3	0.41	3.245	-0.055	12	12	240	792	240	778.8	-13.2	
20	0.4	3.3	0.41	3.245	-0.055	12	12	240	792	240	778.8	-13.2	nonforest group 1
20	0.4	3.3	0.41	3.245	-0.055	12	12	240	792	240	778.8	-13.2	
140	0.6	2.2	0.65	1.925	-0.275	6	6	840	1848	840	1617	-231	
200	0.6	2.2	0.65	1.925	-0.275	6	6	1200	2640	1200	2310	-330	
						Total		179,460	484,468	179,460	445,108	-39,360	-8 % Reduction

Table C-50. Method Difference (MD) Solar Loads for Fish 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)	Fish Creek Shade Curves
510	0.6	2.2	0.65	1.925	-0.28	6	6	3060	6732	3060	5890.5	-841.5	nonforest group 1
450	0.6	2.2	0.65	1.925	-0.28	6	6	2700	5940	2700	5197.5	-742.5	
1000	0.8	1.1	0.89	0.605	-0.495	6	6	6000	6600	6000	3630	-2970	forest group B
540	0.6	2.2	0.65	1.925	-0.275	6	6	3240	7128	3240	6237	-891	nonforest group 1
330	0.6	2.2	0.65	1.925	-0.275	6	6	1980	4356	1980	3811.5	-544.5	
250	0.6	2.2	0.65	1.925	-0.275	6	6	1500	3300	1500	2887.5	-412.5	
470	0.6	2.2	0.65	1.925	-0.275	6	6	2820	6204	2820	5428.5	-775.5	
260	0.6	2.2	0.65	1.925	-0.275	6	6	1560	3432	1560	3003	-429	
Total								22,860	43,692	22,860	36,086	-7,607	-17 % Reduction

Table C-51. Method Difference (MD) Solar Loads for Lower Cocolalla 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)	Lower Cocolalla Creek Shade Curves
3860	0	5.5	0	5.5	0	1000	1000	3,860,000	21,230,000	3,860,000	21,230,000	0	Cocolalla Lake
340	0.5	2.75	0.55	2.475	-0.28	8	8	2,720	7,480	2,720	6,732	-748	nonforest group 1
590	0.5	2.75	0.55	2.475	-0.275	8	8	4,720	12,980	4,720	11,682	-1,298	
480	0.5	2.75	0.55	2.475	-0.275	8	8	3,840	10,560	3,840	9,504	-1,056	
310	0.5	2.75	0.55	2.475	-0.275	8	8	2,480	6,820	2,480	6,138	-682	
380	0.5	2.75	0.55	2.475	-0.275	8	8	3,040	8,360	3,040	7,524	-836	
430	0.5	2.75	0.55	2.475	-0.275	8	8	3,440	9,460	3,440	8,514	-946	
200	0.5	2.75	0.55	2.475	-0.275	8	8	1,600	4,400	1,600	3,960	-440	
160	0.5	2.75	0.55	2.475	-0.275	8	8	1,280	3,520	1,280	3,168	-352	
280	0.5	2.75	0.55	2.475	-0.275	8	8	2,240	6,160	2,240	5,544	-616	
130	0.5	2.75	0.55	2.475	-0.275	8	8	1,040	2,860	1,040	2,574	-286	
340	0.5	2.75	0.55	2.475	-0.275	8	8	2,720	7,480	2,720	6,732	-748	
160	0.5	2.75	0.55	2.475	-0.275	8	8	1,280	3,520	1,280	3,168	-352	
120	0.5	2.75	0.52	2.64	-0.11	9	9	1,080	2,970	1,080	2,851	-119	
150	0.5	2.75	0.52	2.64	-0.11	9	9	1,350	3,713	1,350	3,564	-149	
280	0.5	2.75	0.52	2.64	-0.11	9	9	2,520	6,930	2,520	6,653	-277	
140	0.5	2.75	0.52	2.64	-0.11	9	9	1,260	3,465	1,260	3,326	-139	
290	0.5	2.75	0.52	2.64	-0.11	9	9	2,610	7,178	2,610	6,890	-287	
440	0	5.5	0	5.5	0	500	500	220,000	1,210,000	220,000	1,210,000	0	Round Lake
760	0.5	2.75	0.52	2.64	-0.11	9	9	6,840	18,810	6,840	18,058	-752	nonforest group 1
160	0.5	2.75	0.52	2.64	-0.11	9	9	1,440	3,960	1,440	3,802	-158	
220	0.5	2.75	0.52	2.64	-0.11	9	9	1,980	5,445	1,980	5,227	-218	
220	0.5	2.75	0.52	2.64	-0.11	9	9	1,980	5,445	1,980	5,227	-218	
140	0.5	2.75	0.52	2.64	-0.11	9	9	1,260	3,465	1,260	3,326	-139	
750	0.5	2.75	0.52	2.64	-0.11	9	9	6,750	18,563	6,750	17,820	-743	
700	0.5	2.75	0.52	2.64	-0.11	9	9	6,300	17,325	6,300	16,632	-693	
60	0.5	2.75	0.52	2.64	-0.11	9	9	540	1,485	540	1,426	-59	
4700	0	5.5	0	5.5	0	175	175	822,500	4,523,750	822,500	4,523,750	0	water
Total								4,968,810	27,146,103	4,968,810	27,133,792	-12,310	-0.05 % reduction

Table C-52. Method Difference (MD) Solar Loads for Hoodoo 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)	Hoodoo Creek Shade Curves
330	0.9	0.55	0.98	0.11	-0.44	1	1	330	181.5	330	36.3	-145.2	forest group B
270	0.9	0.55	0.98	0.11	-0.44	1	1	270	148.5	270	29.7	-118.8	
220	0.9	0.55	0.98	0.11	-0.44	1	1	220	121	220	24.2	-96.8	nonforest group 1
1710	0.9	0.55	0.94	0.33	-0.22	2	2	3420	1881	3420	1128.6	-752.4	
1600	0.8	1.1	0.86	0.77	-0.33	3	3	4800	5280	4800	3696	-1584	
760	0.7	1.65	0.78	1.21	-0.44	4	4	3040	5016	3040	3678.4	-1337.6	
1320	0.7	1.65	0.72	1.54	-0.11	5	5	6600	10890	6600	10164	-726	
870	0.6	2.2	0.65	1.925	-0.275	6	6	5220	11484	5220	10048.5	-1435.5	
690	0.6	2.2	0.6	2.2	0	7	7	4830	10626	4830	10626	0	
110	0.6	2.2	0.6	2.2	0	7	7	770	1694	770	1694	0	
210	0.6	2.2	0.6	2.2	0	7	7	1470	3234	1470	3234	0	
80	0.6	2.2	0.6	2.2	0	7	7	560	1232	560	1232	0	
1540	0.5	2.75	0.55	2.475	-0.275	8	8	12320	33880	12320	30492	-3388	
100	0.5	2.75	0.52	2.64	-0.11	9	9	900	2475	900	2376	-99	
480	0.5	2.75	0.52	2.64	-0.11	9	9	4320	11880	4320	11404.8	-475.2	
1360	0	5.5	0	5.5	0	230	230	312800	1720400	312800	1720400	0	water
2980	0.4	3.3	0.48	2.86	-0.44	10	10	29800	98340	29800	85228	-13112	
320	0.4	3.3	0.45	3.025	-0.275	11	11	3520	11616	3520	10648	-968	
9300	0.3	3.85	0.39	3.355	-0.495	13	13	120900	465465	120900	405619.5	-59845.5	
350	0.3	3.85	0.37	3.465	-0.385	14	14	4900	18865	4900	16978.5	-1886.5	
490	0.3	3.85	0.35	3.575	-0.275	15	15	7350	28297.5	7350	26276.25	-2021.25	
190	0.3	3.85	0.35	3.575	-0.275	15	15	2850	10972.5	2850	10188.75	-783.75	
120	0.3	3.85	0.35	3.575	-0.275	15	15	1800	6930	1800	6435	-495	
200	0.3	3.85	0.35	3.575	-0.275	15	15	3000	11550	3000	10725	-825	
110	0.3	3.85	0.35	3.575	-0.275	15	15	1650	6352.5	1650	5898.75	-453.75	
70	0.3	3.85	0.35	3.575	-0.275	15	15	1050	4042.5	1050	3753.75	-288.75	
70	0.3	3.85	0.35	3.575	-0.275	15	15	1050	4042.5	1050	3753.75	-288.75	
150	0.3	3.85	0.35	3.575	-0.275	15	15	2250	8662.5	2250	8043.75	-618.75	
120	0.3	3.85	0.35	3.575	-0.275	15	15	1800	6930	1800	6435	-495	
80	0.3	3.85	0.35	3.575	-0.275	15	15	1200	4620	1200	4290	-330	
480	0.3	3.85	0.35	3.575	-0.275	15	15	7200	27720	7200	25740	-1980	
390	0.3	3.85	0.35	3.575	-0.275	15	15	5850	22522.5	5850	20913.75	-1608.75	
50	0.3	3.85	0.35	3.575	-0.275	15	15	750	2887.5	750	2681.25	-206.25	
						Total		558,790	2,560,239	558,790	2,463,874	-96,365	-4 % Reduction

Appendix D. Public Comments

Document Section	Commenter	Comments	Response	Page
5.1 <i>In-stream Water Quality Targets</i>	Panhandle BAG	The Draft TMDL document indicates that the lower reach of Sand Creek is not included in the temperature TMDL for Sand Creek. The fact that the lower reach is inundated when the LPO level is raised during the summer months should not preclude development of a temperature TMDL for this reach. I suggest that the TMDL for temperature be extended to the mouth of Sand Creek.	These changes have been incorporated into the document.	36-38

Appendix E. Distribution List

Pend Oreille River WAG members:

Greg Becker, U.S.D.A. Natural Resources Conservation Service
Lori Blau, Ponderay Newsprint Company
Pat Buckley, Pend Oreille Public Utility District
Lori Burchett, Bonner County Planning Department
Randy Curliss, City of Dover
Jamie Davis, Bonner Soil & Water Conservation District
Kent Easthouse, U.S. Army Corps of Engineers
Glenda Empsall/Marc Brinkmeyer, Riley Creek Lumber Company
Russ Fletcher, Pend Oreille Conservation District
Todd Johnson, Water association and Agriculture
Jon Jones, Washington Department of Ecology
Ray King, City of Newport
Mike Lithgow, Pend Oreille County Public Works Department
Bill Love, Idaho Department of Lands
Don Martin, U.S. Environmental Protection Agency
Jim Martin, City of Priest River
Brock Morgan/Kevin Kinsella, Teck Cominco American Inc.
Christine Pratt, Seattle City Light
Patty Perry, Kootenai Tribe of Idaho
Helen Rueda, U.S. Environmental Protection Agency
Jaime Short, Washing Department of Ecology
Tom Shuhda, U.S. Forest Service, Colville National Forest
Jim Vander Ploeg, Stimson Lumber Company
Kody VanDyk, City of Sandpoint
Paul Van Middlesworth, Golder Associates, Inc.
Ruth Watkins, Tri-State Water Quality Council
Gary Westcott, Southside Water & Sewer District
Michelle Wingert, Kalispel Tribe

Tributary Work Group members (those, which are not on the WAG):

Channing Swan, Stimson Lumber Company
Charlie Holderman,
Ted Runley, City of Priest River
Jessica Erickson,
Kate Wilson, Lakes Commission
Donna DeFrancesco, Golder

Appendix X. System Potential Effective Shade for the Pend Oreille Basin

Appendix X – System Potential Effective Shade

This document contains estimates of “system potential landcover” conditions for riparian areas for both “forested” and “non-forested” areas within the Pend Oreille Basin. Methods used to delineate between forest and non-forest riparian areas is presented in **Section X-1**. Subsequently, methods to further delineate these groups into various subcategories are presented for both “forest” and “non-forest” riparian groups (Presented in **Sections X-2**, and **X-3**, respectively). “System potential effective shade” conditions were calculated for the individual subcategories for each group.

Section X-1. “Forest/Non-forest” Delineation Method

Background - System Potential Effective Shade Defined

Primary factors that affect shade are near stream vegetation height and channel width (i.e. bankfull width). The maximum level of shade practical at a particular site is termed the “system potential” effective shade level. System Potential Effective Shade occurs when:

1. Near stream vegetation is at a mature life stage
 - Vegetation community is mature and undisturbed from anthropogenic sources;
 - Vegetation height and density is at or near the potential expected for the given plant community;
 - Vegetation is sufficiently wide to maximize solar attenuation; and
 - Vegetation width should accommodate channel migrations.
2. Channel width reflects a suitable range for hydrologic process given that near stream vegetation is at a mature life stage
 - Stream banks reflect appropriate ranges of stability via vegetation rooting strength and floodplain roughness;
 - Sedimentation reflects appropriate levels of sediment input and transport;
 - Substrate is appropriate to channel type; and
 - Local high flow shear velocities are within appropriate ranges based on watershed hydrology and climate.

It is important to distinguish between site potential shade, and system potential shade. System potential shade is a broad scale view of shade conditions along a stream. It could be expected that site potential shade would be greater than system potential shade because over a large area, such as a river reach, it is unlikely that all sites will be at their potential due to localized natural disturbances (e.g., fire, flood, landslide, disease), causing some fraction of the area to be in a less than a “mature” condition. Accordingly, a disturbance component is included in the development “system potential landcover”, which is subsequently used to calculate “system potential effective shade” conditions.

Background - Landcover and Riparian Conditions

Currently, approximately 72% of landcover within the Pend Oreille Basin is categorized as “forest” by the National Landcover Dataset (**Figure X-1**). These “forest” areas are located throughout the basin. The remaining “non-forest” areas are primarily located in low elevation, and low surface gradient areas of the basin.

The following discussion on historic riparian vegetation conditions for both upland (i.e., “forest”) and lowland (i.e., “non-forest”) areas within the Pend Oreille basin was obtained from the Fish and Wildlife subbasin plan.¹

“Historic vegetation patterns in the Upper Pend Oreille Subbasin were largely influenced by wildfire. Early accounts and photographs of the Subbasin indicate that old-growth stands of western red cedar, Thuja plicates, and other species were common in riparian zones and floodplains. Large cedar stumps can still be found in many riparian areas along Subbasin streams. Uplands were more typically dominated by seral species in various stages of succession, with age and composition dependent largely on fire cycles, elevation, slope, and aspect.

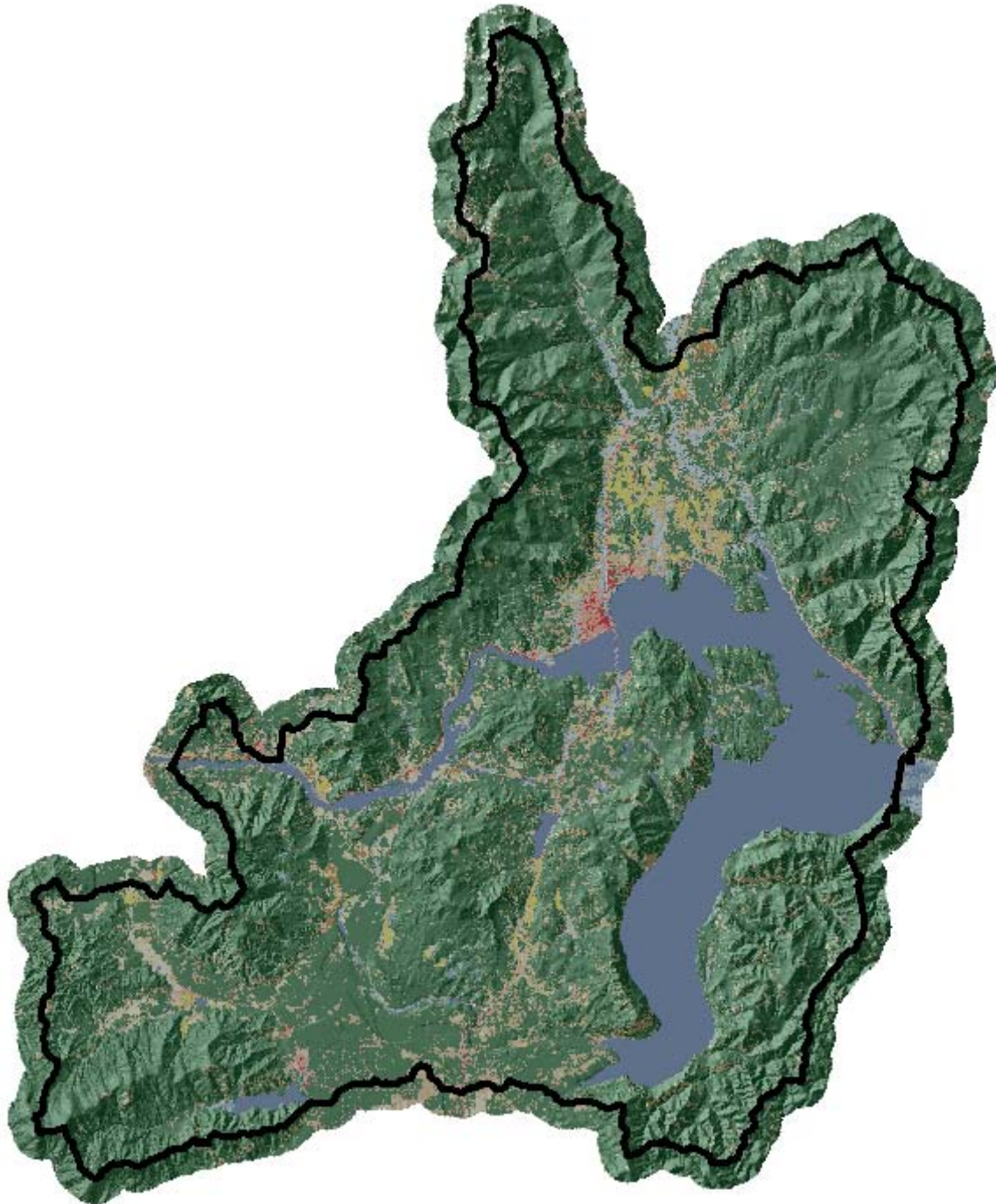
Low elevation riparian zones near tributary mouths include areas with and without tree canopy cover. Along stream corridors where tree overstory does not exist or is thin, vegetation includes shrubs and small trees such as thin-leaf alder, Alnus sinuate; willows, Salix spp.; snowberry, Symphoricarpos albus; mountain maple, Acer glabrum; red-osier dogwood, Cornus stolonifera; blue elderberry, Sambucus cerulea; and black hawthorn, Crataegus douglasii. Where tree canopy is present, tree species include black cottonwood, Populus trichocarpa; water birch, Betula occidentalis; quaking aspen, Populus tremuloides; and a mix of conifer species including western red cedar, Thuja plicates; western hemlock, Tsuga heterophylla; Douglas fir, Psuedotsuga menziesi; grand fir, Abies grandis; and western white pine, Pinus monticola.”

As can be seen in the description above, a higher proportion of upland vegetation is present within the riparian zone for streams within the “forested” areas. Accordingly, there is a need to account for this variability in the landscape when developing **system potential effective shade** conditions for the Pend Oreille basin.

Methods used to estimate system potential riparian landcover for “forested” areas of the basin are presented in Section X-2, and “non-forest” areas are presented in Section X-3. **Aquatic Response Units (ARU)** was used to designate between these two groups and methods are presented in the following pages.

¹ Obtained from - <http://www.nwcouncil.org/fw/subbasinplanning/admin/level2/intermtn/plan/>

Figure X-1. Landcover Designations in the Pend Oreille Basin.
(Forested areas illustrated by green)
[Source – National Landcover Dataset 2000]



Aquatic Response Unit (ARU)

The Aquatic Response Unit (ARU) is a method which the USFS uses to understand the composition, structure, and function of riparian vegetation. ARUs are determined by temporal and spatial patterns of hydrologic and geomorphic processes within defined valley bottoms of predetermined widths. Departure from a range of variability and/or a proper functioning condition can be determined by either comparison to reference stream reaches within a given valley bottom type (or ARU) undisturbed by human influence or from an understanding of aquatic processes developed through ARUs.

The Kootenai National Forest has developed an ARU classification and inventory. The ARUs were grouped based on overall similar descriptive characteristics. Summary description for allocated ARUs classes is presented in **Table X-1**. As can be seen in Table X-1, there are four groups associated with ARU classifications -

1. Group 1: Steep Headwater Streams
2. Group 2: Moderate Gradient , Small to Mid-sized Streams
3. Group 3: Low Gradient, Small to Mid-sized Streams, and
4. Group 4: Low Gradient, Large Streams.

These groups are subsequently subdivided into the individual ARUs. Each ARU is coded so the first number reflects the dominant stream order. The second and third letters reflect the overall gradient (stream gradient) where “A” is the highest gradient and “C” is the lowest gradient. Additional detailed information can be found in the draft ARU document on file at the Supervisor’s Office in Libby. The Idaho Panhandle National Forest (IPNF) has developed input parameters associated with ARU development (sinuosity, gradient, Rosgen, stream order, valley bottom width), but has not yet completed the final classification work.

This input data was obtained from IPNF staff and was used to develop an “ARU filter” for the Pend Oreille basin. The “ARU filter” was used to delineate between “forest” and “non-forest” riparian classes within the Pend Oreille basin. Specifically, general conditions presented in the KNF ARU document for the four ARU Groups (**Table X-2**) were used to establish the benchmarks (**Table X-3**) used in the development of the “ARU filter” groups for the Pend Oreille.

As can be seen in Table X-3, stream order (**Figure X-2**) and stream gradient are the parameters used to develop the “ARU filter” groupings (**Figure X-3**). These parameters were found to efficiently delineate areas of “forest” riparian areas vs. “non-forest” riparian areas. Specifically, “ARU filter Group A” are small to medium sized streams with a moderate to high stream gradient. These areas are more likely to have a higher proportion of forest type upland vegetation within the riparian zone. “ARU filter Group B” are low gradient reaches of small and medium sized streams. Similarly “ARU filter Group C” are also low gradient streams, but are large in size.

Table X-1. Summary of ARUs on the Kootenai National Forest.

Group	ARU	Proportion of the KNF	Description	Vegetation
1	1A	33%	First and some second order, very steep streams. Commonly found at elevations between 3000-5500'. Major landtype groups are 300 and 400 series. Valley bottoms are narrow.	Grand fir, Black Cottonwood, Western Redcedar, Western Hemlock, Common Snowberry,
1	1AB	19%	First and 2 nd order, steep streams. Commonly found at elevations between 2500-5500'. Major landtype group is 300 series. Valley bottoms are fairly narrow.	Western Redcedar, Mountain Alder, Sitka Alder, Fools's Huckleberry, Drummond Willow, Arnica
1	3AB	1%	Third order, steep streams. Commonly found at elevations below 4500'. Major landtype groups are 300 and 400 series, followed by 100 series. Valley bottoms are fairly narrow.	Grand fir, Western Redcedar, Rocky Mountain Maple, Common Prince's-pine, Twinflower, Thimbleberry
2	1B	17%	First and second order, moderate gradient streams. Mainly found at elevations between 2500-5000'. Most common landtype group is 300 series, followed by the 100 then the 400 series. Valley bottoms are moderately wide.	Engelmann Spruce, Western Redcedar, Sitka Alder, Sphagnum sp., Ticklegass, Oak-fern
2	1B	17%	First and second order, moderate gradient streams. Mainly found at elevations between 2500-5000'. Most common landtype group is 300 series, followed by the 100 then the 400 series. Valley bottoms are moderately wide.	Engelmann Spruce, Western Redcedar, Sitka Alder, Sphagnum sp., Ticklegass, Oak-fern
2	3B	4%	Third order, moderate gradient streams. Mainly found at elevations between 2500-4500'. Most common landtype group is the 300 series, followed by the 100 and 400 series. Valley bottoms are moderately wide.	Grand fir, Paper Birch, Western Redcedar, Western Hemlock, Sitka Alder, Fools's Huckleberry, Devil's Club,
2	4B		Characteristics of this group include 1 st , 2 nd , and 3 rd order streams with low gradient, higher sinuosity, and wide valley bottoms.	
3	1C	7%	First and second order, low gradient streams. Commonly found at elevations between 2000-4000'. Major landtype groups are 100 and 300 series. Valley bottoms are wide.	Spruce, Sitka Alder, Thimbleberry, Reedgrass, Ladyfern,
3	3C	5%	Third order, low gradient streams. Commonly found at elevations between 2000-4500'. Major landtype groups are 100 and 300 series. Valley bottoms are wide.	Grand fir, Engelmann Spruce, Black Cottonwood, Red-osier Dogwood, Douglas Spiraea, Ticklegass,
4	4C	6%	Fourth order, low gradient streams. Mainly found at elevations below 4000'. Major landtype groups are 100 and 300 series. Valley bottoms are wide.	Paper Birch, Paper Birch, Balsam Poplar, Scouler Willow, Bentgrass, Beaked Sedge, Reed Canarygrass, Fowl Bluegrass
4	5C	2%	Fifth order, low gradient streams. Commonly found at elevations below 3500'. Major landtype group is the 100 series. Valley bottoms are wide.	Black Cottonwood, Western Redcedar, Shrubby Cinquefoil, Reed Canarygrass, Ladyfern
4	6C	1%	Average gradient is 1%. Gradient and sinuosity were computer generated and may differ from actual measurements. Sixth order streams are large and typically occur in the lowest reaches of the watershed at elevations under 3000'. The average width of the valley bottom in ARU 6C is 355 meters.	Paper Birch, Western Larch, Engelmann Spruce, Western Redcedar, Western Hemlock, Common Snowberry
5	LT32	1%	These streams are within landtype group 325. Streams are generally low to moderate gradient and occur in fairly wide valley bottoms. Stream order is generally 3 rd order or smaller.	Engelmann Spruce, White Spruce, Rocky Mountain Maple, Alder, Alder Buckthorn, Redtop, Field Horsetail

Table X-2. Summary Stream Characteristics for ARU Groups

<i>Group 1 - Steep Headwater Streams</i>
The Kootenai National Forest describes this group as small (1 st and 2 nd order), fairly low sinuosity, and high gradient streams within narrow valley bottoms.
Riparian vegetation is characterized by upland coniferous forest.
<i>Group 2: Moderate gradient, small to mid-sized streams</i>
The Kootenai National Forest describes this group as small (1 st and 2 nd order) to mid-sized (3 rd to 4 th order) streams with moderate gradient and fairly low sinuosity.
Riparian vegetation is characterized by upland coniferous forest.
<i>Group 3: Low gradient, small to mid-sized streams</i>
The Kootenai National Forest describes this group as small (1 st and 2 nd order) to mid-sized (3 rd order) streams with low gradient and slight sinuosity.
Riparian Vegetation - 1 st and 2 nd Order Streams - Along lower gradient streams, valley bottom vegetation is shrub wetland, mountain alder community type on low alluvial terraces and upland coniferous forest on glacial outwash terraces. Along slightly higher gradient streams, vegetation is commonly upland coniferous forest and coniferous wetland. 3 rd Order Streams - Along lower gradient streams, valley bottom vegetation is herbaceous and shrub wetlands on low alluvial terraces and wetland coniferous forest such as spruce/red osier dogwood, spruce/field horsetail, or western redcedar/bracken fern on alluvial terraces. Along moderate gradient streams, valley bottom vegetation is dominated by upland coniferous forest and coniferous wetland.
<i>Group 4: Large, low gradient streams</i>
The Kootenai National Forest describes this group as mid-sized (4 th order) to large (5 th and 6 th order) streams with low gradient and fairly sinuous.
Low alluvial terraces support a complex pattern of herbaceous and shrub vegetation and upland coniferous forest on glacial outwash terraces.

Table X-3. Summary ARU filter Group Characteristics

<u>ARU filter Group A - Forest Riparian Group</u> • Stream Order – 1st, 2nd, 3rd and 4th • Stream gradient $\geq$ 3 percent
<u>ARU filter Group B - Non-Forest Riparian Group 1</u> • Stream Order – 1st, 2nd, 3rd and 4th • Stream gradient < 3 percent
<u>ARU filter Group C - Non-Forest Riparian Group 2</u> • Stream Order – 5th and 6th

Only thirteen percent of stream miles for 1st order streams had a gradient less than 3%. These areas were primarily located in the lower elevation valley locations with the basin (see Figure X-2). “ARU filter Group B” would be applied to these areas. The remaining 87% of stream miles for first order streams would be within the “ARU filter Group A” (e.g., Forest Riparian Groups). Similarly, the proportions of stream miles having a gradient less than 3% for 2nd, 3rd and 4th order streams is 33%, 54%, and 87%, respectively. (Once again, “ARU filter Group B” would be applied to these areas.)

Once again, Section X-1 will present methods used to estimate system potential riparian landcover for forested areas of the basin, and Section X-2 will present methods used for “non-forested” areas of the basin.

Figure X-2. Stream Order in the Pend Oreille Basin.

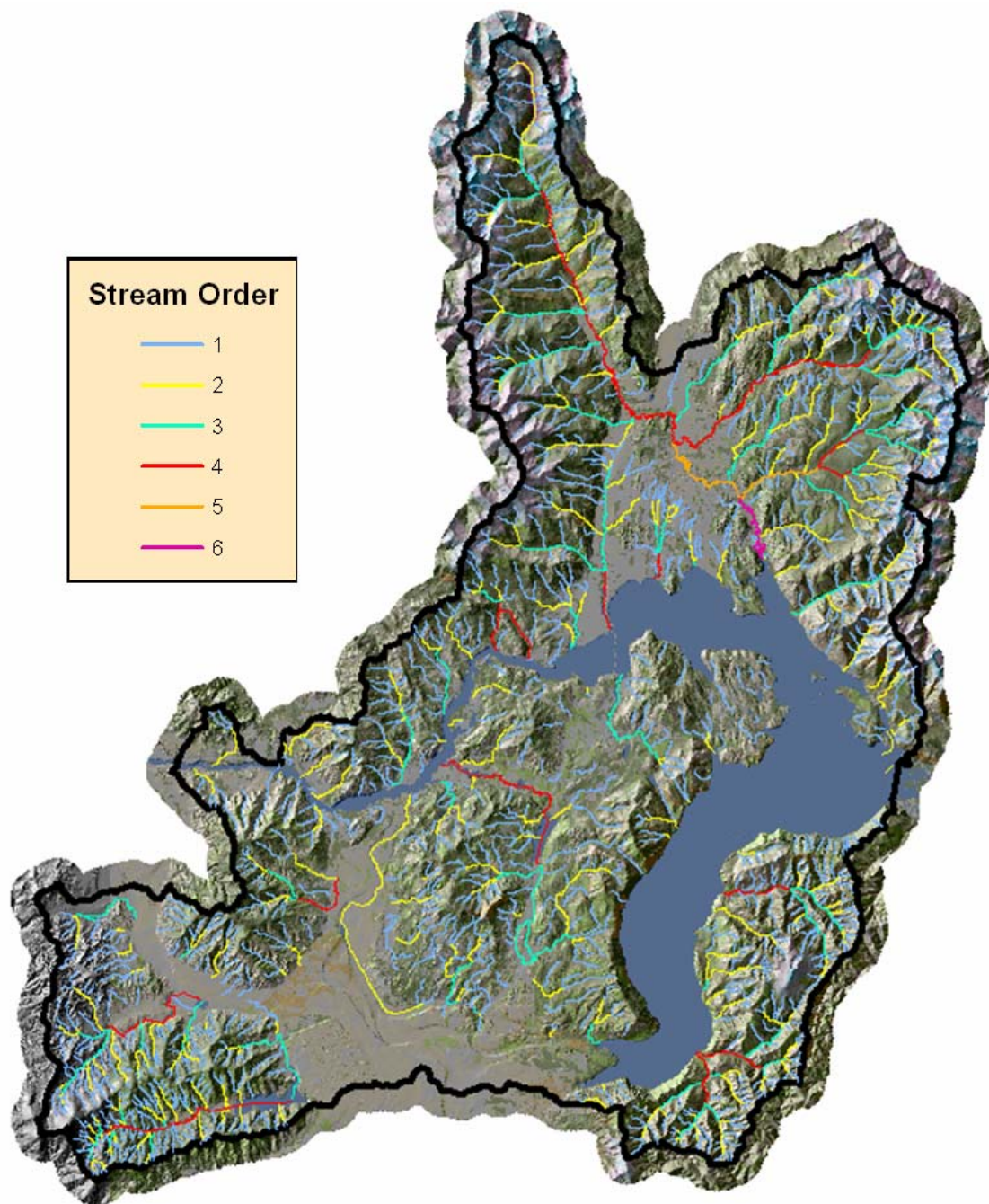
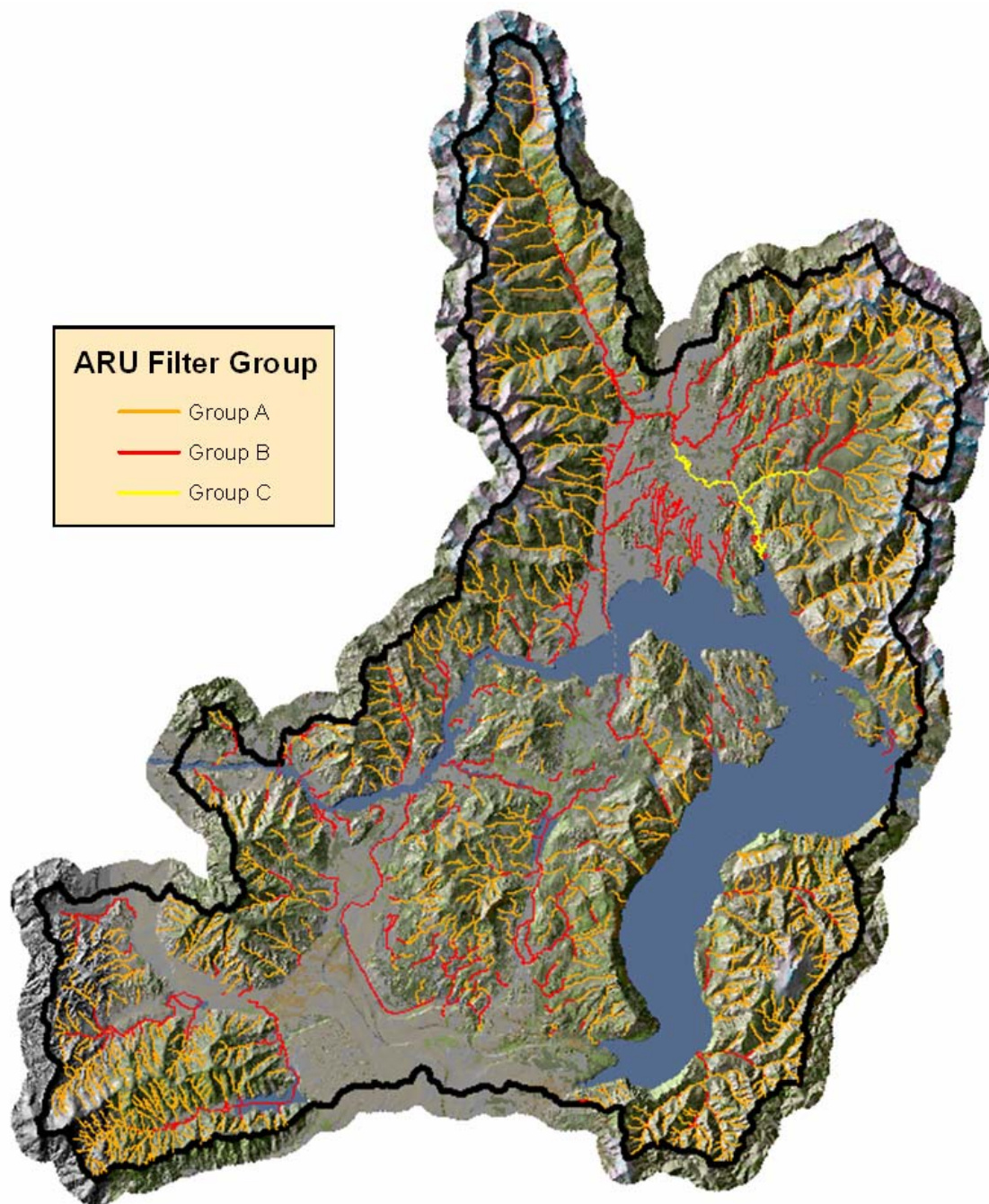


Figure X-3. “ARU filter” Groups in the Pend Oreille Basin.



X-2. System Potential “Forest” Vegetation Landcover Estimates

The United States Forest Service manages significant portions of land within the Pend Oreille Basin. Accordingly, the Idaho Panhandle National Forest (IPNF) has developed detailed analysis of current and historic forest conditions within the basin. The “Historic Range of Variability” (HRV) was the method which the IPNF incorporated the concept of historical/natural conditions and processes as a reference for understanding ecosystem potential².

Historic Range of Variability is defined as the range of variation in spatial, structural, compositional, and temporal characteristics of ecosystem elements as **affected by minor climatic fluctuations and disturbances**. This range is measured using a reference period prior to intensive resource use and management. The HRV is the baseline for comparison with current conditions to assess the degree of past change.

Existing and historic conditions and vegetation response to disturbance vary by ecological or biophysical setting. Each biophysical setting has characteristic potential natural communities, soils, hydrologic function, landform and topography, climate, air quality, and natural processes (nutrient and biomass cycling, succession, productivity, and fire regimes). Each setting also includes moisture and temperature gradient, resulting in growing conditions that are more similar within than between each setting.

Vegetation Response Units and Habitat Type Groups³

The IPNF used the concept of “Vegetation Response Units” (VRUs) and “Habitat Type Groups” (HTGs) as the method to describe the biophysical settings associated with historic and current forest vegetation conditions.

Vegetation Response Units VRUs are aggregations of land having similar capabilities and potentials for management. These ecological units have similar patterns in potential natural communities; soils; hydrologic function; landform and topography; lithology; climate; air quality; and natural processes (nutrient and biomass cycling, succession, productivity, and fire regimes). Each VRU has an associated description of its ecological structure, composition, and function. Detailed description of VRUs categories can be obtained from the following report – “Vegetative Response Unit Characterizations and Target Landscape Prescriptions”.⁴

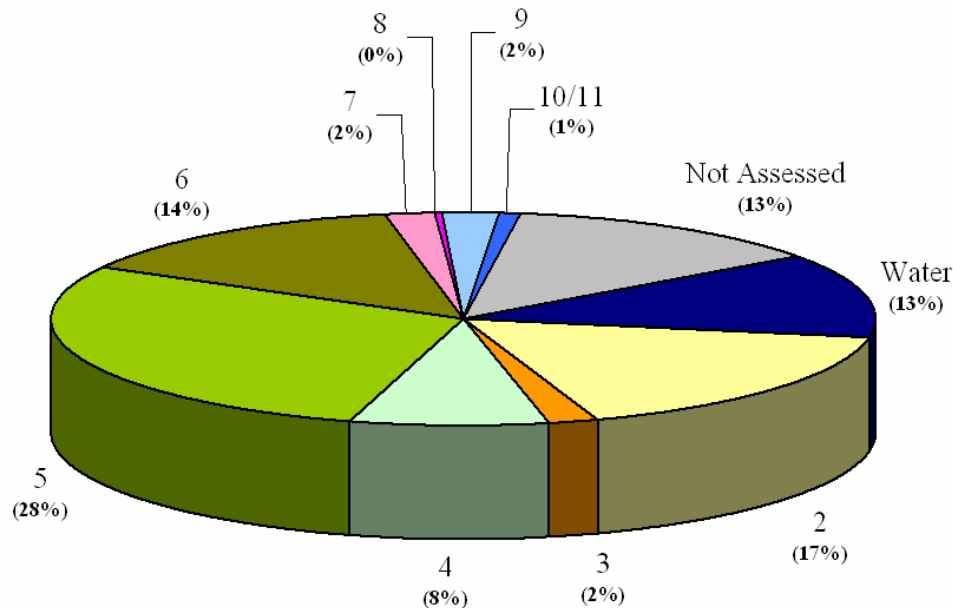
² A detailed discussion about the “Range of Variability” concept is contained in Appendix B of the following report - “Draft Comprehensive Evaluation Report for the Kootenai and Idaho Panhandle Proposed Land Management Plans”, and can be downloaded from the following website (<http://www.fs.fed.us/kipz/documents/plmp/CER>). In addition, the Technical Report – “Analysis of the Management Situation for the KIPZ Forest Plan Revisions” (March 2003) contains information on HRV for the planning zone. This report can be downloaded from the following website (<http://www.fs.fed.us/kipz/documents/ams/>).

³ The primary source of information about VRU and HTG proportion, structure and composition was obtained from technical work associated the 2003 Analysis of Management Situation (AMS) for the Panhandle and Kootenai National Forests (<http://www.fs.fed.us/kipz/documents/ams/>).

⁴ Document downloaded from – (http://www.fs.fed.us/r1/kootenai/projects/planning/documents/vru_doc/).

There are 11 designated VRU/HTG groups in the IPNF⁵. The distribution and location of VRU/HTG groups in the Pend Oreille Basin are illustrated in **Figures X-4 and X-5**, respectively. These 11 VRU/HTG groups were merged during the AMS process into four (4) “Assessment Groups” in order to incorporate biophysical settings to describe the historic distributions of vegetation composition and size class structure (**Tables X-4 through X-6**⁶).

Figure X-4. Distribution of VRU/HTG Groups in the Pend Oreille Basin.



Measured Vegetation Conditions - Sandpoint Ranger District

Over the past 26 years, forest vegetation conditions within the Sandpoint Ranger District⁷ has been collected and this information has been stored within the FS Veg database (Natural Resource Information System: Field Sampled Vegetation database). This database currently contains measured information for over 150,000 individual trees within the Pend Oreille Basin.

The relationship between measured tree height and Diameter Breast Height (dbh) for the individual tree species are illustrated in **Figure X-6**. (Only “live” trees were included in this analysis.) Also included in this figure are tables summarizing measured height conditions for the different seral age classes. These “age class” groups for the IPNF were defined on page B-4 (i.e., Appendix B) of the KIPZ Draft Comprehensive Report (<http://www.fs.fed.us/kipz/documents/plmp/CER>).

⁵ Vegetation on the Idaho Panhandle National Forest is summarized by Habitat Type Groups, which are fairly synonymous with VRUs (e.g., HTGs and VRUs are used interchangeably by IPNF staff).

⁶ Information contained in Tables X-5 and X-6 was obtained directly from IPNF staff.

⁷ The Sandpoint Ranger District Boundaries correspond to approximately Pend Oreille Basin boundary.

Figure X-5. Vegetation Response Units in the Pend Oreille Basin

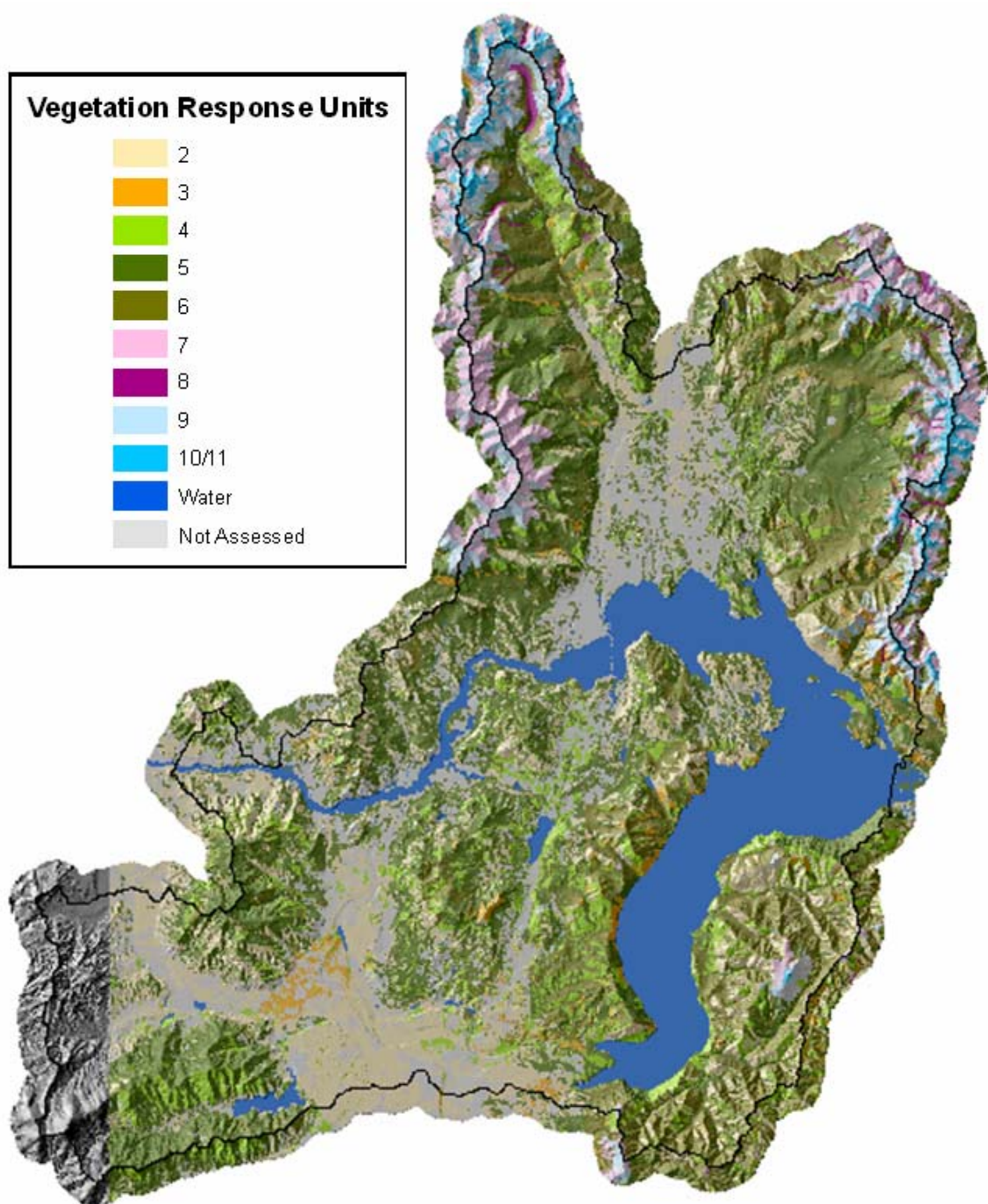


Table X-4. VRU/HTG Assessment Groups in the Pend Oreille Basin (KPIZ 2003)

Assessment Group	Description
<u>Group A:</u> VRU 1/HTG 1 (Warm/Dry), VRU 2/HTG 2 (Moderately Warm/Dry), and VRU 3/HTG 3 (Moderately Warm/Moderately Dry).	This group contains the more warm and dry habitat types with VRU 1 being the warmest and driest to the more moderate conditions of VRU 3. These sites include warm, dry grasslands to moderately cool and dry upland sites. The dry, lower elevation open ridges are composed of mixed Douglas-fir and ponderosa pine in well-stocked and fairly open-grown conditions. Moderately moist, upland sites and dense draws also include larch and lodgepole pine, with lesser amounts of ponderosa pine. Tree regeneration occurs in patches and is largely absent in the understory, particularly in the driest sites. Annual precipitation ranges from 14” to 30”, about 75% of that falling as rain. While the growing season is fairly long, high solar input and moderately shallow soils often result in soils that dry out early in the growing season, which results in low to moderate site productivity.
<u>Group B:</u> VRU 4/HTG 4 (Moderately Warm/Moist), VRU 5/HTG 5 (Moderately Cool/Moist), and VRU 6/HTG 6 (Moderately Cool/Wet).	This group occupies most of the moist sites along benches and stream bottoms. The moderating effects of the inland maritime climate ecologically influence this group. This group includes the more moderate sites of VRU 4 and scattered riparian and wet sites of VRU 6. This group is widespread throughout the forest and has the most biological productivity. Precipitation is moderate to high ranging from 30” to 55” per year.
<u>Group C:</u> VRU 7/HTG 7 (Cool/Moist) and VRU 8/HTG 8 (Cool/Wet).	This group occurs in the moist, lower subalpine forest setting and is common on northwest to east facing slopes, riparian and poorly drained subalpine sites, and moist frost pockets. This landscape is typically bordered by warmer sites (Group B) and cool, drier subalpine sites (Group D). This group includes characteristics of each. Average precipitation is estimated between 35” and 55” per year, less than half as rain. Vegetative productivity is moderate to high as a result of the high moisture-holding capacity and nutrient productivity of loess deposits, adequate precipitation, and a good growing season.
<u>Group D:</u> VRU 9/HTG 9 (Cool/ Moderately Dry), HTG 10 (Cold/Moderately Dry) and HTG 11 (Cold).	This group is typified by cool and moderately dry conditions with moderate solar input. The climate is characterized by a short growing season with early summer frosts. Annual precipitation ranges from 35”-70”, mostly in the form of snow. Due to generally shallow soils (low water holding capacity), slope position, and aspect, soil moisture is often limited during late summer months. It is generally found on rolling, ridges and upper reaches of convex mountain slopes.

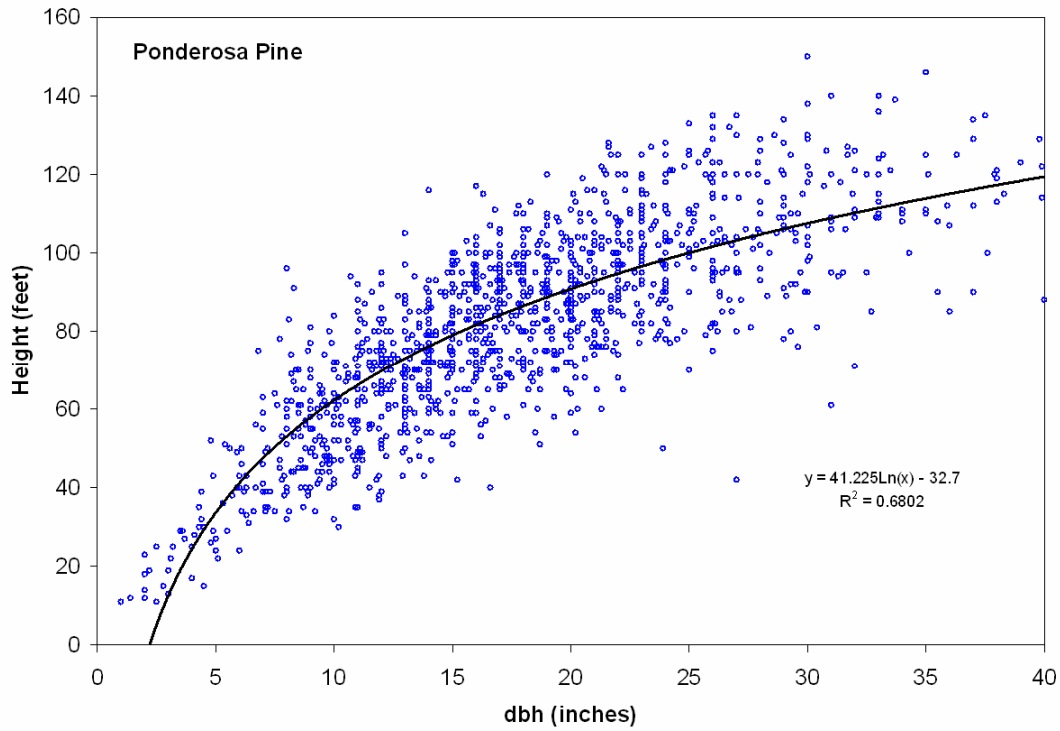
Table X-5. Pend Oreille Basin Historical Forest Vegetation Structure Estimates

Assessment Group	% of Area	Shrub/Seed/ SAP	Small/ Pole	Medium/ Immature	Large/ Mature	Old Growth
Warm/Dry (Group A)	17%	20%	8%	12%	17%	43%
Moist (Group B)	56%	25%	15%	27%	21%	12%
Cool/Moist (Group C)	16%	22%	13%	22%	23%	20%
Cool/Dry (Group D)	11%	22%	13%	22%	23%	20%
Historical Weighted Avg.		23.3%	13.3%	23.1%	20.9%	19.4%
<i>National Forest Current</i>		28.4%	4.4%	39.2%	20.7%	7.4%
<i>% Change from Historic</i>		21.7%	-67.1%	69.7%	-0.8%	-62.1%
<i>Current as % of Historic</i>		121.7%	32.9%	169.7%	99.2%	37.9%

Table X-6. Pend Oreille Basin Historical Forest Vegetation Composition Estimates

Assessment Group	PP	WP	WL	DF	GF/WH	WRC	LP	SAF	WBP
Warm/Dry (Group A)	60%	--	10%	20%	--	--	10%	--	--
Moist (Group B)	1%	40%	25%	20%	5%	5%	3%	1%	--
Cool/Moist (Group C)	--	12%	15%	1%	--	--	12%	60%	--
Cool/Dry (Group D)	--	--	--	--	--	--	20%	65%	15%
Historical Weighted Avg	10.8%	24.3%	18.1%	14.8%	2.8%	2.8%	7.5%	17.3%	1.7%
<i>National Forest Current</i>	2.2%	2.0%	3.8%	36.5%	16.9%	7.9%	4.5%	25.6%	0.2%
<i>% Change from Historic</i>	-80%	-91.8%	-79%	147.3%	503.6%	182.1%	-40%	47.9%	-88%
<i>Current as % of Historic</i>	20.4%	8.2%	21.0%	247.3%	603.6%	282.1%	60.0%	147.9%	12.1%

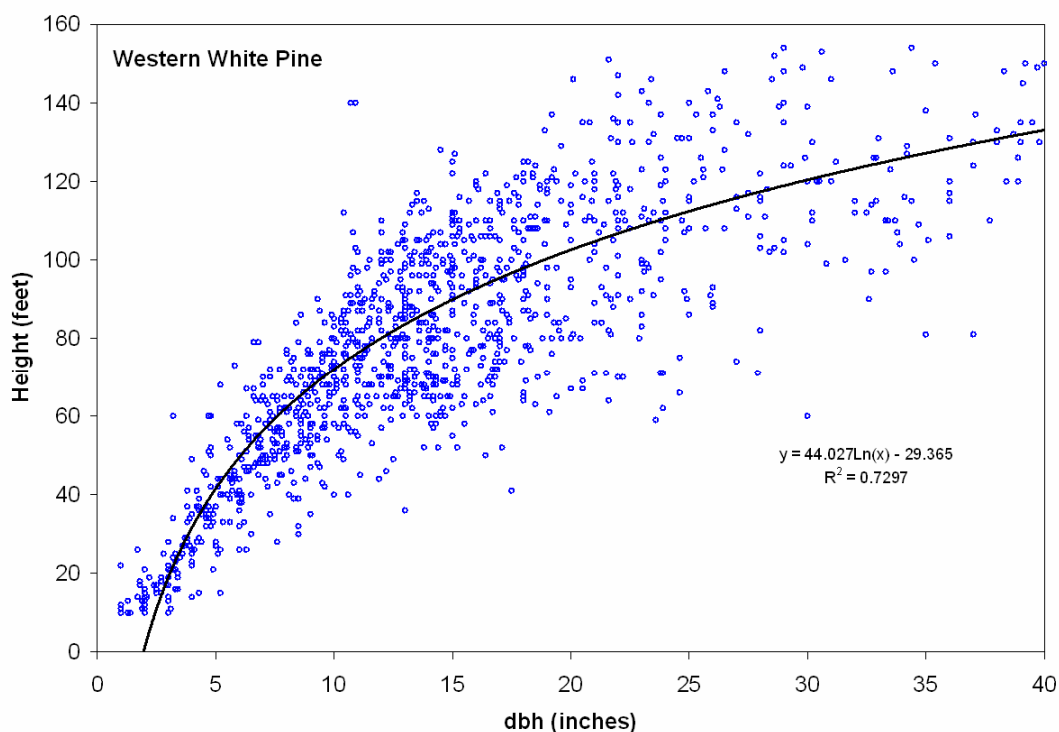
Figure X-6. Measured Ponderosa Pine Height - Sandpoint Ranger District.



Measured Ponderosa Pine Height (feet) by Size Classification Groups.

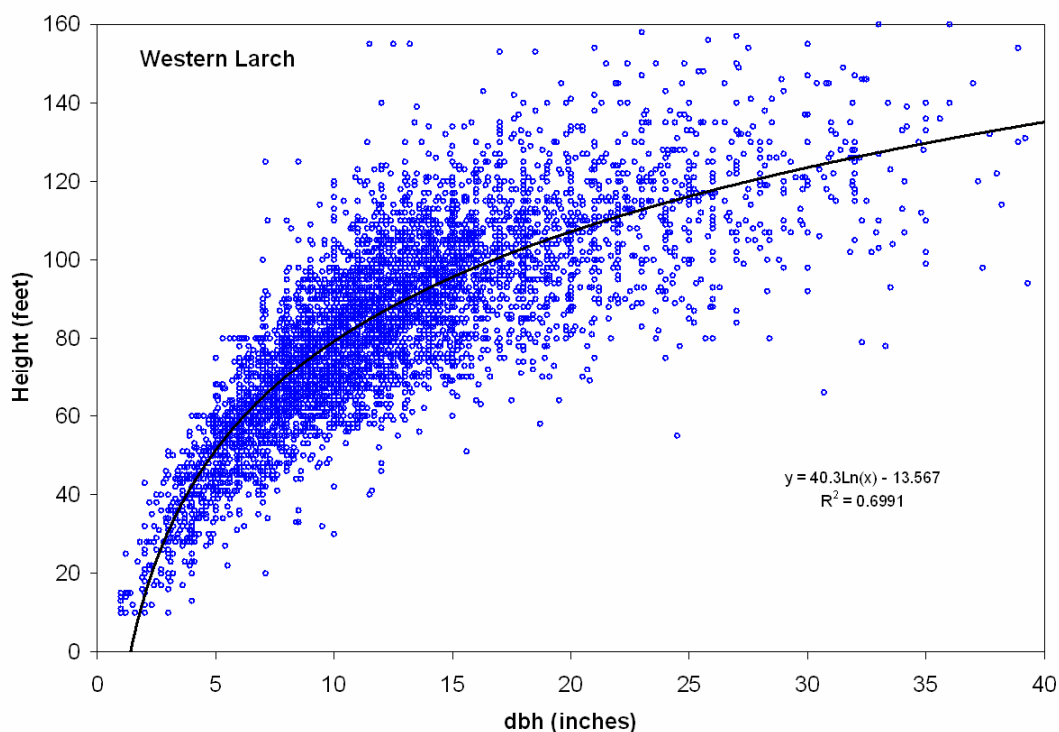
Percentile	Size Class (Group Name and Year Range)				
	Seed/Sap Less than 35	Small 35 through 59	Medium 60 through 99	Large 100 through 149	Oldest Greater than 150
90th	34	73	103	120	124
75th	23	60	93	106	112
50th	14	43	81	95	99
25th	7	36	70	80	83
10th	5	30	58	66	67
Number of Measurements	119	820	1039	378	415

Figure X-6 (cont.). Measured Western White Pine Height - Sandpoint Ranger District.



Measured Western White Pine Height (feet) by Size Classification Groups.					
Percentile	Size Class (Group Name and Year Range)				
	Seed/Sap Less than 35	Small 35 through 59	Medium 60 through 99	Large 100 through 149	Oldest Greater than 150
90th	30	85	111	121	157
75th	17	72	98	108	137
50th	8	56	80	91	120
25th	6	39	67	73	102
10th	5	24	55	62	83
Number of Measurements	152	325	650	198	313

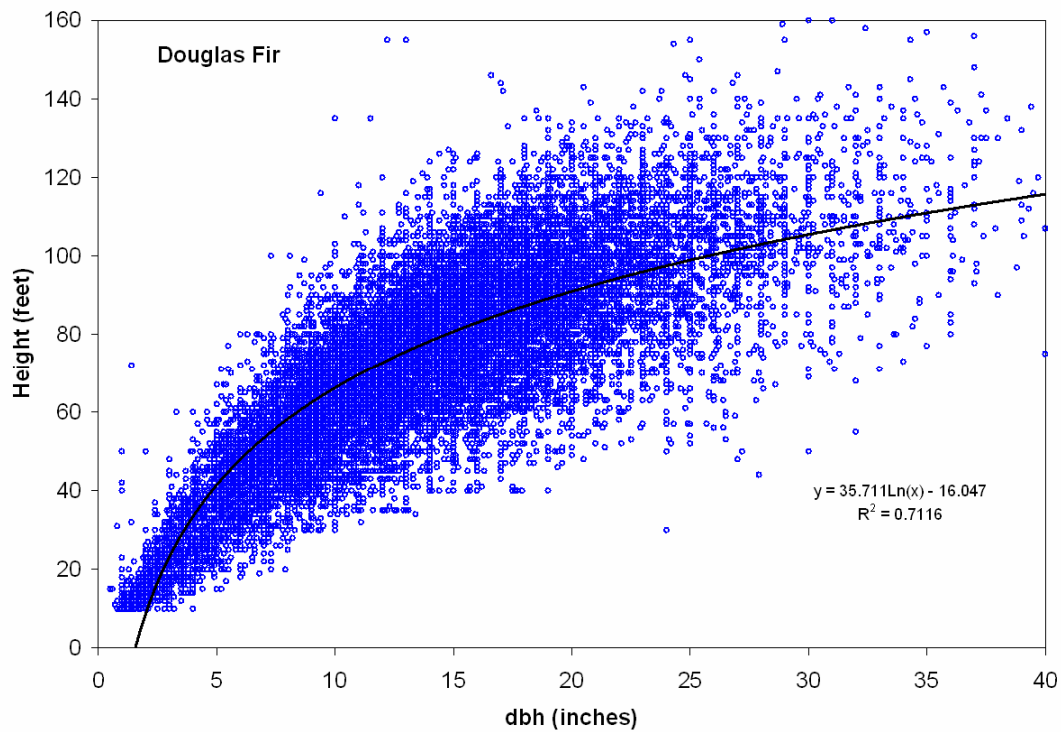
Figure X-6 (continued). Measured Western Larch Height - Sandpoint Ranger District.



Measured Western Larch Height (feet) by Size Classification Groups.

Percentile	Size Class (Group Name and Year Range)				
	Seed/Sap Less than 35	Small 35 through 59	Medium 60 through 99	Large 100 through 149	Oldest Greater than 150
90th	47	85	108	120	136
75th	32	74	96	110	122
50th	18	62	84	99	110
25th	9	51	72	88	95
10th	6	40	61	78	85
Number of Measurements	129	1358	3377	758	827

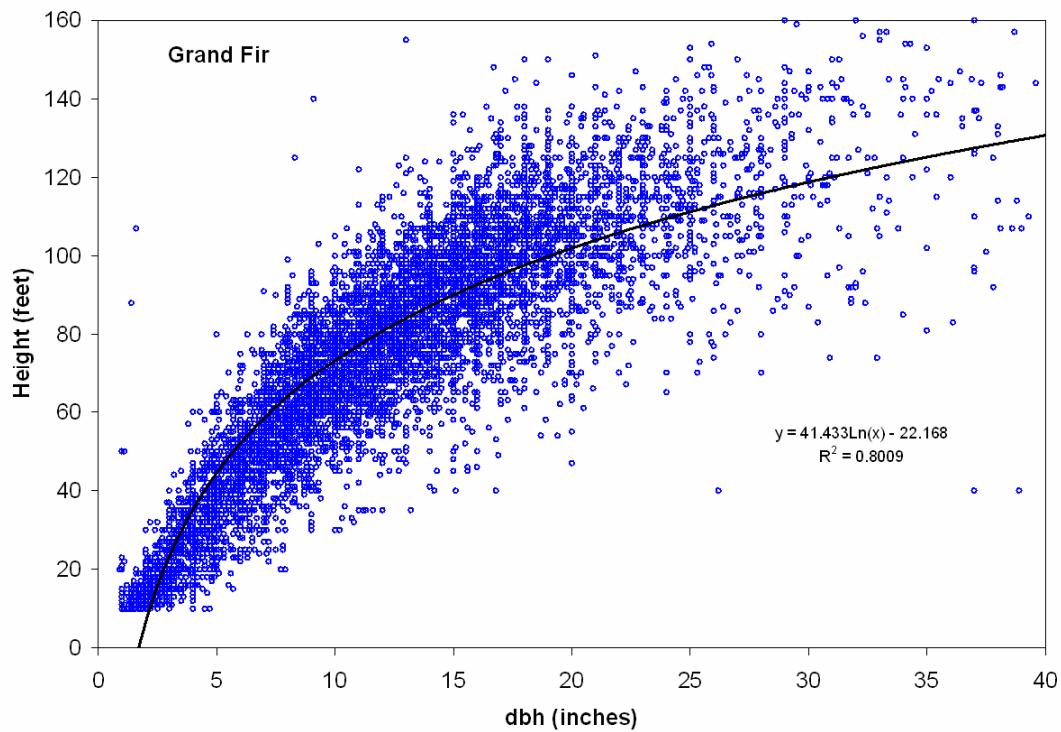
Figure X- 6 (continued). Measured Douglas Fir Height - Sandpoint Ranger District.



Measured Douglas Fir Height (feet) by Size Classification Groups.

Percentile	Size Class (Group Name and Year Range)				
	Seed/Sap Less than 35	Small 35 through 59	Medium 60 through 99	Large 100 through 149	Oldest Greater than 150
90th	40	78	101	115	123
75th	25	67	91	103	110
50th	13	55	80	91	96
25th	7	41	67	78	83
10th	6	25	54	64	70
Number of Measurements	1866	6323	15983	3029	1600

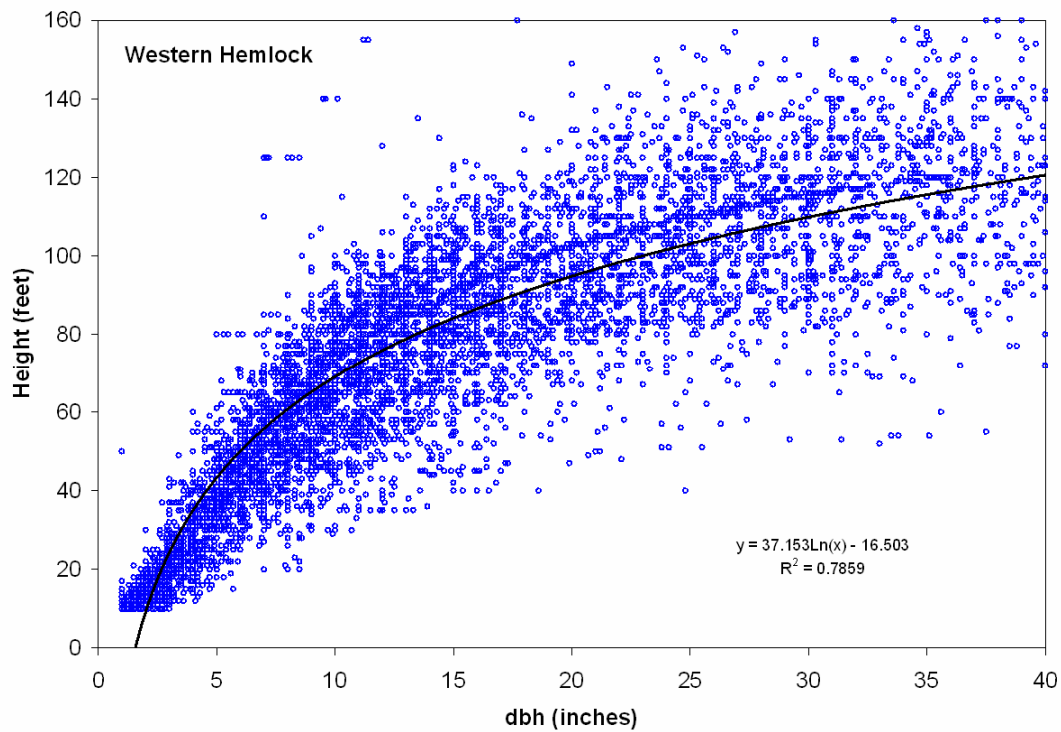
Figure X-6 (continued). Measured Grand Fir Height - Sandpoint Ranger District.



Measured Grand Fir Height (feet) by Size Classification Groups.

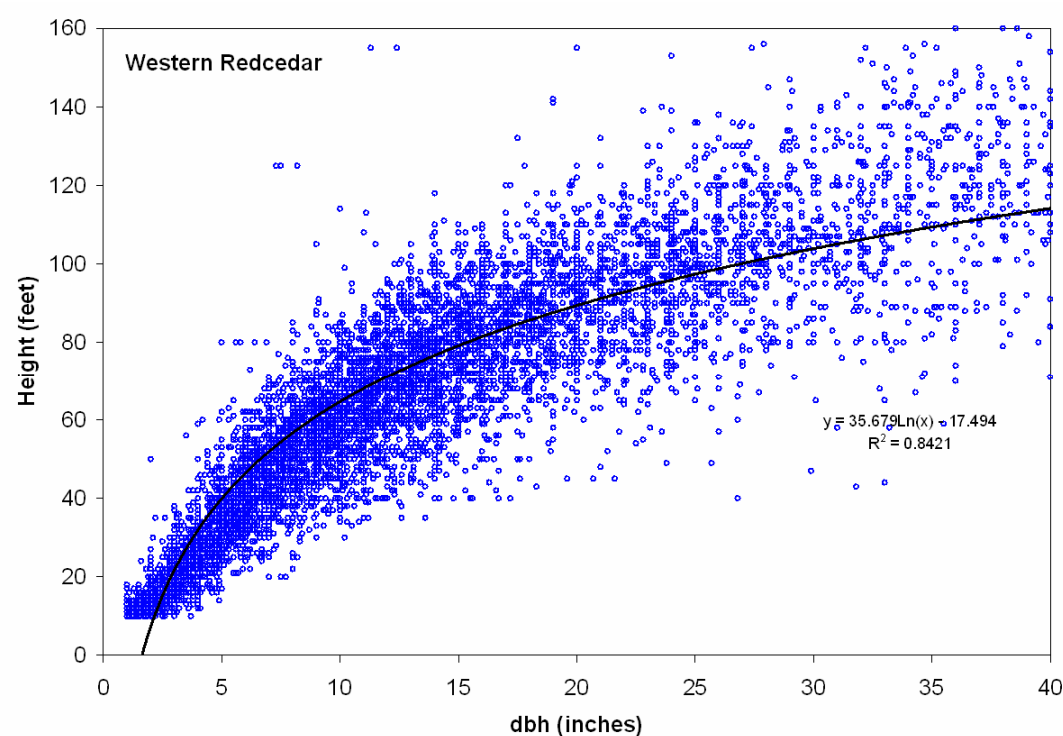
Percentile	Size Class (Group Name and Year Range)				
	Seed/Sap Less than 35	Small 35 through 59	Medium 60 through 99	Large 100 through 149	Oldest Greater than 150
90th	22	84	110	128	145
75th	15	70	97	115	130
50th	9	47	81	100	114
25th	6	25	65	85	97
10th	5	13	46	69	87
Number of Measurements	1267	2288	6861	1384	342

Figure X-6 (cont.). Measured Western Hemlock Height - Sandpoint Ranger District.



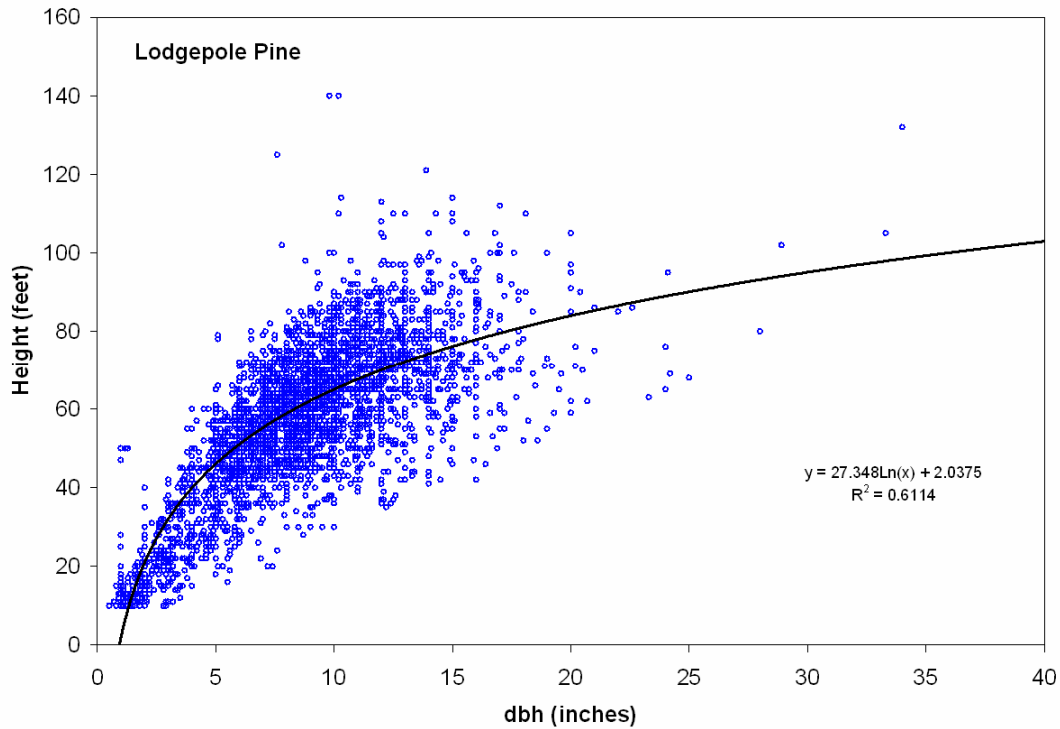
Measured Western Hemlock Height (feet) by Size Classification Groups.					
Percentile	Size Class (Group Name and Year Range)				
	Seed/Sap Less than 35	Small 35 through 59	Medium 60 through 99	Large 100 through 149	Oldest Greater than 150
90th	21	65	96	112	135
75th	14	52	85	100	121
50th	8	35	70	85	107
25th	6	16	53	70	92
10th	5	9	36	50	78
Number of Measurements	895	1378	2575	1365	2850

Figure X-6 (cont.). Measured Western Redcedar Height - Sandpoint Ranger District.



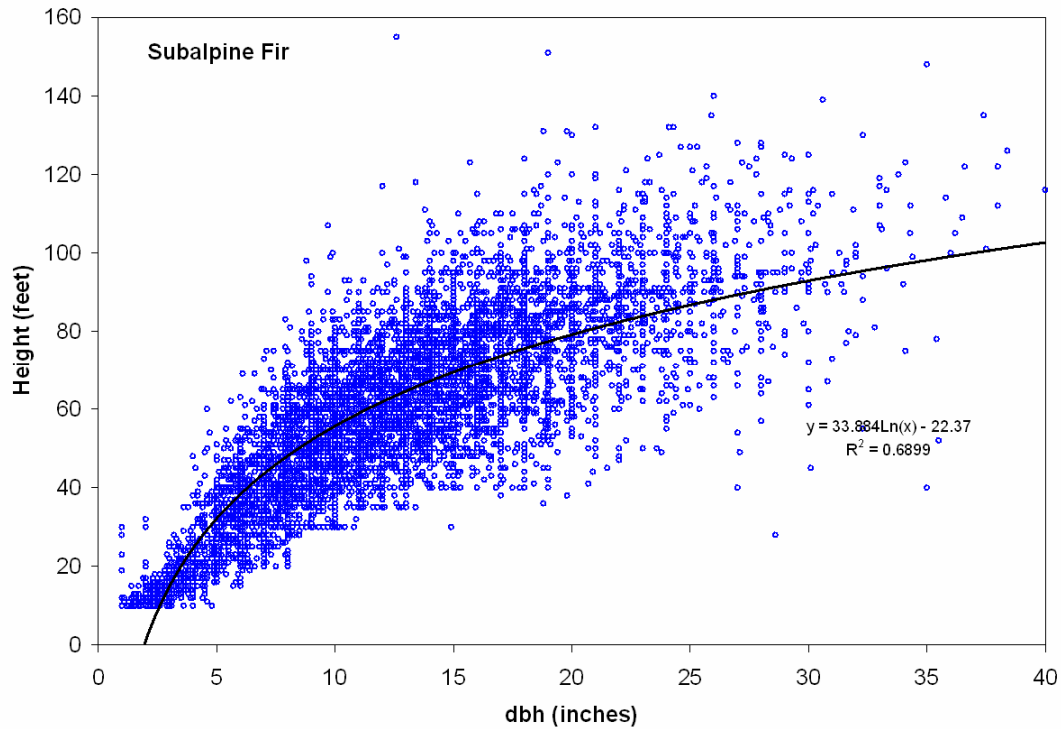
Measured Western Redcedar Height (feet) by Size Classification Groups.					
Percentile	Size Class (Group Name and Year Range)				
	Seed/Sap Less than 35	Small 35 through 59	Medium 60 through 99	Large 100 through 149	Oldest Greater than 150
90th	19	65	91	110	140
75th	13	53	80	100	125
50th	8	36	66	87	109
25th	6	18	50	73	94
10th	5	11	35	58	80
Number of Measurements	2183	2622	3965	1498	1772

Figure X-6 (cont.). Measured Lodgepole Pine Height - Sandpoint Ranger District.



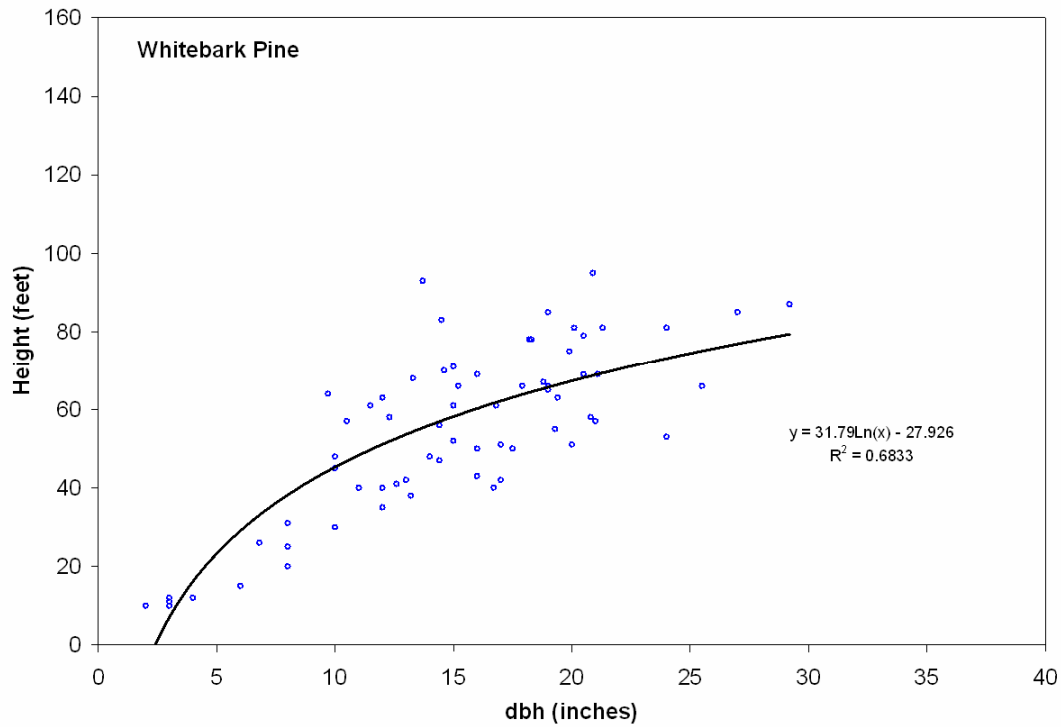
Measured Lodgepole Pine Height (feet) by Size Classification Groups.					
Percentile	Size Class (Group Name and Year Range)				
	Seed/Sap Less than 35	Small 35 through 59	Medium 60 through 99	Large 100 through 149	Oldest Greater than 150
90th	32	67	83	90	100
75th	24	60	74	82	88
50th	15	52	67	74	77
25th	10	44	59	65	66
10th	6	36	52	57	55
Number of Measurements	560	1297	1830	136	102

Figure X-6 (continued). Measured Subalpine Fir Height - Sandpoint Ranger District.



Measured Subalpine Fir Height (feet) by Size Classification Groups.					
Percentile	Size Class (Group Name and Year Range)				
	Seed/Sap Less than 35	Small 35 through 59	Medium 60 through 99	Large 100 through 149	Oldest Greater than 150
90th	21	61	82	90	104
75th	13	47	71	77	91
50th	8	30	58	63	78
25th	6	11	44	51	63
10th	5	6	30	40	52
Number of Measurements	768	1515	3707	2770	1222

Figure X-6 (cont.). Measured Whitebark Pine Height - Sandpoint Ranger District.



Measured Whitebark Pine Height (feet) by Size Classification Groups.					
Percentile	Size Class (Group Name and Year Range)				
	Seed/Sap Less than 35	Small 35 through 59	Medium 60 through 99	Large 100 through 149	Oldest Greater than 150
90th	10	12	53	68	85
75th	8	12	48	61	78
50th	5	10	42	51	66
25th	3	7	36	43	56
10th	2	7	23	27	42
Number of Measurements	30	10	8	13	40

Methods used to estimate “system potential landcover” for Forest Areas

As described above, "system potential landcover" is necessary to achieve “system potential effective shade” and is defined for purposes of the TMDL as "the potential near stream land cover condition which can grow and reproduce on a site, given: climate, elevation, soil properties, plant biology and hydrologic processes." It is also important to point out again that “system potential does not consider management or land use as limiting factors.”

In essence, system potential is the design condition used for TMDL analysis that meets the temperature standard by minimizing human-related warming. In other words, system potential is an estimate of the condition where anthropogenic activities that cause stream warming are minimized. However it is import to point out again that a “natural disturbance” component was included with the estimate for “system potential landcover” conditions. This analysis produces a weighted average estimate of “system potential land cover” condition for each Assessment Group. This information is subsequently used to calculate “***system potential effective shade condition***”.

The following parameters were used to develop “system potential land cover conditions”:

- “System Potential Land Cover” conditions were defined for the four (4) VRU/HTG “Assessment Groups” (see Table X-1);
- Forest Vegetation Structure for each of the “Assessment Groups” were assigned as weighted average historical level (see Table X-2);
- Forest Vegetation Composition for each of the “Assessment Groups” were assigned as weighted average historical level (see Table X-3);
- Vegetation height conditions were assigned to the 50th percentile (median) of measured vegetation conditions within the Sand Point Ranger District for each of the size class groups (see Figure X-5); and
- Vegetation Canopy Cover Conditions was assigned to 80%.

Calculated System Potential Effective Shade Values for Forest Areas

Calculated System Potential Effective Shade values for the four “Assessment Units” are presented in **Figures X-7** though **X-10**. The corresponding energy loading associated with these targeted conditions is presented in **Figure X-11**. Although this TMDL allocates a specific “target” condition (e.g., “system potential effective shade”), a range of values can be expected to occur as a results of “natural” variability of riparian land cover. In other words, although the individual measurements may not be at the “dot”, average condition over a distance must be at or above the “dot”.

Figure X-7. System Potential Effective Shade for “Assessment Group A” (Warm/Dry) at Various Stream Aspect and Stream Width Conditions.

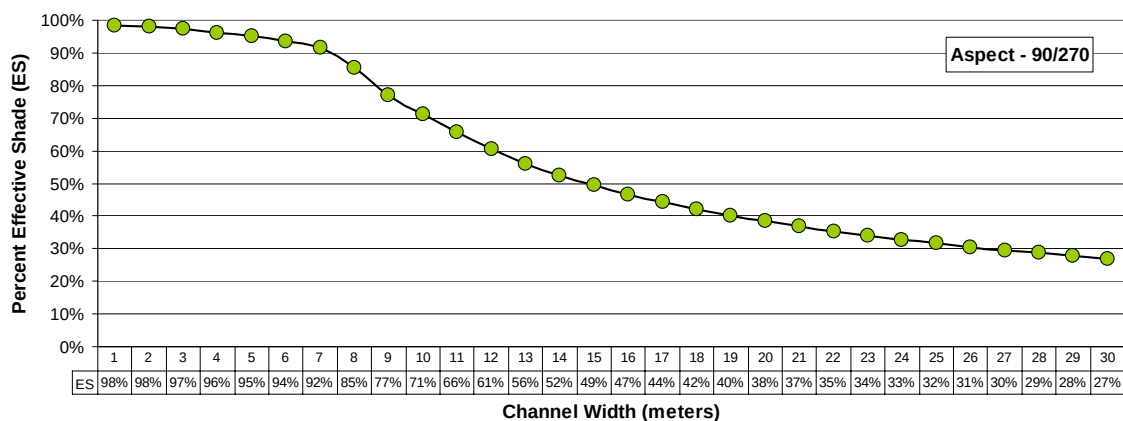
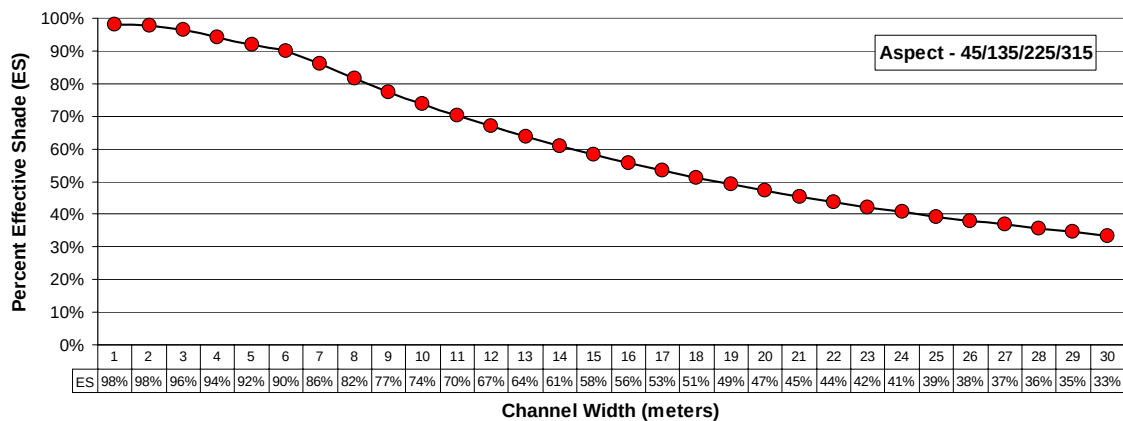
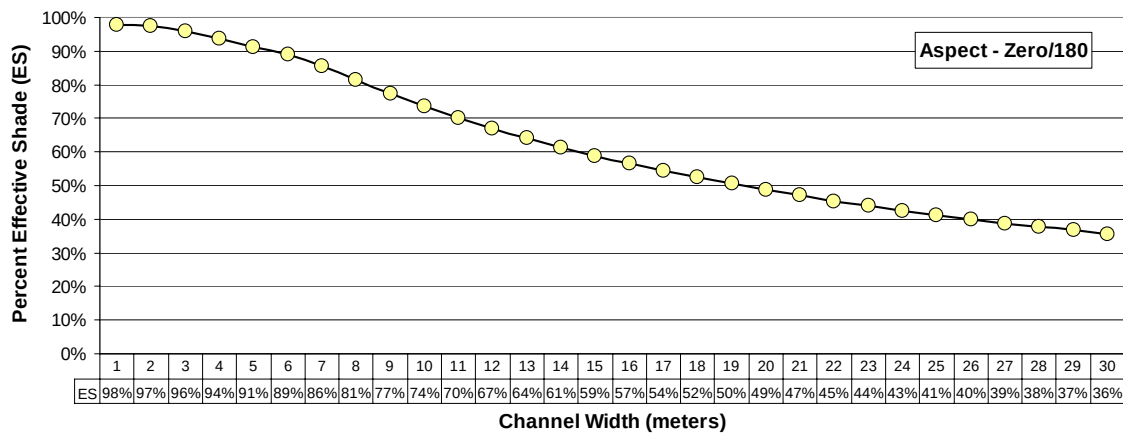


Figure X-8. System Potential Effective Shade for “Assessment Group B” (Moist) at Various Stream Aspect and Stream Width Conditions.

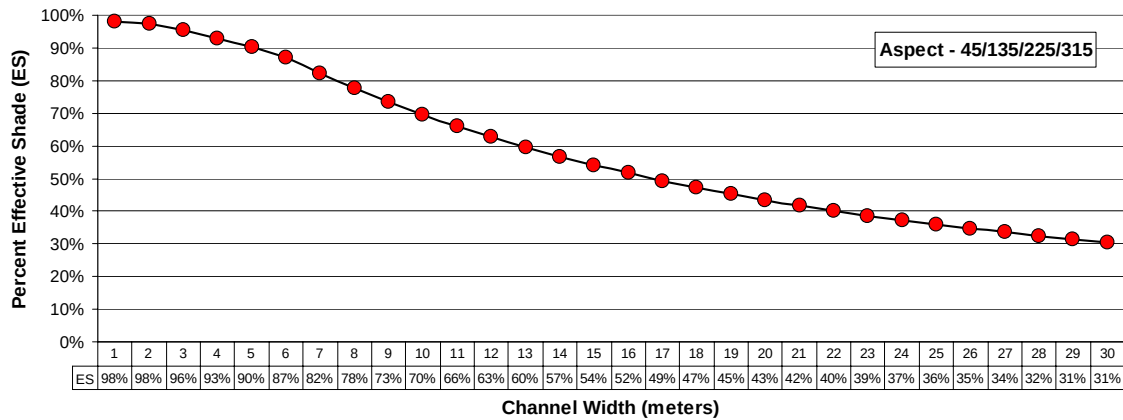
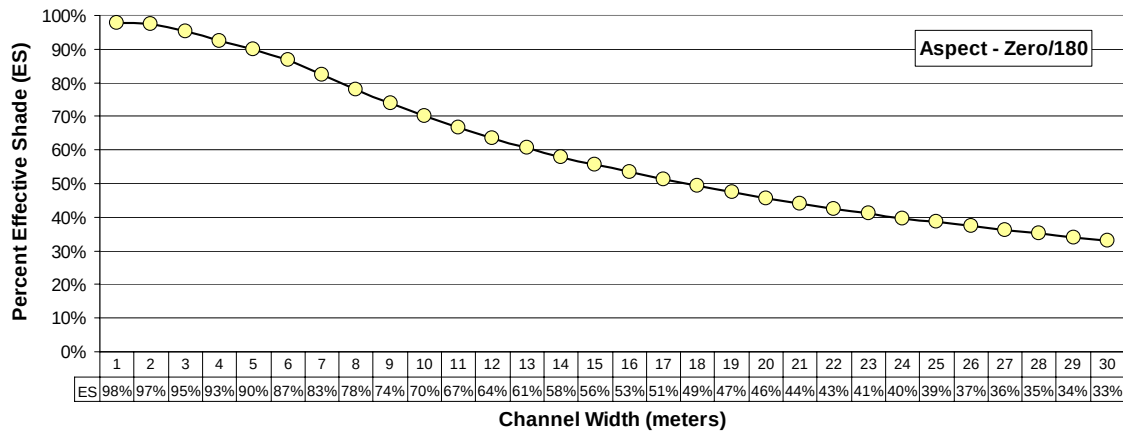


Figure X-9. System Potential Effective Shade for “Assessment Group C” (Cool/Moist) at Various Stream Aspect and Stream Width Conditions.

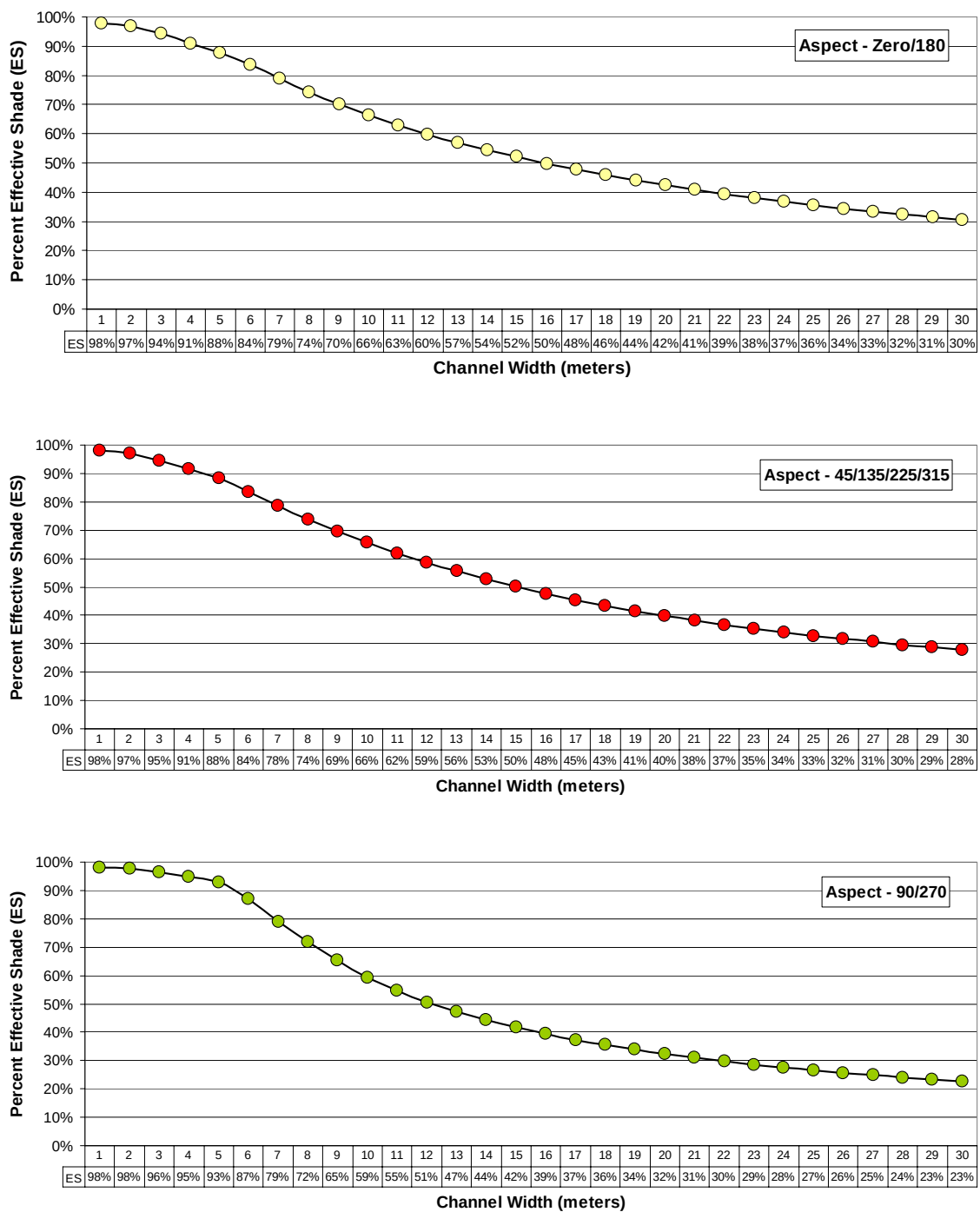


Figure X-10. System Potential Effective Shade for “Assessment Group D” (Cool/Dry) at Various Stream Aspect and Stream Width Conditions.

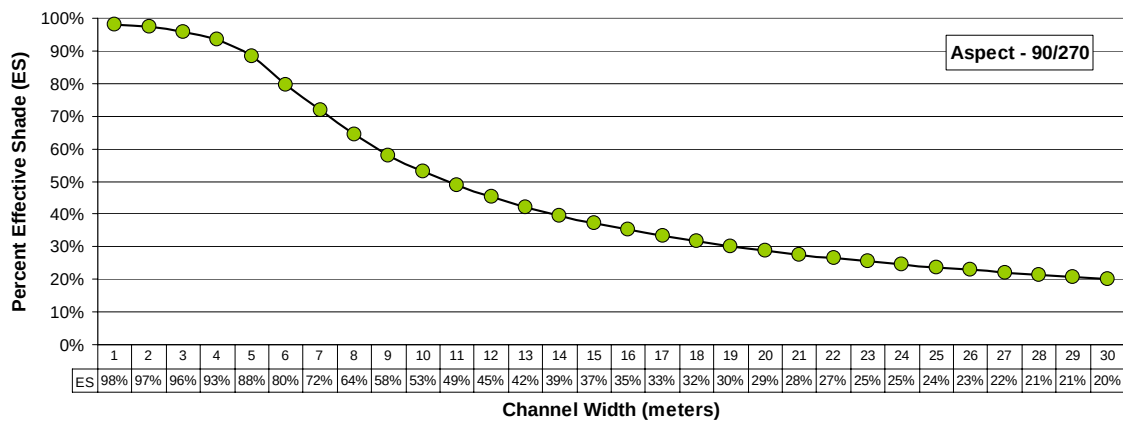
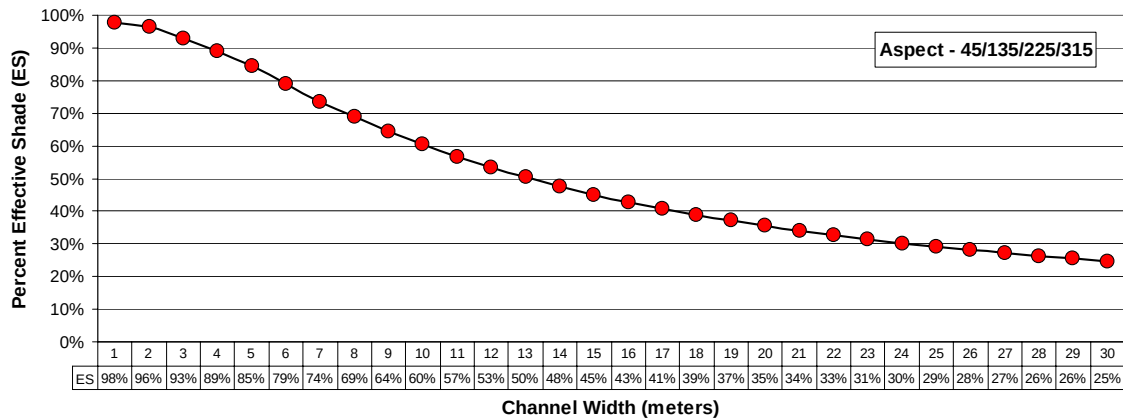
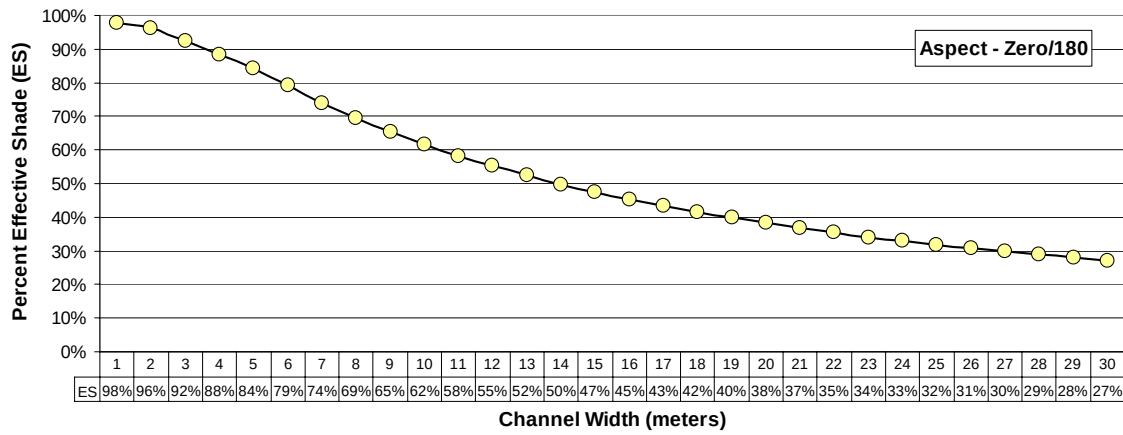
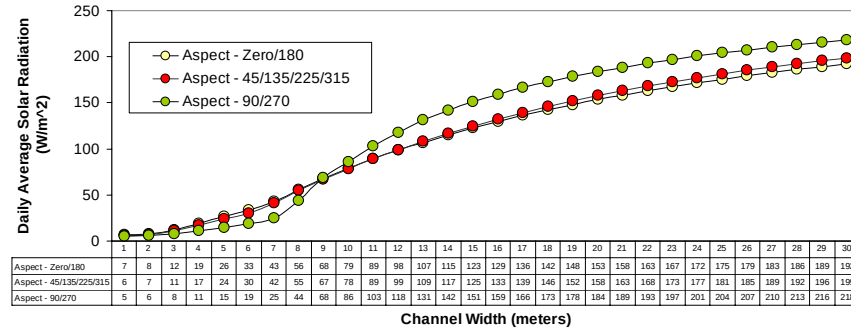
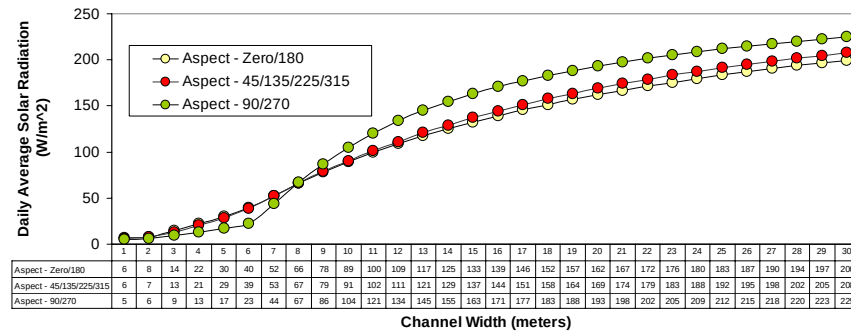


Figure X-11. Daily Average Solar Radiation Loading at System Potential Effective Shade Conditions for the four “Forest” Riparian Groups in the Pend Oreille Basin.

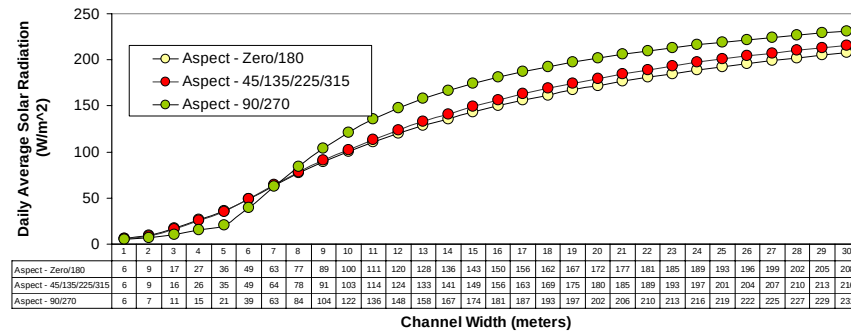
Group A – Warm/Dry



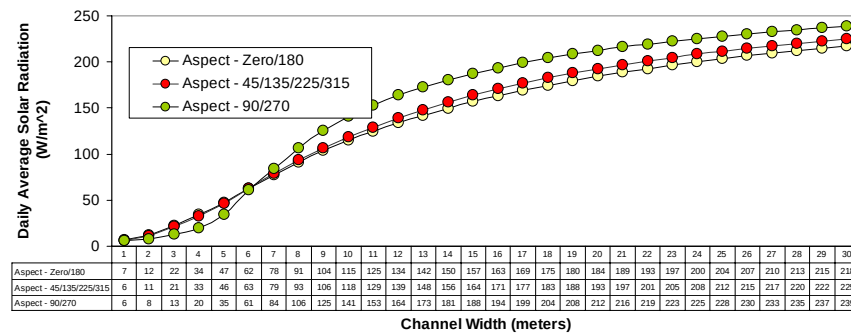
Group B – Moist



Group C – Cool/Moist



Group D – Cool/Dry



X-3. System Potential “Non-Forest” Vegetation Landcover Estimates

This section will discuss methods used to develop system potential landcover estimates for riparian areas of the Pend Oreille basin located within “non-forest” areas. These areas are primarily located within low elevation and low surface gradient areas. It is important to point out that these “non-forest” riparian areas still have an upland forest component, but at lower levels than “forest” riparian areas described in the previous section.

These “non-forest” areas are often located in areas that have been exposed to anthropogenic changes over the past several decades. Accordingly, these areas often deviate dramatically from “potential” landcover conditions. It is important to point out once again that “system potential landcover” is necessary to achieve “system potential effective shade” and is defined for purposes of the TMDL as “the potential near stream land cover condition which can grow and reproduce on a site, given: climate, elevation, soil properties, plant biology and hydrologic processes.” In addition, “system potential does not consider management or land use as limiting factors.”

Recently, there have been efforts to assess riparian areas for “non-forest” areas in the Pend Oreille basin. For example, a detailed survey of stream channel conditions was recently developed for the Pack River system. As part of this effort, riparian vegetation conditions were assessed, including estimates of “vegetation reference conditions”. In addition, the Bonner Soil and Water Conservation District conducted riparian vegetation surveys along several stream reaches located within the Pend Oreille basin lowlands. This effort included estimates for “Potential Natural Vegetation” for these assessed reaches. Information provided from these efforts will provide insight into riparian vegetation conditions for areas located within “Non-Forest Riparian Group 1” and “Non-Forest Riparian Group 2” (see Table X-3).

Pack River Stream Channel Assessment

Discussions included in the Pack River Stream Channel Assessment (Pack River Technical Advisory Committee Report 10/7/2003) described reference riparian vegetation along the Pack River as the following

“The reference sub-reaches for riparian vegetation on the Pack River can be found in Reaches A and B. Sub-reaches 5 and 17 both contain a high percentage of late-seral Western redcedar vegetation type (88 and 90 percent, respectively).

The locations of these sub-reaches within more confined portions of the valley appear to have limited their exposure to the Sundance fire effects. The riparian habitat is less disturbed in these sub-reaches than in others on the Pack River. Based on these reference sub-reaches, it is likely that more stable, larger substrate B-type streams have alder as a subordinate species (as in subreach 5), while the more dynamic C and F-type stream reaches are likely to contain willow as a subordinate species (as in sub-reach 17).

Sub-reach 5 likely represents the reference vegetation condition for B channel types within the watershed. Despite elevational differences between the lower and upper watershed, it is likely that sub-reach 17 is indicative of reference conditions for C and F channel types within Reaches C, D, and E of the watershed as indicated by the presence of Western redcedar trees and stumps.”

Photographs for subreaches 5 and 17 are presented in **Figure X-12** (These images were obtained from the Pack River Report). River reach designations used for the Pack River within this report are illustrated in **Figure X-13**.

Figure X-12. Photographs of available reference riparian areas along the Pack River.

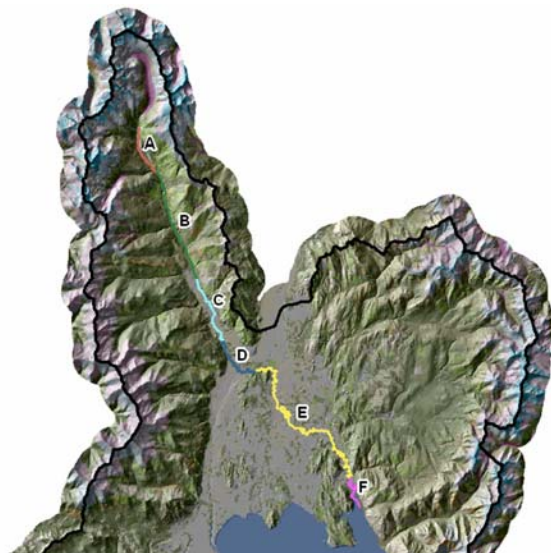
Subreach 5



Subreach 17



Figure X-13. Reach Designations along the Pack River⁸



⁸ Reach A contains subreaches 1 through 8, Reach B contains subreaches 9 through 21, Reach C contains subreaches 22 through 30, Reach D contains subreaches 31 through 39, Reach E contains subreaches 40 through 52, and Reach F contains subreaches 53 and 54.

2006 Riparian Vegetation Surveys in Pend Oreille Basin Lowlands

In the summer of 2006, staff at the Bonner Soil and Water Conservation District conducted riparian vegetation surveys along several stream reaches located within the Pend Oreille basin lowlands. The locations areas for these sampling sites are highlighted in **Figure X-14**. These surveys were for the purpose of identifying priority areas for agricultural TMDL implementation plan development in the Pack River watershed. Given this focus, the areas that were surveyed were chosen based on the presence of agricultural activity. As part of this effort, descriptions of “potential natural vegetation” was estimated by the field crew for many of the sampling reaches.

Recall that these riparian areas associated with these sites are currently modified by landuse activities, and thus estimates of “**potential natural vegetation**” conditions could be problematic to accurately establish. However, this information is the best estimate considering available information at the site. In addition, descriptions of **current vegetation** conditions can also be valuable in developing “system potential landcover” estimates for these areas of the basin. This information is summarized in **Figure X-15**.

Figure X-14. Riparian Vegetation Survey Locations in the Pend Oreille Basin Lowlands.

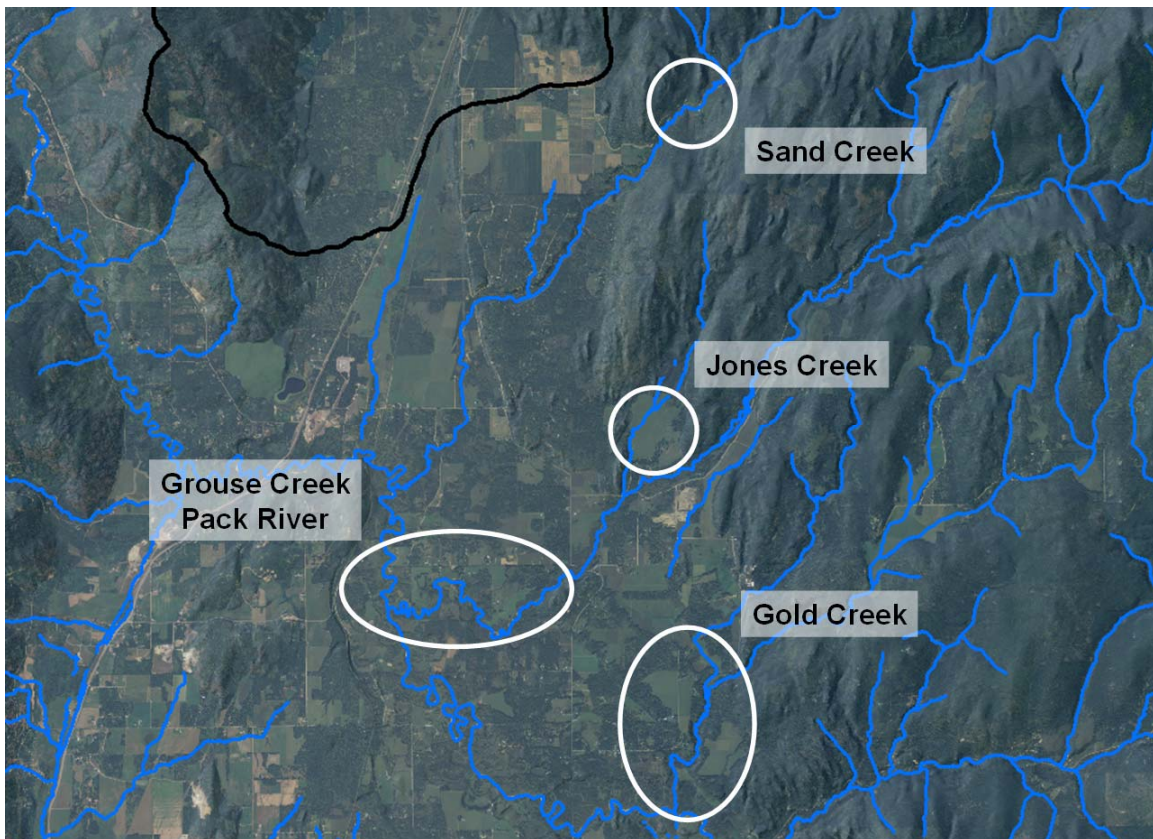
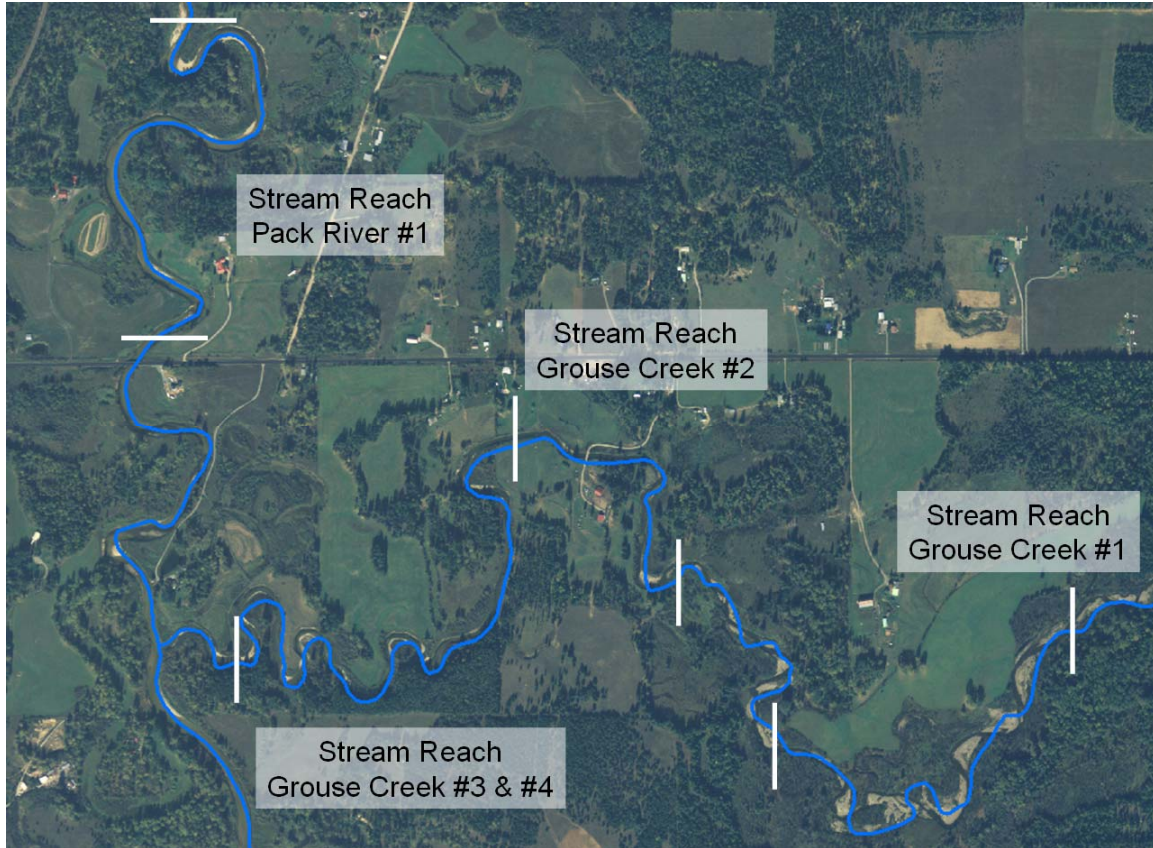
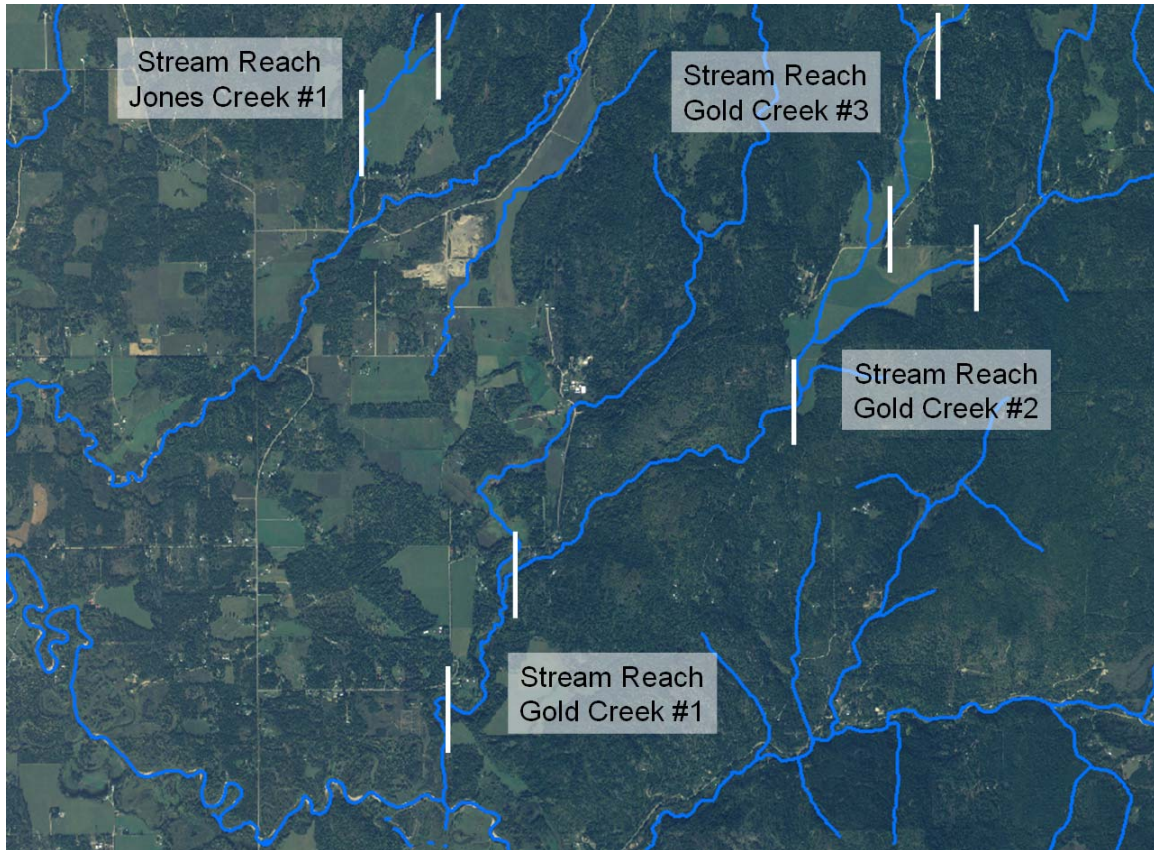


Figure X-15. Pack River and Grouse Creek Reaches



Site ID	Potential Natural Vegetation	Vegetation providing the major source of Shade	Observed “Woody” Vegetation
Pack River #1	Cottonwoods Willow Cedar	Cedar Cottonwoods	<u>Abundant</u> - Cedar <u>Common</u> – Hawthorn, Alder, Willow, Cottonwood, Douglas fir, Grand fir, Larch
Grouse Creek #1	Cottonwoods Willow Alder	Alder	<u>Abundant</u> – Alder <u>Common</u> – Hawthorn <u>Trace</u> - Cottonwood
Grouse Creek #2	Cedar Cottonwood Willow Sedges	Alder (Very little shade currently)	<u>Abundant</u> – Alder <u>Common</u> – Willow <u>Trace</u> – Grand fir, Douglas fir, larch
Grouse Creek #3 & #4	Birch Cedar Conifers Cottonwood Willows	Lodgepole Douglas fir Larch	Hawthorn, Alder, Larch, Lodgepole Pine, Birch, Willow, Cottonwood, Cedar,

Figure X-15 (continued). Jones Creek and Gold Creek Reaches



Site ID	Potential Natural Vegetation	Vegetation providing the major source of Shade	Observed “Forest” Vegetation
Jones Creek #1	Alder Willow	Grasses Sedge Invasive Weeds	<u>Trace</u> - Alder
Gold Creek #1	Not Completed	Not Completed	<u>Abundant</u> – Alder <u>Common</u> – Willow, Cottonwood, Cedar <u>Trace</u> - Hawthorn
Gold Creek #2	Alder Willows, Cedars Cottonwood	Alder Willows Reeds	<u>Common</u> – Alder, Cottonwood, Cedar <u>Trace</u> – Hawthorn, Douglas fir, Grand fir
Gold Creek #3	Not Completed	Alder	<u>Common</u> – Alder, Cottonwood, Cedar <u>Trace</u> – Hawthorn, Douglas fir, Grand fir

Figure X-15 (continued). Sand Creek Reaches



Site ID	Potential Natural Vegetation	Vegetation providing the major source of Shade	Observed “Woody” Vegetation
Sand Creek #1	Spirea Alder	Spirea Alder	<u>Common</u> – Alder, Willow
Sand Creek #2	Spirea	Spirea Alder	<u>Common</u> – Alder <u>Trace</u> - Willow

As can be seen from riparian survey results, riparian habitat within lowland areas of the Pend Oreille basin is comprised of mixture of deciduous and conifer vegetation. Similarly, the Pend Oreille subbasin plan⁹ states that historical riparian habitat varied greatly in structure, including multi-canopy forest, woodlands, and shrublands. In addition, it is proposed that black cottonwood, quaking aspen, paper birch and other deciduous trees were a historic riparian vegetation component of lowland areas.

Methods used to estimate “system potential landcover” for “Non-Forest” Areas

Riparian vegetation descriptions for the Aquatic Response Units (ARU) in the Kootenai basin was used as the framework to develop estimates of height and canopy cover conditions for the “non-forest” riparian groups in the Pend Oreille Basin (see Table X-3). This analysis produced a weighted average estimate of “system potential land cover” condition for each Assessment Group. This information is subsequently used to calculate “***system potential effective shade condition***”.

“Non-forest” Riparian Group 1- Ecodata plots collected along streams of this group describe a very diverse group of plant communities. The different communities include late-successional cedar-hemlock, black cottonwood, mixed conifer and riparian shrubs. Measured constancy and canopy cover conditions for significant shade producing riparian vegetation (i.e., Overstory) within the “Non-forest “ Riparian Group 1 are presented in **Table X-7**.

“Non-forest” Riparian Group 2 - Ecodata plots collected along streams of this group describe an area that is subject to flooding disturbance, indicated by the common presence of black cottonwood. Shrubs and grasses are also common and reflect the dynamic nature of these areas. Although conifer tree species are present in many plots, the average canopy cover is low. Measured constancy and canopy cover conditions for significant shade producing riparian vegetation (i.e., Overstory) within the “Non-forest “ Riparian Group 2 are presented in **Table X-8**.

Calculated System Potential Effective Shade Values for Forest Areas

Calculated System Potential Effective Shade values for the two “non-forest” riparian groups are presented in **Figures X-16** and **X-17**. The corresponding energy loading associated with these targeted conditions is presented in **Figure X-18**. Although this TMDL allocates a specific “target” condition (e.g., “system potential effective shade”), a range of values can be expected to occur as a results of “natural” variability of riparian land cover. In other words, although the individual measurements may not be at the “dot”, average condition over a distance must be at or above the “dot”.

⁹ Obtained from - <http://www.nwcouncil.org/fw/subbasinplanning/admin/level2/intermtn/plan/>

Table X-7. Canopy Cover and Constancy Conditions for Riparian “Overstory” Vegetation along VRU3C and VRU4C Streams.

Common Name	Canopy Cover (CC)	Constancy	Weighted CC ¹⁰	System Potential (SP) Height ¹¹	Weighting Factor ¹²	Weighted SP Height
VRU 3C (n = 43 Ecodata plots)						
Grand Fir	20	51	10	100	14%	14
Engelmann Spruce	16	33	5	90	9%	8
Black Cottonwood	15	30	5	100	8%	8
Douglas Fir	8	35	3	91	10%	9
Western Redcedar	30	40	12	87	11%	10
Western Hemlock	19	56	11	85	16%	13
Rocky Mountain Maple	8	65	5	30	18%	5
Mountain Alder	21	21	4	30	6%	2
Sitka Alder	11	28	3	30	8%	2
Total			58	Total		72
VRU 4C (n = 34 Ecodata plots)						
Grand Fir	6	35	2	100	10%	10
Subalpine Fir	5	18	1	63	5%	3
Paper Birch	40	9	4	70	3%	2
Engelmann Spruce	13	44	6	90	13%	11
Balsam Poplar	30	3	1	80	1%	1
Black Cottonwood	16	24	4	100	7%	7
Douglas Fir	16	50	8	91	14%	13
Western Red Cedar	32	26	8	87	7%	6
Western Hemlock	5	26	1	85	7%	6
Rocky Mountain Maple	11	56	6	30	16%	5
Mountain Alder	34	35	12	30	10%	3
Sitka Alder	21	24	5	30	7%	2
Total			58	Total		70

¹⁰ Calculated as Canopy Cover times Constancy

¹¹ Heights were assigned as the median of measured “large” trees in Figure X-6. Tree species not included in the FSVeg database (i.e., deciduous) were assigned maximum height values obtained from the following NRCS webpage - <http://plants.usda.gov/>

¹² Calculated as relative weight that the species was observed (i.e., observed divided by total constancy)

Table X-8. Canopy Cover and Constancy Conditions for Riparian “Overstory” Vegetation along VRU5C Streams.

Common Name	Canopy Cover (CC)	Constancy	Weighted CC ¹³	System Potential (SP) Height ¹⁴	Weighting Factor ¹⁵	Weighted SP Height
VRU 5C (n = 9 Ecodata plots)						
Grand Fir	16	50	8	100	15%	15
Paper Birch	12	31	4	70	10%	7
Engelmann Spruce	5	31	2	90	10%	9
Black Cottonwood	28	63	18	100	19%	19
Douglas Fir	2	38	1	91	12%	11
Western Red Cedar	18	44	8	87	13%	12
Western Hemlock	6	25	2	85	8%	7
Mountain Alder	20	44	9	25	13%	3
Sitka Alder	11	28	3	30	8%	2
Total			50	Total		82

¹³ Calculated as Canopy Cover times Constancy

¹⁴ Heights were assigned as the median of measured “large” trees in Figure X-6. Tree species not included in the FSVeg database (i.e., deciduous) were assigned maximum height values obtained from the following NRCS webpage - <http://plants.usda.gov/>

¹⁵ Calculated as relative weight that the species was observed (i.e., observed divided by total constancy)

Figure X-16. System Potential Effective Shade for “Non-Forest” Assessment Group 1 at Various Stream Aspect and Stream Width Conditions.

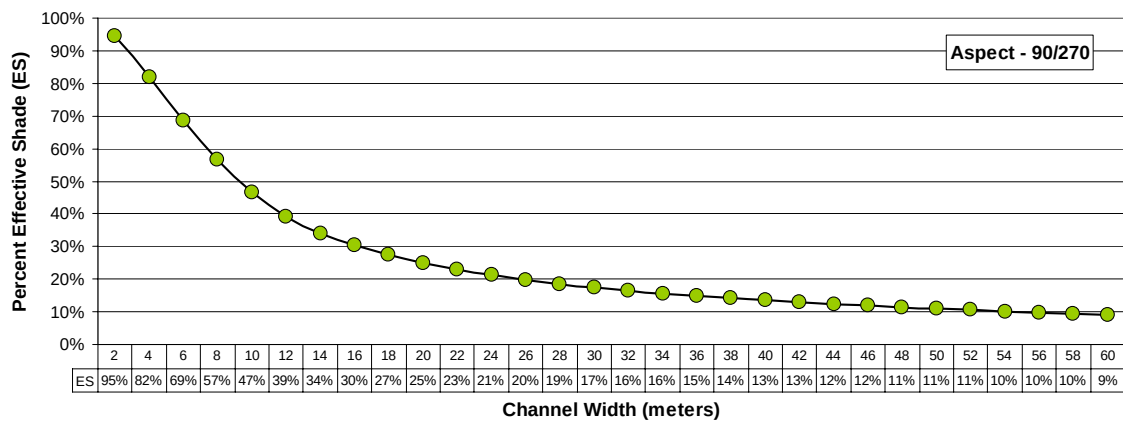
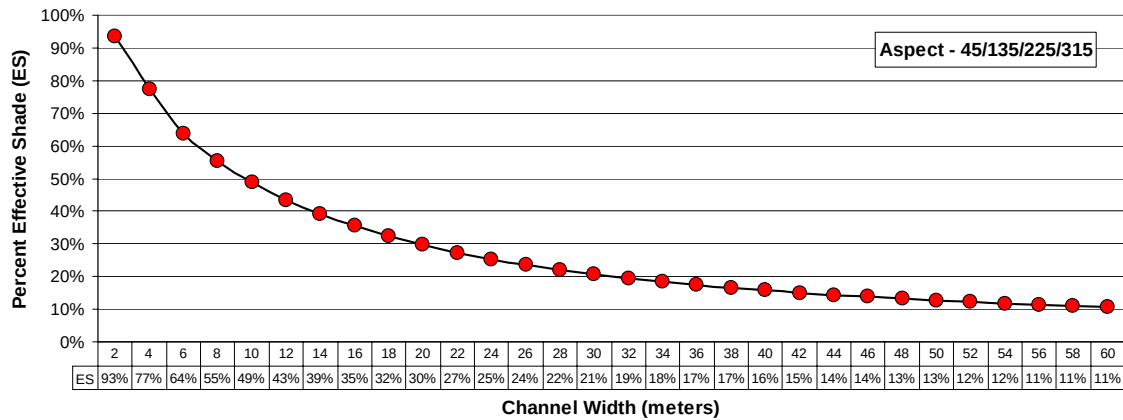
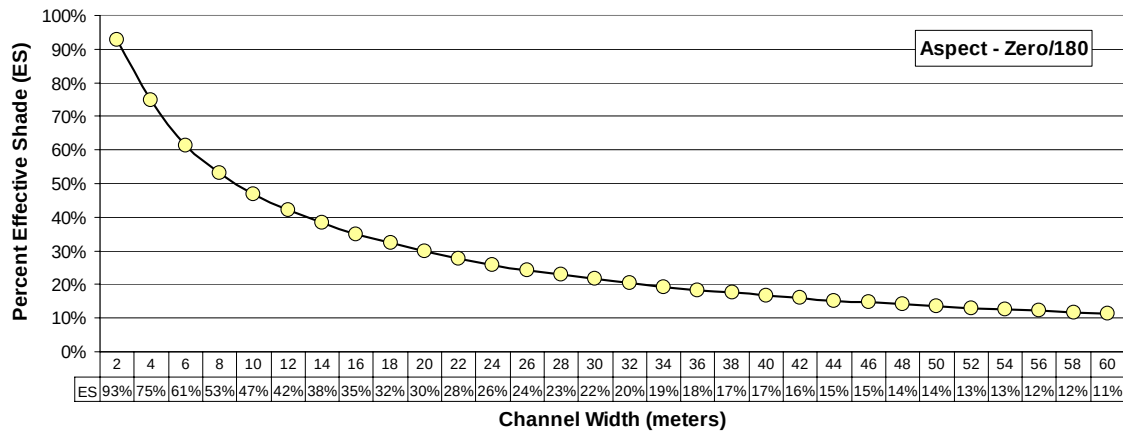


Figure X-17. System Potential Effective Shade for “Non-Forest” Assessment Group 2 at Various Stream Aspect and Stream Width Conditions.

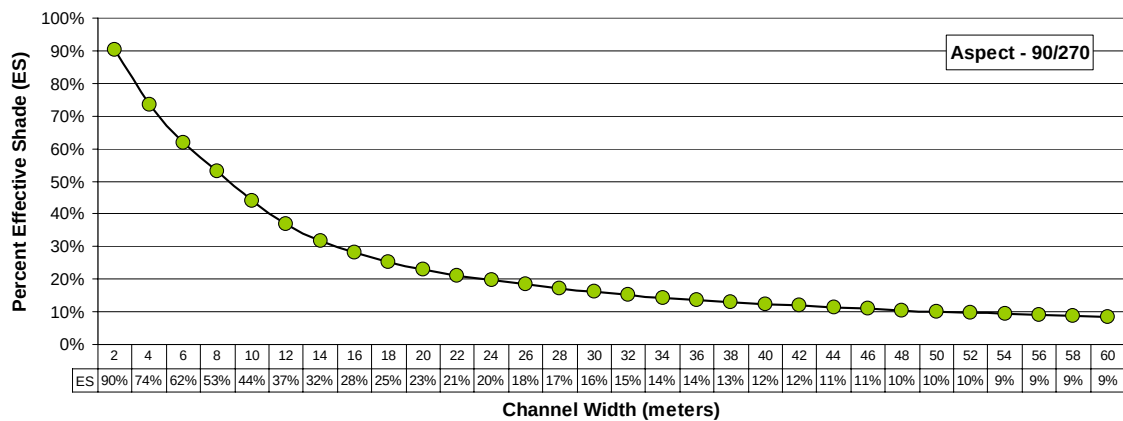
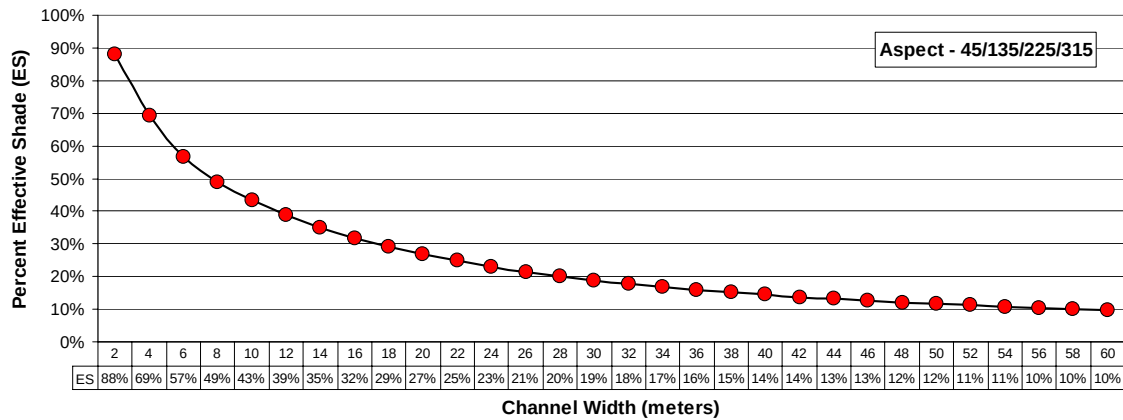
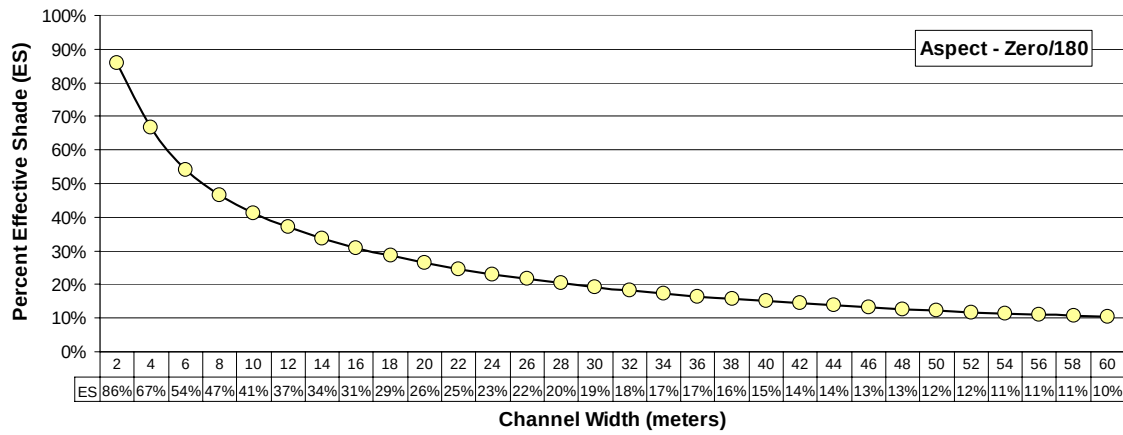
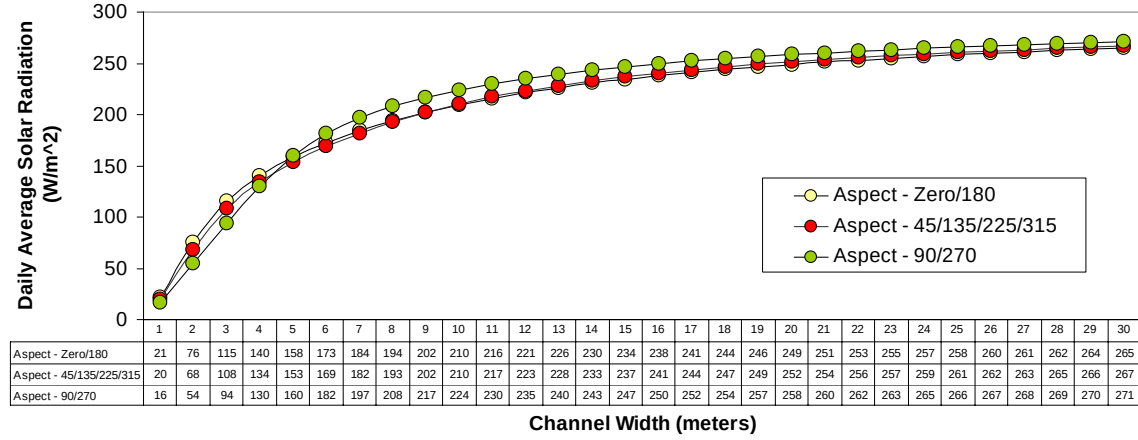


Figure X-18. Daily Average Solar Radiation Loading at System Potential Effective Shade Conditions for the two “Non-Forest” Riparian Groups in the Pend Oreille Basin.

Non-Forest Riparian Group 1



Non-Forest Riparian Group 2

