Middle Fork Payette River Temperature Total Maximum Daily Loads:

Addendum to the Middle Fork Payette River Subbasin Assessment and TMDL

Hardscrabble Bridge, courtesy Emmett Ranger District, Boise National Forest

Boiling Springs Bridge, courtesy Emmett Ranger District, Boise National Forest

Department of Environmental Quality

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Abbreviations, Acronyms, and Symbols

§303(d)	Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section
AU	assessment unit
BMP	best management practice
BURP	Beneficial Use Reconnaissance Program
C	Celsius
CWA	Clean Water Act
DEQ	Department of Environmental Quality
EPA	United States Environmental Protection Agency
FPA	Idaho Forest Practices Act
GIS	Geographical Information Systems
HUC	Hydrologic Unit Code
I.C.	Idaho Code
IDAPA	Refers to citations of Idaho administrative rules
IDL	Idaho Department of Lands
LA	load allocation
LC	load capacity
m	meter
md	method difference
mi	mile
mi^2	square miles
MOS	margin of safety
MWMT	maximum weekly maximum temperature
n.a.	not applicable
NA	not assessed
NB	natural background
nd	no data (data not available)
NPDES	National Pollutant Discharge Elimination System
PNV	potential natural vegetation
SBA	subbasin assessment
TMDL	total maximum daily load
U.S.	United States
U.S.C.	United States Code
USFS	United States Forest Service
WAG	Watershed Advisory Group
WLA	wasteload allocation
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 one water body (four assessment units) in the Middle Fork Payette River Subbasin, the mainstem river itself, that has been placed on Idaho's current §303(d) list. This document addresses the temperature TMDL for the MF Payette River. For more information about this subbasin as a whole, the previous TMDL for sediment and the implementation plan for that sediment TMDL see the Subbasin Assessment and TMDL for the Middle Fork Payette River (IDEQ, 1998) and the Final Total Maximum Daily Load Implementation Plan for the Middle Fork Payette River and Addendum to the Subbasin Assessment and Total Maximum Daily Load for the Middle Fork Payette River (IDEQ 2003).

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 Middle Fork Payette River Subbasin (17050121) is located in west-central Idaho, north of Garden Valley, Idaho. There were no streams listed on the Idaho 1998 303d list for temperature pollution in this subbasin. The Environmental Protection Agency (EPA) added streams to Idaho's 1998 303d list of impaired waters that exceeded Idaho's temperature criteria. In this Subbasin, the MF Payette River was among those EPA additions (Figure A) and it was listed for the entire mainstem from headwaters to the mouth. Additionally, 12 tributaries to the MF Payette River were examined as sources of solar loading. These tributaries are shown in Figure A.

<u>Temperature</u>

Temperature is a water quality factor essential to the life cycle of fish and other aquatic species. Different temperature regimes also result in different aquatic community compositions. Water temperature dictates whether a warm, cool, or coldwater aquatic community is present. Many factors, natural and human caused, affect stream temperatures. Natural factors include altitude, aspect, climate, weather, riparian vegetation (shade), and channel morphology (width and depth). Human influenced factors include heated discharges (such as those from point sources), riparian alteration, channel alteration, and flow alteration.

Elevated stream temperatures can be harmful to fish at all life stages, especially if they occur in combination with other habitat limitations such as low dissolved oxygen or poor food supply. Acceptable temperature ranges vary for different species of fish, with cold water species being the least tolerant of high water temperatures. Consistently high temperatures can result in reduced body weight, reduced oxygen exchange, increased susceptibility to disease, and reduced reproductive capacity in adult fish. Acutely high temperatures can result in death if they persist for an extended length of time. Juvenile fish are even more sensitive to temperature variations than adult fish, and can experience negative impacts at a lower value than adults, resulting in lower growth rates.

Tables A and B show the temperature criteria applicable to the Middle Fork Payette River and the beneficial uses designated for the river. In regards to the MF Payette River, high temperatures affect cold water aquatic life and salmonid spawning. These are the beneficial uses that are impaired as shown by the violations of state and federal temperature critera. This temperature analysis focuses on those beneficial uses specifically.

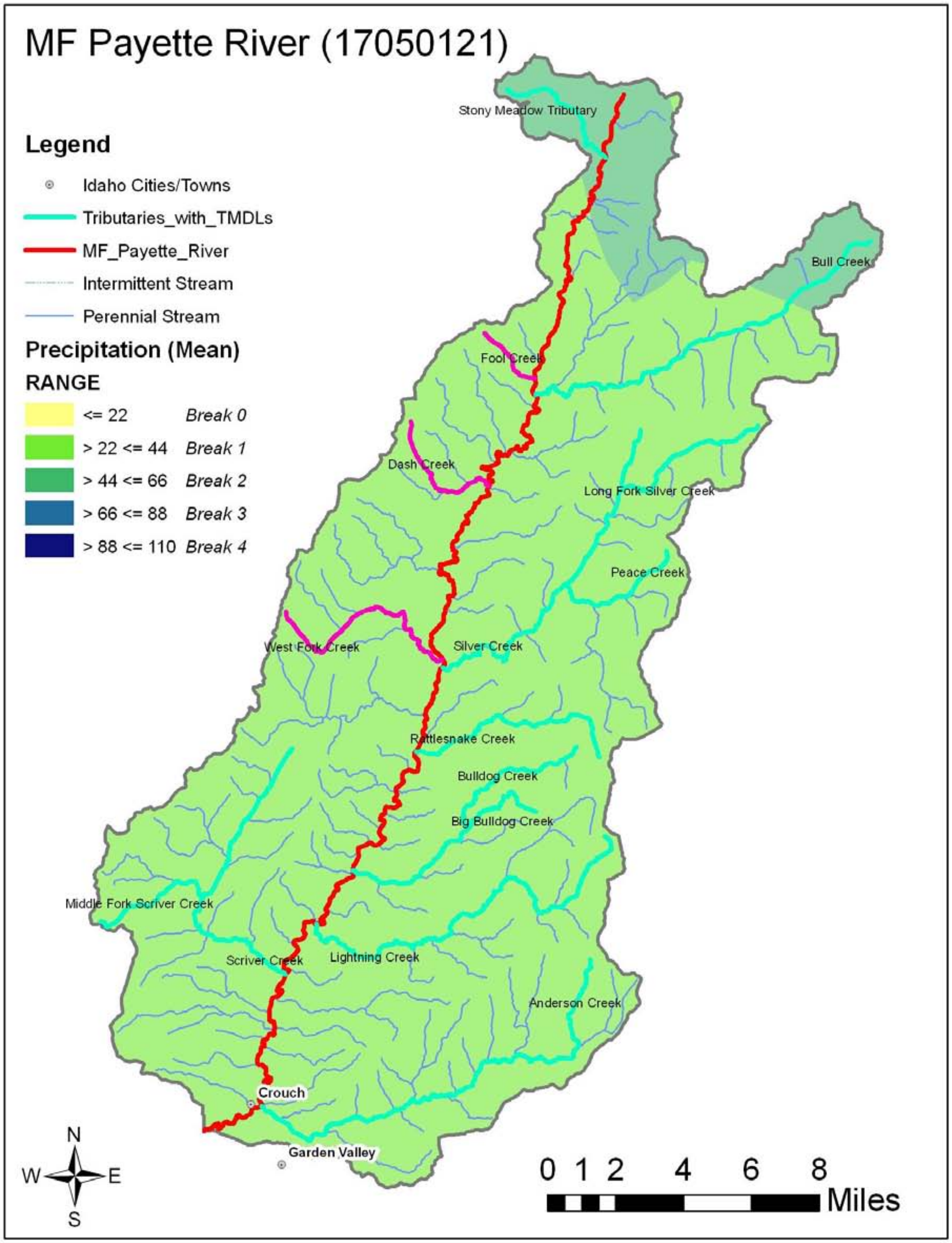
Table A. Numeric temperature criteria supportive of designated beneficial uses in Idaho water quality standards.

Water Quality Parameter	Cold Water Aquatic Life	Salmonid Spawning (During Spawning and Incubation Periods for Inhabiting Species)
Temperature	22 °C or less daily maximum; 19 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average Bull trout: not to exceed 13 °C maximum weekly maximum temperature over warmest 7-day period, June – August; not to exceed 9 °C daily average in September and October at elevations above 1400 meters
EPA Bull Trout Temperature criteria (40 CFR Part 131) for MF Payette River above Fool Creek (Fool Creek is at approximately 1400 meters- Figure A shows location)		7 day moving average of 10 °C or less maximum daily temperature for June - September

Table B. Designated Beneficial Uses for the Middle Fork Payette River

Assessment Units	Designated Uses
ID17050121SW001_04, ID1705012SW005_03, ID1705012SW005_02, IW1705012SW005_04	Coldwater Aquatic Life, Salmonid Spawning, Drinking Water Supply, Primary Contact Recreation, Special Resource Water

Figure A. Subbasin at a glance.



Fires

Fire activity has been high in the watershed over the past several years. The Rattlesnake Fire of 2006 burned in the subwatersheds of Silver Creek, Rattlesnake Creek, Lightning Creek, and Bulldog Creek. In 2007, the Lucky Fire burned in the Six Mile subwatershed and the Lightning Creek fire burned in the Lightning Creek and Anderson Creek subwatersheds. The Monumental Fire (Part of the Cascade Complex burned the upper portions of the Bull Creek subwatershed in 2007. Fire can clearly reduce the vegetative component for shading which may result in higher instream temperatures. During the implementation process, riparian areas that have been affected by fire can be identified and decisions made as to whether the area is healing on its own or could benefit from a rehabilitation project. More information on implementation can be found in the section below.

Key Findings

The MF Payette River (assessment units ID17050121SW001_04, ID1705012SW005_03, ID1705012SW005_02, IW1705012SW005_04) was placed on the 1998 303d list of impaired waters by EPA for reasons associated with temperature criteria violations (Table C) This listing was carried forward to the 2002 303(d) list, but was erroneously listed as ID17050121SW005_04 and ID17050121SW001_04 for an unknown pollutant. The correct listing should be assessment units ID17050121SW001_04, ID1705012SW005_03, ID1705012SW005_02, IW1705012SW005_04 for temperature (IDEQ 2007, Craig Shepard personal communication). The river is designated for the following beneficial uses: coldwater aquatic life, salmonid spawning, domestic water supply, special resource water and primary contact recreation. As seen in Figures B and C, the MF Payette River does not meet Idaho's coldwater aquatic life temperature criteria of water temperatures of 22 °C or less daily maximum; 19 °C or less daily average nor does it meet the salmonid spawning criteria of 13 °C or less daily maximum; 9 °C or less daily average during spawning periods (March 15-July 15). As expected, temperature exceedances of the coldwater aquatic life criteria occur during the hottest part of the year (July through mid-August). The upstream location where both salmonid spawning and cold water aquatic life temperature weren't met was in the MF Payette River above West Fork Creek. Figure A shows the location of this creek.

The Middle Fork Payette River above Dash Creek was the highest elevation site that temperature data was successfully collected at (see Figure A for location of Dash Creek). As shown in Figure D, salmonid spawning and the coldwater aquatic life criteria were both met.

Bull trout criteria apply at elevations above 1400 meters (4950 feet) which is roughly demarcated as the area upstream of where Fool Creek flows in. EPA bull trout criteria apply in the MF Payette River upstream of Fool Creek. Most of the section of the Middle Fork Payette River above 1400 meters flows through a narrow, roadless canyon with the exception of the uppermost 3-4 miles. No temperature data for bull trout was collected in the mainstem Middle Fork Payette River above 1400 meters. A temperature logger was deployed about two miles below the headwaters but malfunctioned. Since the TMDL covers from the headwaters to the mouth, the assumption was made that natural background conditions would be achieved in the bull trout areas because any areas that were lacking in shade would be identified. Due to the roadless nature of the bull trout area, shade levels are fairly close to target levels.

To determine if in fact, the natural background temperatures of the Middle Fork Payette River were above the coldwater aquatic life criteria, a study of potential natural vegetation was initiated.

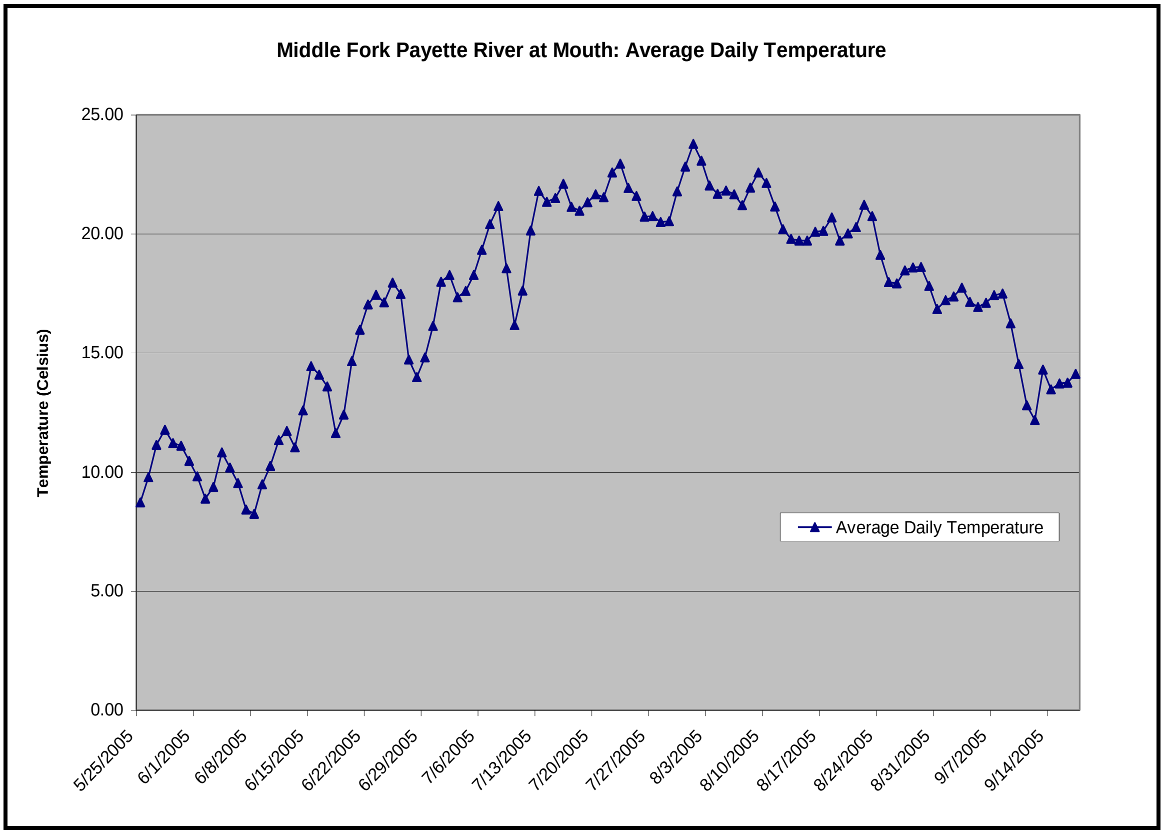


Figure B. Middle Fork Payette River at Mouth Average Daily Temperature

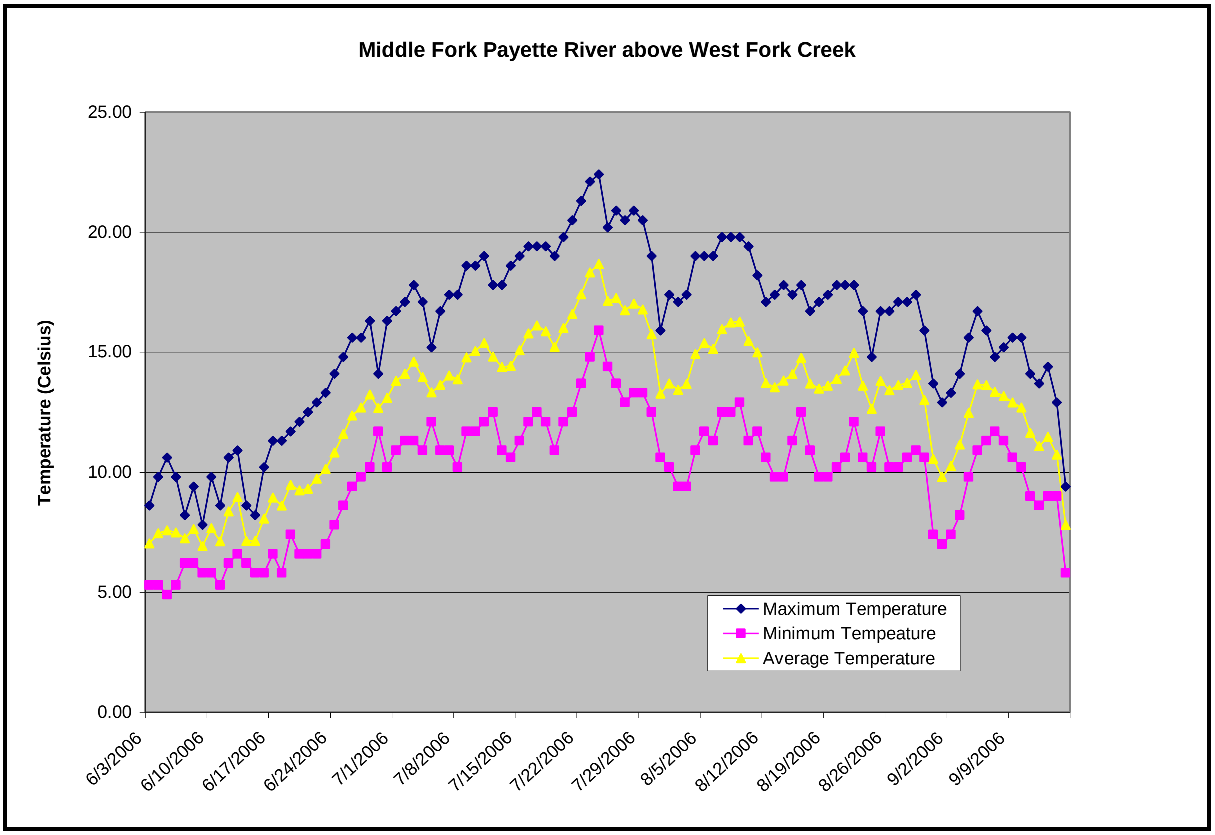


Figure C. Middle Fork Payette River Stream Temperatures above West Fork Creek

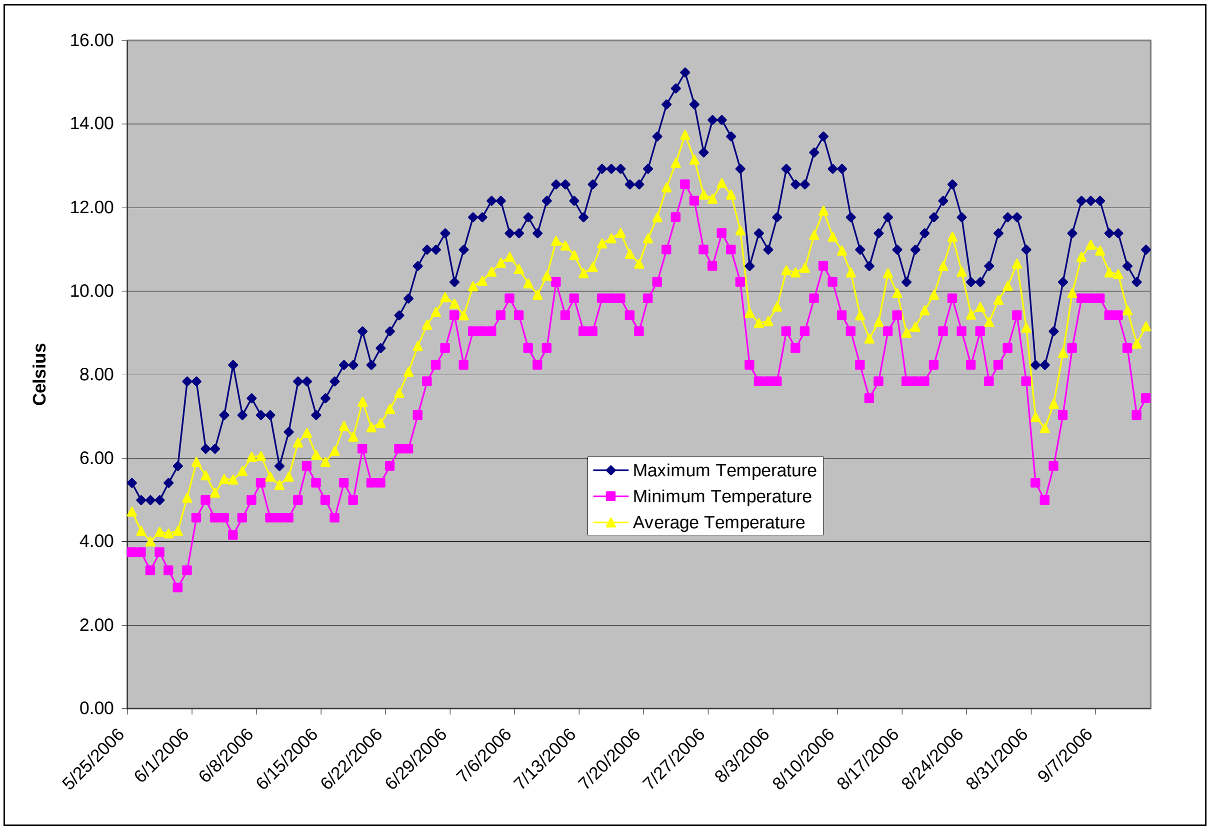


Figure D. Middle Fork Payette River above Dash Creek

Twelve tributaries to the MF Payette River were examined along with the river as sources of solar loading. These tributaries were chosen based on stream volume. Effective shade targets were established for these waters 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. TMDLs were developed for the MF Payette River and the 12 tributaries (Table D).

A majority of the streams examined show at least some impacts from a lack of riparian shade. A few areas along the streams exceed the shade targets. This may be due to forest overcrowding or topographic shade or variability in the shade curves used. An increase needed in shading is translated into a reduction needed in solar load per day in this document. This conversion is done in order to meet federal requirements regarding how pollutant loads are developed.

Several of the larger streams examined have percent reductions of solar load needed between 30% and 50%, while most of the streams have percent reductions needed well below 30%. The MF Payette River has an excess solar load of about 1.3 million kWh/day and has near 20% reductions needed. Lightning Creek and Anderson Creek have excess solar loads of near 150,000 kWh/day and greater than 30% percent reductions needed. Silver Creek had a high excess load and a lack of shade in places as well. Peace Creek and Bulldog Creek have

0% reductions needed. Peace Creek has no excess solar load, while Bulldog Creek has a negligible excess solar load.

Table C. Streams and pollutants for which TMDLs were developed.

Stream	Pollutant(s)
MF Payette River	Temperature
Stony Meadow tributary	Temperature
Bull Creek	Temperature
Long Fork Silver Creek	Temperature
Silver Creek	Temperature
Peace Creek	Temperature
Rattlesnake Creek	Temperature
Bulldog Creek	Temperature
Big Bulldog Creek	Temperature
Lightning Creek	Temperature
Anderson Creek	Temperature
MF Scriver Creek	Temperature
Scriver Creek	Temperature

Table D. Summary of assessment outcomes.

Water Body Segment/ AU	Pollutant	TMDL(s) Completed	Recommended Changes to §303(d) List	Justification
MF Payette River/ ID17050121SW005_02 ID17050121SW005_03 ID17050121SW005_04 ID17050121SW001_04	Temperature	Yes	n.a.	Excess Solar Load
Stony Meadow tributary/ ID17050121SW005_02	Temperature	Yes	n.a.	Excess Solar Load
Bull Creek/ ID17050121SW009_02 ID17050121SW009_03	Temperature	Yes	n.a.	Excess Solar Load
Long Fork Silver Creek/ ID17050121SW007_02	Temperature	Yes	n.a.	Excess Solar Load
Silver Creek/ ID17050121SW007_02 ID17050121SW007_03	Temperature	Yes	n.a.	Excess Solar Load
Peace Creek/ ID17050121SW008_02 ID17050121SW005_03	Temperature	Yes	n.a.	Excess Solar Load
Rattlesnake Creek/ ID17050121SW006_02	Temperature	Yes	n.a.	Excess Solar Load
Bulldog Creek/ ID17050121SW004_02	Temperature	Yes	n.a.	Excess Solar Load
Big Bulldog Creek/ ID17050121SW004_02	Temperature	Yes	n.a.	Excess Solar Load
Lightning Creek/ ID17050121SW003_02 ID17050121SW003_03	Temperature	Yes	n.a.	Excess Solar Load

Water Body Segment/ AU	Pollutant	TMDL(s) Completed	Recommended Changes to §303(d) List	Justification
Anderson Creek/ ID17050121SW002_02 ID17050121SW002_03	Temperature	Yes	n.a.	Excess Solar Load
Scriver Creek/ ID17050121SW010_02 ID17050121SW010_03	Temperature	Yes	n.a.	Excess Solar Load
MF Scriver Creek/ ID17050121SW010_02	Temperature	Yes	n.a.	Excess Solar Load

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.

5.1 In-stream Water Quality Targets

For the MF Payette River and tributaries 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 effects on stream water temperature, the reader is referred to the South Fork Clearwater Subbasin Assessment and TMDL (IDEQ, 2004)

<u>Potential Natural Vegetation for Temperature TMDLs</u>

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 MF Payette River and 12 tributaries 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, the Boise, Idaho station was used. The difference between existing and potential solar load, assuming existing load is higher, is the load reduction necessary to bring the stream back into compliance with water quality standards (see Appendix B). PNV shade and loads are assumed to be the natural condition, thus stream temperatures under PNV conditions are assumed to be natural (so long as there are no point sources or any other anthropogenic sources of heat in the watershed), and are thus considered to be consistent with the Idaho water quality standards, even though they may exceed numeric criteria.

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 100m, every 100 paces, every degree change on a GPS, every 0.1 mile change on an odometer, 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.

Cover class	Typical vegetation type on 5m wide stream
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 were 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 presented above 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).

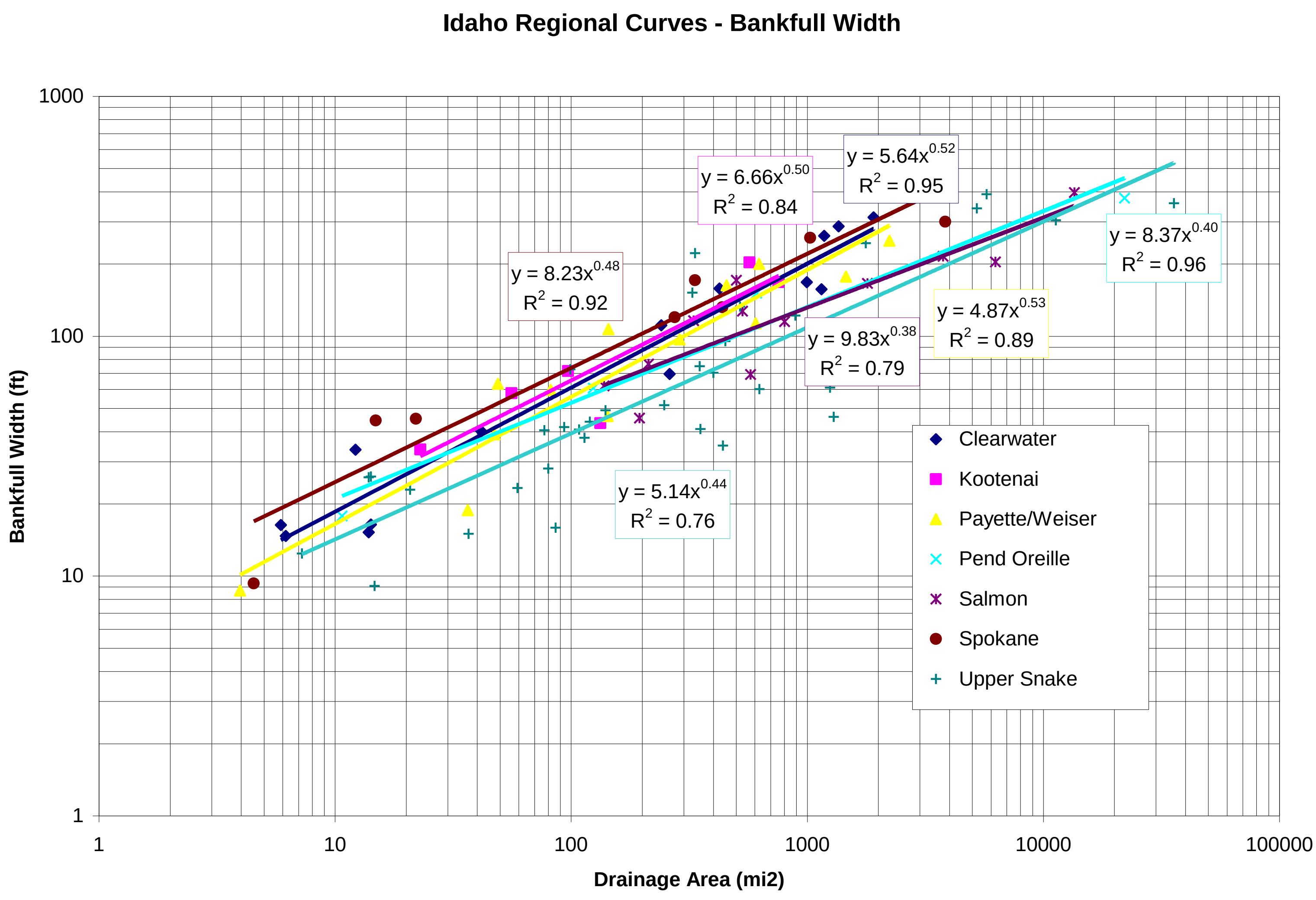
For each stream evaluated in the loading analysis, natural bankfull width is estimated based on drainage area of the Payette/Weiser curve from Figure 1. Additionally, existing width is evaluated from available data. Although we evaluated the Salmon curve (Salm) and the Upper Snake curve (US), we chose the Payette/Weiser curve (P/W) as best representing natural bankfull width for the Middle Fork Payette River (Table 1). The Payette/Weiser curve represents the precipitation/hydrology of this subbasin and predicted bankfull widths are congruent with the existing bankfull width data.

For the loading analyses, if the stream's existing width is wider than that predicted by the Payette/Weiser curve in Figure 1, then the Figure estimate of bankfull width is used in the loading analysis for natural width. If existing width is smaller, then existing width is used in the loading analysis for natural width. In most cases, the Payette/Weiser Figure estimates are used in these areas.

Table 1. Regional Curve Estimates and Existing Measurements of Bankfull Width

Location	area (sq mi)	US (m)	Salm (m)	P/W (m)	existing (m)
MF Payette at Mouth	338	20	27	32	30
MF Payette above Bell	186	16	22	24	25.9
MF Payette below Six Mile	169	15	21	23	
MF Payette above Silver	115	13	18	18	
MF Payette above Bridge	85	11	16	16	20.4
MF Payette below Bull	62.5	10	14	13	
Bull at Mouth	37.6	8	12	10	
Bull above 16-to-1	27.4	7	11	9	
Bull below Oxtail	9	4	7	5	
Long Fork Silver at Mouth	6.98	4	6	4	
Silver at Mouth	40	8	12	10	10.5
Silver below Peace	31.5	7	11	9	
Silver above Peace	17.7	6	9	7	
Peace at Mouth	13.6	5	8	6	
Rattlesnake at Mouth	7.46	4	6	4	4.1
Bulldog at Mouth	5.86	3	6	4	
Big Bulldog at Mouth	15.8	5	9	6	
Big Bulldog below Bulldog	7.36	4	6	4	
Big Bulldog above Bulldog	1.47	2	3	2	
Lightning at Mouth	25.8	7	10	8	10.25
Lightning below Onion	13.2	5	8	6	
Lightning above Onion	8.21	4	7	5	
Anderson at Mouth	35.3	8	12	10	6.6
Anderson above Little Anderson	29.1	7	11	9	13.97
Anderson above Cow	20.5	6	9	7	
Anderson above Granite	7.89	4	7	4	
MF Scriver at Mouth	6	3	6	4	
Scriver at Mouth	30.1	7	11	9	
Scriver below MF Scriver	21	6	10	7	
Scriver above MF Scriver	14.9	5	8	6	
Scriver below LF Scriver	25.9	7	10	8	8.7
Stony Meadow Tributary at Mouth	4.9	3	5	3	

Figure 1. Bankfull Width as a Function of Drainage Area



Design Conditions

The MF Payette River subbasin lies in the Southern Forested Mountain Ecoregion (McGrath et al., 2001). Grand fir and subalpine fir grow in higher elevations of this area, while ponderosa pine grows in the canyons. Open Douglas fir is common and mountain sagebrush is found on drier slopes. Streams in this subbasin typically begin in mixed conifer/ponderosa pine forests and, as they get wider, flow through more open shrub dominated riparian vegetation where the trees are varying distances from the bank.

Riparian vegetation types were assigned to streams according to the type of plant communities expected and observed to be present. The Potential Vegetation Groups (PVGs) from the Boise National Forest Land and Resource Management Plan (BNF, 2003) were also used to determine which vegetation classes areas of the subbasin fell into. The dominant PVGs along the streams in the MF Payette River subbasin are PVG 10 – Persistent Lodgepole Pine, PVG 7 – Warm, Dry Subalpine Fir, PVG 2 – Warm, Dry Douglas-fir/Moist Ponderosa Pine, PVG 3 – Cool, Moist Douglas-fir, and PVG 6 – Moist Grand Fir.

We classified areas where the conifer forest is closest to the stream as being in a conifer riparian vegetation type. Where PVG 10 and 7 are dominant along the stream, the area was classified as being in the ‘Conifer 1’ vegetation type, and where PVG 2 and 6 are dominant, the area was classified as being in the ‘Conifer 2’ vegetation type. Areas where the conifers are further from the stream bank so as to provide less shade and where shrubs dominate the groundcover were classified as conifer/shrub. Conifer/shrub areas where PVG 10 and 7 are dominant were classified as ‘Conifer/shrub 1’ and areas where PVGs 3, 6 and 2 are dominant were classified as ‘Conifer/shrub 2.’

Areas where the conifers are further from the stream bank and where grasses and low shrubs dominate the groundcover were classified as being in a conifer/meadow vegetation type. As with the conifer/shrub types, these areas were classified further as either ‘Conifer/meadow 1’ or ‘Conifer/meadow 2’ depending on whether PVGs 7 and 10 or PVGs 2, 6 and 3 are dominant.

A few areas along the MF Payette River and one area on Silver Creek were classified as being in a meadow riparian vegetation type due to the distance of the conifer forests from the bank and the groundcover consisting of grasses and low shrubs. Willow/Alder dominated areas were classified as shrub. There were several areas, on the MF Payette River and on lower Lightning Creek, where geologic constraints prevent the typical riparian cover from being established on one side of the streams. Using best professional judgment based on what we saw in the aerial photos, we assigned these areas shade targets that are lower by half than those used for the vegetation types these areas would otherwise be in to accommodate for the influence of the exposed slopes. This number was chosen because one side (half) of the stream consisted predominantly of rock.

Target Selection

To determine potential natural vegetation shade targets for the MF Payette River subbasin, effective shade curves from several existing temperature TMDLs were examined. These TMDLs had previously used vegetation community modeling to produce these shade curves. 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. Although these TMDLs reflect a wide variety of geomorphologies and topographies, effective shades at the same stream width were remarkably similar. For the MF Payette River subbasin, curves for the most similar vegetation type were selected for shade target determinations. Because no two landscapes are exactly the same, shade targets were derived by taking an average of the various shade curves available. Thus, the selected shade curves represent a range of shade conditions that presumably the riparian community of interest in this TMDL falls into.

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).

Shade Curves

To develop shade targets for the Conifer 1 vegetation type (Table 2) we averaged the shade curves for a lodgepole pine vegetation type, a subalpine fir type and a Douglas fir type. These are representative of the potential vegetation groups (PVGs) shown to be present in the area by the Boise National Forest Land and Resource Management Plan (BNF, 2003). The Conifer 1 type was designated as consisting mainly of PVG 10 and PVG 7. The PVGs used to classify areas of the streams are described above in the Design Conditions section.

Two of the shade curves, Douglas fir and subalpine fir, came from the Salmon-Chamberlain (Crooked Creek) TMDL (IDEQ, 2002) and one, VRU1, came from the SF Clearwater TMDL (IDEQ, 2004). The VRU1 shade curve was composed of grand fir, subalpine fir and lodgepole pine as dominant vegetation with 15% large trees, 10% non-forest, 30% medium trees, 30% pole-sized trees and 15% seedling/sapling trees. The subalpine fir shade curve had an average canopy cover of 80% and average height of 83 feet. The Douglas fir shade curve had an average canopy cover of 64% and an average height of 83 feet.

Table 2. Shade Targets for the Conifer 1 Vegetation Type at Various Stream Widths

Conifer 1	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m
VRU1(IDEQ 2004)	98	95	94	92	89	87	85	82	80	78	74	71
Subalpine fir (IDEQ, 2002)	95	95	93	92	90	88	86	85	83	81	80	78
Douglas fir (IDEQ, 2002)	91	89	86	85	84	82	80	79	77	75	73	70
Average	94.667	93	91	89.667	87.667	85.667	83.667	82	80	78	75.667	73
Target (%)	**95**	**93**	**91**	**90**	**88**	**86**	**84**	**82**	**80**	**78**	**76**	**73**

Conifer dominated areas with a persistence of PVG 2 and PVG 6 were considered to be in the Conifer 2 vegetation type. To produce shade targets for the Conifer 2 vegetation type (Table 3) we averaged the shade curves for a ponderosa pine vegetation type, a Douglas fir type and a grand fir type.

All three of the shade curves used in Table 3 are from the Salmon-Chamberlain (Crooked Creek) TMDL (IDEQ, 2002). The grand fir shade curve had an average canopy cover of 76% and an average height of 98 feet, and the ponderosa pine shade curve had an average canopy cover of 58% and an average height of 59 feet. The Douglas fir shade curve is described above.

Table 3. Shade Targets for the Conifer 2 Vegetation Type at Various Stream Widths

Conifer 2	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m
Ponderosa pine (IDEQ, 2002)	83	80	77	75	74	72	69	65	62	59	57	55
Douglas fir (IDEQ, 2002)	91	89	86	85	84	82	80	79	77	75	73	70
Grand fir (IDEQ 2002)	98	96	94	93	92	90	89	88	86	84	82	80
Average	90.667	88.333	85.667	84.333	83.333	81.333	79.333	77.333	75	72.667	70.667	68.333
Target (%)	**91**	**88**	**86**	**84**	**83**	**81**	**79**	**77**	**75**	**73**	**71**	**68**

For the Conifer/Shrub 1 community, the subalpine fir and Douglas fir shade curves are described above for Table 2. The mountain alder shade curve comes from the Willow-Whitehorse Ecological Provence of the Alvord Lake TMDL (ODEQ, 2003). The mountain alder community had an average canopy height of 25 feet and an average canopy density of 30%.

Table 4. Shade Targets for the Conifer/Shrub 1 Vegetation Type at Various Stream Widths

Conifer/Shrub 1	1m	2m	3m	4m	5m	6m
Subalpine fir (IDEQ, 2002)	95	95	93	92	90	88
Douglas fir (IDEQ, 2002)	91	89	86	85	84	82
Mountain alder (ODEQ, 2003)	91	89	85	80	72	63
Average	92.333	91	88	85.667	82	77.667
Target (%)	**92**	**91**	**88**	**86**	**82**	**78**

For the Conifer/Shrub 2 community, the ponderosa pine and Douglas fir shade curves from the Salmon-Chamberlain (Crooked Creek) TMDL described for Table 3 above, and the mountain alder shade curve from the Alvord Lake TMDL described for Table 4 above were used.

Table 5. Shade Targets for the Conifer/Shrub 2 Vegetation Type at Various Stream Widths

Conifer/Shrub 2	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	12m	13m	14m	15m
Ponderosa pine (IDEQ, 2002)	83	80	77	75	74	72	69	65	62	59	57	55	53	51	49
Douglas fir (IDEQ, 2002)	91	89	86	85	84	82	80	79	77	75	73	70	69	68	66
Mountain alder (ODEQ, 2003)	91	89	85	80	72	63	60	54	50	47	45	42	41	40	38
Average	88.333	86	82.667	80	76.667	72.333	69.667	66	63	60.333	58.333	55.667	54.333	53	51
Target (%)	**88**	**86**	**83**	**80**	**77**	**72**	**70**	**66**	**63**	**60**	**58**	**56**	**54**	**53**	**51**

Conifer/Shrub 2	16m	17m	18m	19m	20m	21m	22m	23m	24m	25m	26m	27m	28m
Ponderosa pine (IDEQ, 2002)	48	47	46	45	44	43	42	41	40	39	38	37	36
Douglas fir (IDEQ, 2002)	64	62	60	58	56	54	52	50	48	46	44	42	40
Mountain alder (ODEQ, 2003)	35	34	34	33	32	31	30	29	28	27	26	25	24
Average	49	47.667	46.667	45.333	44	42.667	41.333	40	38.667	37.333	36	34.667	33.333
Target (%)	**49**	**48**	**47**	**45**	**44**	**43**	**41**	**40**	**39**	**37**	**36**	**35**	**33**

For the Conifer/Meadow 1 community, the subalpine fir and Douglas fir shade curves described for Table 2 above were used. The tufted hairgrass shade curve from the Salmon-Chamberlain (Crooked Creek) TMDL which has an average canopy cover of 42% and an average height of 2 feet, was added.

Table 6. Shade Targets for the Conifer/Meadow 1 Vegetation Type at Various Stream Widths

Conifer/Meadow 1	1m	2m	3m	4m	5m	6m	7m	8m
Subalpine fir (IDEQ, 2002)	95	95	93	92	90	88	86	85
Douglas fir (IDEQ, 2002)	91	89	86	85	84	82	80	79
Tufted hairgrass (IDEQ 2002)	43	30	17	15	12	10	9	8
Average	76.333	71.333	65.333	64	62	60	58.333	57.333
Target (%)	**76**	**71**	**65**	**64**	**62**	**60**	**58**	**57**

For the Conifer/Meadow 2 community, the ponderosa pine, Douglas fir and tufted hairgrass shade curves from the Salmon-Chamberlain (Crooked Creek) TMDL described above were used.

Table 7. Shade Targets for the Conifer/Meadow 2 Vegetation Type at Various Stream Widths

Conifer/Meadow 2	1m	2m	3m	4m	5m	6m	7m	8m	9m	10m	11m	14m	15m	16m	29m	30m
Ponderosa pine (IDEQ, 2002)	83	80	77	75	74	72	69	65	62	59	57	51	49	48	34	32
Douglas fir (IDEQ, 2002)	91	89	86	85	84	82	80	79	77	75	73	68	66	64	38	36
Tufted hairgrass (IDEQ 2002)	43	30	17	15	12	10	9	8	7	6	5	4	3	3	1	1
Average	72.333	66.333	60	58.333	56.667	54.667	52.667	50.667	48.667	46.667	45	41	39.333	38.333	24.333	23
Target (%)	**79**	**74**	**69**	**67**	**66**	**64**	**62**	**60**	**58**	**56**	**54**	**50**	**49**	**48**	**24**	**23**

For areas where the conifers have lost dominance and taller shrubs have become more prevalent, we developed targets based on various shrub communities. The willow/alder shade curve from the Trout Creek Mountains Ecological Province of the Alvord Lake TMDL (ODEQ, 2003) had an average canopy density of 75% and an average height of 24 feet. The herb/scrub shade curve from the SF Clearwater TMDL (IDEQ, 2004) resulted from a community of 80% shrub, 20% grass with an average shrub height of 13.8 feet and grass height of 1.5 feet. The mountain alder shade curve is the same as used in the Conifer/Shrub types.

Table 8. Shade Targets for the Shrub Vegetation Type at Various Stream Widths

Shrub	3m	6m	9m	10m
Willow/alder (ODEQ, 2003)	79	57	44	40
Herb/scrub (IDEQ, 2004)	43	25	18	16
Mountain alder (ODEQ, 2003)	85	63	50	47
Average	69	48.333	37.333	34.333
Target (%)	**69**	**48**	**37**	**34**

Areas where grasses and lower shrubs dominate were classified as meadow. The graminoid/willow shade curve from the Trout Creek Mountains Ecological Province of the Alvord Lake TMDL has an average canopy cover of 10% and an average height of 8.5 feet. The plant community structure of this curve is similar to the Middle Fork Payette and is one of the few meadow community curves available. The VRU12/16 shade curve from SF Clearwater TMDL is a bunchgrass/shrubland community. It is 80% shrub, 20% grass with an average shrub height of 8.4 feet and average grass height of 1 foot. The tufted hairgrass shade curve is described above for Table 6.

Table 9. Shade Targets for the Meadow Vegetation Type at Various Stream Widths

Meadow	7m	8m	9m	10m	11m	12m	13m	14m	15m	16m	29m	30m
Graminoid/willow (ODEQ, 2003)	8	6	5	4	3	3	2	2	2	1	1	1
VRU12/16 (IDEQ, 2004)	23	21	19	17	15	14	13	12	11	10	6	6
Tufted hairgrass (IDEQ 2002)	9	8	7	6	5	5	4	4	3	3	1	1
Average	13.333	11.667	10.333	9	7.6667	7.3333	6.3333	6	5.3333	4.6667	2.6667	2.6667
Target (%)	**13**	**12**	**10**	**9**	**8**	**7**	**6**	**6**	**5**	**5**	**3**	**3**

Monitoring Points

The accuracy of the aerial photo interpretations was field verified with a solar pathfinder in the summer of 2007. Seventeen reaches were sampled for effective shade including six reaches on the MF Payette River, three on Anderson Creek, four in the Scriver Creek watershed, three on Silver Creek, and one on Rattlesnake Creek. Our original aerial photo interpretation of shade on the MF Payette River itself was low with four of the six sites sampled having actual shade values 10 to 20% higher than our original interpretations. These locations were adjusted accordingly as were other reaches in their vicinity. Conversely, the three sites sampled on Anderson Creek showed that original aerial photo estimates were higher than actual shade measured in the field by an average of 10%. Thus shade estimates on Anderson Creek were adjusted downward in response. The four sites on Scriver and MF Scriver Creeks showed our original estimates of shade to be accurate in that drainage, thus no further changes were made there. The three sites on Silver Creek showed that two original estimates were accurate and one was high by 20%. After re-examining the aerial photo interpretation for Silver Creek, the one incorrect location was adjusted, but no other sections on this creek were changed. Our original aerial photo interpretation at the mouth of Rattlesnake Creek was high by 10% compared to the one site sampled there. That location was adjusted accordingly; however, not enough sites were sampled to make any further adjustments on Rattlesnake Creek. Other locations in the watershed, especially the northern half, were not adjusted from our original aerial photo interpretations because of a lack of sampling in that area. All of the solar pathfinder data considered together showed that on average our estimations were balanced with an average difference between aerial estimates and actual data as 0% ± 6.4% (mean ± 95% C.I.). Therefore, we assumed that our estimates of shade in non-sampled portions of the watershed were as high as much as they were low balancing out the estimates, and if there were differences they were unlikely to be greater than 20%. However, field verifications of actual shade should take place before any implementation is undertaken on areas not sampled.

Effective shade monitoring can take place on any reach throughout the MF Payette River subbasin and be compared to estimates of existing shade seen on Figure 3 and described in Tables 10 through 22. 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 plat collector (under full sun) for a given period of time by the fraction of the solar radiation that is not blocked by shade (i.e. the percent open or 1-percent shade). In other words, if a shade target is 60% (or 0.6), then the solar load hitting the stream under that target is 40% of the load hitting the flat plate collector under full sun.

We obtained solar load data for flat plate collectors from National Renewable Energy Laboratory (NREL) weather stations near by. In this case, data from the Boise, Idaho station was used. The solar loads used in this TMDL are spring/summer averages, thus, we use an average load for the six month period from April through September. These months coincide with time of year that stream temperatures are increasing and when deciduous vegetation is in leaf. Tables 10 through 22 show the PNV shade targets (identified as Target or Potential Shade) and their corresponding potential summer load (in kWh/m^2/day and kWh/day) that serve as the loading capacities for the streams.

Loading capacities vary from over 6 million kWh/day on the river itself (Table 10) to 8,505 kWh/day on the unnamed tributary from Stony Meadows (Table 20) at the river's headwaters.

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 10 through 22. Like loading capacities (potential loads), existing loads in Tables 10 through 22 are presented on an area basis (kWh/m^2/day) and as a total load (kWh/day). Existing loads vary from over 7.5 million kWh/day on the mainstem river to 12,026 kWh/day on the unnamed tributary from Stony Meadows (Table 20).

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 10. Existing and Potential Solar Loads for MF Payette River.

Reach #	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)	MF Payette
1	160	0.9	0.638	0.88	0.7656	0.13	1	1	160	102.08	160	122.496	20.416	Conifer 2
2	240	0.8	1.276	0.88	0.7656	-0.51	1	1	240	306.24	240	183.744	-122.496	
3	1580	0.9	0.638	0.88	0.7656	0.13	2	1	3160	2016.08	1580	1209.648	-806.432	
4	1450	0.7	1.914	0.79	1.3398	-0.57	3	2	4350	8325.9	2900	3885.42	-4440.48	Conifer/Meadow 2
5	540	0.8	1.276	0.86	0.8932	-0.38	4	3	2160	2756.16	1620	1446.984	-1309.176	Conifer 2
6	360	0.6	2.552	0.69	1.9778	-0.57	4	3	1440	3674.88	1080	2136.024	-1538.856	Conifer/Meadow 2
7	830	0.7	1.914	0.86	0.8932	-1.02	4	3	3320	6354.48	2490	2224.068	-4130.412	Conifer 2
8	780	0.6	2.552	0.67	2.1054	-0.45	5	4	3900	9952.8	3120	6568.848	-3383.952	Conifer/Meadow 2
9	980	0.7	1.914	0.84	1.0208	-0.89	5	4	4900	9378.6	3920	4001.536	-5377.064	Conifer 2
10	1250	0.5	3.19	0.66	2.1692	-1.02	6	5	7500	23925	6250	13557.5	-10367.5	Conifer/Meadow 2
11	1830	0.6	2.552	0.64	2.2968	-0.26	7	6	12810	32691.12	10980	25218.864	-7472.256	
12	280	0.5	3.19	0.62	2.4244	-0.77	7	7	1960	6252.4	1960	4751.824	-1500.576	
13	410	0.7	1.914	0.79	1.3398	-0.57	8	7	3280	6277.92	2870	3845.226	-2432.694	Conifer 2
14	240	0.5	3.19	0.62	2.4244	-0.77	8	7	1920	6124.8	1680	4072.992	-2051.808	Conifer/Meadow 2
15	1110	0.6	2.552	0.6	2.552	0.00	8	8	8880	22661.76	8880	22661.76	0	
16	170	0.1	5.742	0.1	5.742	0.00	9	9	1530	8785.26	1530	8785.26	0	Meadow
17	160	0.5	3.19	0.58	2.6796	-0.51	9	9	1440	4593.6	1440	3858.624	-734.976	Conifer/Meadow 2
18	870	0.4	3.828	0.58	2.6796	-1.15	9	9	7830	29973.24	7830	20981.268	-8991.972	
19	530	0.1	5.742	0.09	5.8058	0.06	10	10	5300	30432.6	5300	30770.74	338.14	Meadow
20	720	0.4	3.828	0.56	2.8072	-1.02	10	10	7200	27561.6	7200	20211.84	-7349.76	Conifer/Meadow 2
21	2090	0.5	3.19	0.56	2.8072	-0.38	11	11	22990	73338.1	22990	64537.528	-8800.572	
22	450	0.7	1.914	0.68	2.0416	0.13	12	12	5400	10335.6	5400	11024.64	689.04	Conifer 2
23	640	0.6	2.552	0.68	2.0416	-0.51	12	12	7680	19599.36	7680	15679.488	-3919.872	
24	2170	0.4	3.828	0.54	2.9348	-0.89	13	13	28210	107987.88	28210	82790.708	-25197.172	Conifer/Shrub 2
25	320	0.3	4.466	0.5	3.19	-1.28	14	14	4480	20007.68	4480	14291.2	-5716.48	Conifer/Meadow 2
26	1050	0.4	3.828	0.53	2.9986	-0.83	14	14	14700	56271.6	14700	44079.42	-12192.18	Conifer/Shrub 2
27	650	0.1	5.742	0.06	5.9972	0.26	15	14	9750	55984.5	9100	54574.52	-1409.98	Meadow
28	1540	0.4	3.828	0.53	2.9986	-0.83	15	14	23100	88426.8	21560	64649.816	-23776.984	Conifer/Shrub 2
29	390	0.2	5.104	0.26	4.7212	-0.38	16	15	6240	31848.96	5850	27619.02	-4229.94	geologic constraints
30	300	0.1	5.742	0.26	4.7212	-1.02	16	15	4800	27561.6	4500	21245.4	-6316.2	
31	370	0.3	4.466	0.26	4.7212	0.26	16	15	5920	26438.72	5550	26202.66	-236.06	
32	470	0.2	5.104	0.26	4.7212	-0.38	16	15	7520	38382.08	7050	33284.46	-5097.62	
33	380	0	6.38	0.25	4.785	-1.60	17	15	6460	41214.8	5700	27274.5	-13940.3	Conifer/Meadow 2
34	1230	0.1	5.742	0.26	4.7212	-1.02	17	15	20910	120065.22	18450	87106.14	-32959.08	Conifer/Shrub 2
35	220	0.2	5.104	0.26	4.7212	-0.38	17	15	3740	19088.96	3300	15579.96	-3509	
36	400	0.1	5.742	0.25	4.785	-0.96	18	16	7200	41342.4	6400	30624	-10718.4	
37	600	0	6.38	0.05	6.061	-0.32	18	16	10800	68904	9600	58185.6	-10718.4	Meadow
38	170	0.3	4.466	0.48	3.3176	-1.15	18	16	3060	13665.96	2720	9023.872	-4642.088	Conifer/Meadow 2
39	450	0.1	5.742	0.24	4.8488	-0.89	18	16	8100	46510.2	7200	34911.36	-11598.84	geologic constraints
40	1870	0	6.38	0.05	6.061	-0.32	19	16	35530	226681.4	29920	181345.12	-45336.28	Meadow
41	300	0.2	5.104	0.49	3.2538	-1.85	20	16	6000	30624	4800	15618.24	-15005.76	Conifer/Shrub 2
42	1190	0.1	5.742	0.48	3.3176	-2.42	20	17	23800	136659.6	20230	67115.048	-69544.552	
43	770	0.2	5.104	0.48	3.3176	-1.79	20	17	15400	78601.6	13090	43427.384	-35174.216	
44	570	0.1	5.742	0.48	3.3176	-2.42	20	17	11400	65458.8	9690	32147.544	-33311.256	
45	2320	0.2	5.104	0.48	3.3176	-1.79	21	17	48720	248666.88	39440	130846.144	-117820.736	
46	3280	0.3	4.466	0.47	3.3814	-1.08	21	18	68880	307618.08	59040	199637.856	-107980.224	
47	460	0.1	5.742	0.47	3.3814	-2.36	22	18	10120	58109.04	8280	27997.992	-30111.048	
48	1890	0.2	5.104	0.45	3.509	-1.60	22	19	41580	212224.32	35910	126008.19	-86216.13	
49	310	0.4	3.828	0.43	3.6366	-0.19	22	21	6820	26106.96	6510	23674.266	-2432.694	
50	520	0.2	5.104	0.41	3.7642	-1.34	23	22	11960	61043.84	11440	43062.448	-17981.392	
51	530	0.1	5.742	0.4	3.828	-1.91	23	23	12190	69994.98	12190	46663.32	-23331.66	
52	1290	0.2	5.104	0.4	3.828	-1.28	23	23	29670	151435.68	29670	113576.76	-37858.92	
53	260	0.1	5.742	0.4	3.828	-1.91	23	23	5980	34337.16	5980	22891.44	-11445.72	
54	3140	0.2	5.104	0.39	3.8918	-1.21	24	24	75360	384637.44	75360	293286.048	-91351.392	
55	200	0.2	5.104	0.37	4.0194	-1.08	24	25	4800	24499.2	5000	20097	-4402.2	
56	4380	0.2	5.104	0.37	4.0194	-1.08	25	25	109500	558888	109500	440124.3	-118763.7	
57	1170	0.2	5.104	0.36	4.0832	-1.02	26	26	30420	155263.68	30420	124210.944	-31052.736	
58	280	0.1	5.742	0.36	4.0832	-1.66	26	26	7280	41801.76	7280	29725.696	-12076.064	
59	1830	0.2	5.104	0.35	4.147	-0.96	26	27	47580	242848.32	49410	204903.27	-37945.05	
60	5140	0.2	5.104	0.33	4.2746	-0.83	27	28	138780	708333.12	143920	615200.432	-93132.688	
61	2040	0.1	5.742	0.24	4.8488	-0.89	28	29	57120	327983.04	59160	286855.008	-41128.032	Conifer/Meadow 2
62	830	0.2	5.104	0.24	4.8488	-0.26	28	29	23240	118616.96	24070	116710.616	-1906.344	
63	10200	0	6.38	0.03	6.1886	-0.19	29	30	295800	1887204	306000	1893711.6	6507.6	Meadow
64	1180	0	6.38	0.23	4.9126	-1.47	30	30	35400	225852	35400	173906.04	-51945.96	Conifer/Meadow 2
								Total	**1,437,670**	**7,532,611**	**1,395,180**	**6,175,922**	**-1,356,689**	**-18 % Reduction**

Table 11. Existing and Potential Solar Loads for Bull Creek.

Reach #	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)	Bull Creek
1	650	0.9	0.638	0.95	0.319	-0.32	1	1	650	414.7	650	207.35	-207.35	Conifer 1
2	790	0.7	1.914	0.76	1.5312	-0.3828	1	1	790	1512.06	790	1209.648	-302.412	Conifer/Meadow 1
3	1230	0.8	1.276	0.93	0.4466	-0.8294	2	2	2460	3138.96	2460	1098.636	-2040.324	Conifer 1
4	400	0.9	0.638	0.93	0.4466	-0.1914	2	2	800	510.4	800	357.28	-153.12	
5	470	0.8	1.276	0.91	0.5742	-0.7018	3	3	1410	1799.16	1410	809.622	-989.538	
6	920	0.9	0.638	0.91	0.5742	-0.0638	3	3	2760	1760.88	2760	1584.792	-176.088	
7	130	0.8	1.276	0.91	0.5742	-0.7018	3	3	390	497.64	390	223.938	-273.702	
8	120	0.5	3.19	0.65	2.233	-0.957	3	3	360	1148.4	360	803.88	-344.52	Conifer/Meadow 1
9	2250	0.8	1.276	0.9	0.638	-0.638	4	4	9000	11484	9000	5742	-5742	Conifer 1
10	420	0.7	1.914	0.88	0.7656	-1.1484	5	5	2100	4019.4	2100	1607.76	-2411.64	
11	1040	0.8	1.276	0.88	0.7656	-0.5104	5	5	5200	6635.2	5200	3981.12	-2654.08	
12	330	0.9	0.638	0.88	0.7656	0.1276	5	5	1650	1052.7	1650	1263.24	210.54	
13	2330	0.8	1.276	0.86	0.8932	-0.3828	6	6	13980	17838.48	13980	12486.936	-5351.544	
14	510	0.7	1.914	0.84	1.0208	-0.8932	7	7	3570	6832.98	3570	3644.256	-3188.724	
15	430	0.9	0.638	0.84	1.0208	0.3828	7	7	3010	1920.38	3010	3072.608	1152.228	
16	1810	0.7	1.914	0.7	1.914	0	7	7	12670	24250.38	12670	24250.38	0	Conifer/Shrub 2
17	480	0.6	2.552	0.66	2.1692	-0.3828	8	8	3840	9799.68	3840	8329.728	-1469.952	
18	2050	0.7	1.914	0.66	2.1692	0.2552	8	8	16400	31389.6	16400	35574.88	4185.28	
19	1500	0.6	2.552	0.63	2.3606	-0.1914	9	9	13500	34452	13500	31868.1	-2583.9	
20	510	0.7	1.914	0.63	2.3606	0.4466	9	9	4590	8785.26	4590	10835.154	2049.894	
21	2320	0.6	2.552	0.6	2.552	0	10	10	23200	59206.4	23200	59206.4	0	
								Total	**122,330**	**228,449**	**122,330**	**208,158**	**-20,291**	**-9**
														% Reduction

Table 12. Existing and Potential Solar Loads for Long Fork Silver Creek.

Reach #	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)	Long Fork Silver
1	480	0.6	2.552	0.76	1.5312	-1.02	1	1	480	1224.96	480	734.976	-489.984	Conifer/Meadow 1
2	640	0.8	1.276	0.95	0.319	-0.957	1	1	640	816.64	640	204.16	-612.48	Conifer 1
3	240	0.5	3.19	0.76	1.5312	-1.6588	1	1	240	765.6	240	367.488	-398.112	Conifer/Meadow 1
4	600	0.7	1.914	0.92	0.5104	-1.4036	1	1	600	1148.4	600	306.24	-842.16	Conifer/Shrub 1
5	270	0.8	1.276	0.95	0.319	-0.957	1	1	270	344.52	270	86.13	-258.39	Conifer 1
6	2680	0.9	0.638	0.93	0.4466	-0.1914	2	2	5360	3419.68	5360	2393.776	-1025.904	
7	1720	0.8	1.276	0.88	0.7656	-0.5104	3	3	5160	6584.16	5160	3950.496	-2633.664	Conifer/Shrub 1
8	990	0.7	1.914	0.86	0.8932	-1.0208	4	4	3960	7579.44	3960	3537.072	-4042.368	
9	560	0.8	1.276	0.86	0.8932	-0.3828	4	4	2240	2858.24	2240	2000.768	-857.472	
10	390	0.6	2.552	0.86	0.8932	-1.6588	4	4	1560	3981.12	1560	1393.392	-2587.728	
								Total	**20,510**	**28,723**	**20,510**	**14,974**	**-13,748**	**-48**
														% Reduction

Table 13. Existing and Potential Solar Loads for Silver Creek.

Reach #	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)	Silver Creek
1	3,100	0.9	0.638	0.91	0.5742	-0.0638	1	1	3100	1977.8	3100	1780.02	-197.78	Conifer 2
2	100	0.4	3.828	0.83	1.0846	-2.7434	3	3	300	1148.4	300	325.38	-823.02	Conifer/Shrub 2
3	160	0.6	2.552	0.8	1.276	-1.276	4	4	640	1633.28	640	816.64	-816.64	
4	730	0.7	1.914	0.84	1.0208	-0.8932	4	4	2920	5588.88	2920	2980.736	-2608.144	Conifer 2
5	1190	0.7	1.914	0.83	1.0846	-0.8294	5	5	5950	11388.3	5950	6453.37	-4934.93	
6	810	0.5	3.19	0.81	1.2122	-1.9778	6	6	4860	15503.4	4860	5891.292	-9612.108	
7	360	0.4	3.828	0.64	2.2968	-1.5312	6	6	2160	8268.48	2160	4961.088	-3307.392	Conifer/Meadow 2
8	100	0.7	1.914	0.81	1.2122	-0.7018	6	6	600	1148.4	600	727.32	-421.08	Conifer 2
9	460	0.4	3.828	0.64	2.2968	-1.5312	6	6	2760	10565.28	2760	6339.168	-4226.112	Conifer/Meadow 2
10	1870	0.1	5.742	0.13	5.5506	-0.1914	7	7	13090	75162.78	13090	72657.354	-2505.426	Meadow
11	780	0.2	5.104	0.58	2.6796	-2.4244	9	9	7020	35830.08	7020	18810.792	-17019.288	Conifer/Meadow 2
12	1200	0.1	5.742	0.58	2.6796	-3.0624	9	9	10800	62013.6	10800	28939.68	-33073.92	
13	410	0.4	3.828	0.63	2.3606	-1.4674	9	9	3690	14125.32	3690	8710.614	-5414.706	Conifer/Shrub 2
14	2180	0.5	3.19	0.63	2.3606	-0.8294	9	9	19620	62587.8	19620	46314.972	-16272.828	
15	220	0.4	3.828	0.63	2.3606	-1.4674	9	9	1980	7579.44	1980	4673.988	-2905.452	
16	650	0.5	3.19	0.6	2.552	-0.638	10	10	6500	20735	6500	16588	-4147	
17	140	0.4	3.828	0.6	2.552	-1.276	10	10	1400	5359.2	1400	3572.8	-1786.4	
18	4030	0.6	2.552	0.6	2.552	0	10	10	40300	102845.6	40300	102845.6	0	
19	620	0.2	5.104	0.56	2.8072	-2.2968	10	10	6200	31644.8	6200	17404.64	-14240.16	Conifer/Meadow 2
								Total	**133,890**	**475,106**	**133,890**	**350,793**	**-124,312**	**-26**
														% Reduction

Table 14. Existing and Potential Solar Loads for Peace Creek.

Reach #	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)	Peace Creek
1	490	0.9	0.638	0.91	0.5742	-0.06	1	1	490	312.62	490	281.358	-31.262	Conifer 2
2	2710	0.9	0.638	0.88	0.7656	0.13	2	2	5420	3457.96	5420	4149.552	691.592	
3	2000	0.9	0.638	0.84	1.0208	0.38	4	4	8000	5104	8000	8166.4	3062.4	
4	1190	0.9	0.638	0.83	1.0846	0.45	5	5	5950	3796.1	5950	6453.37	2657.27	
5	470	0.7	1.914	0.78	1.4036	-0.5104	6	6	2820	5397.48	2820	3958.152	-1439.328	Conifer/Shrub 1
								Total	**22,680**	**18,068**	**22,680**	**23,009**	**4,941**	**0**
														% reduction

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

Reach #	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)	Rattlesnake
1	4350	0.9	0.638	0.95	0.319	-0.32	1	1	4350	2775.3	4350	1387.65	-1387.65	Conifer 1
2	610	0.8	1.276	0.91	0.5742	-0.70	2	2	1220	1556.72	1220	700.524	-856.196	Conifer/Shrub 1
3	4510	0.8	1.276	0.83	1.0846	-0.19	3	3	13530	17264.28	13530	14674.638	-2589.642	Conifer/Shrub 2
4	1030	0.8	1.276	0.8	1.276	0.00	4	4	4120	5257.12	4120	5257.12	0	
5	890	0.7	1.914	0.8	1.276	-0.64	4	4	3560	6813.84	3560	4542.56	-2271.28	
6	430	0.5	3.19	0.8	1.276	-1.91	4	4	1720	5486.8	1720	2194.72	-3292.08	
								Total	**28,500**	**39,154**	**28,500**	**28,757**	**-10,397**	**-27**
														% Reduction

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

Reach #	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)	Bulldog
1	1200	0.9	0.638	0.95	0.319	-0.32	1	1	1200	765.6	1200	382.8	-382.8	Conifer 1
2	580	0.8	1.276	0.92	0.5104	-0.77	1	1	580	740.08	580	296.032	-444.048	Conifer/Shrub 1
3	1010	0.8	1.276	0.91	0.5742	-0.70	2	2	2020	2577.52	2020	1159.884	-1417.636	
4	1130	0.8	1.276	0.86	0.8932	-0.38	2	2	2260	2883.76	2260	2018.632	-865.128	Conifer/Shrub 2
5	3980	0.9	0.638	0.86	0.8932	0.26	3	3	11940	7617.72	11940	10664.808	3047.088	Conifer 2
6	360	0.8	1.276	0.8	1.276	0.00	4	4	1440	1837.44	1440	1837.44	0	Conifer/Shrub 2
								Total	**19,440**	**16,422**	**19,440**	**16,360**	**-63**	**0**
														% Reduction

Table 17. Existing and Potential Solar Loads for Big Bulldog Creek.

Reach #	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)	Big Bulldog
1	2110	0.9	0.638	0.92	0.5104	-0.13	1	1	2110	1346.18	2110	1076.944	-269.236	Conifer/Shrub 1
2	4190	0.9	0.638	0.83	1.0846	0.45	3	3	12570	8019.66	12570	13633.422	5613.762	Conifer/Shrub 2
3	2750	0.8	1.276	0.8	1.276	0.00	4	4	11000	14036	11000	14036	0	
4	2000	0.7	1.914	0.77	1.4674	-0.45	5	5	10000	19140	10000	14674	-4466	
5	1250	0.6	2.552	0.72	1.7864	-0.77	6	6	7500	19140	7500	13398	-5742	
								Total	**43,180**	**61,682**	**43,180**	**56,818**	**-4,863**	**-8**
														% Reduction

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

Reach #	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)	Lightning
1	490	0.9	0.638	0.92	0.5104	-0.13	1	1	490	312.62	490	250.096	-62.524	Conifer/Shrub 1
2	250	0.8	1.276	0.92	0.5104	-0.77	1	1	250	319	250	127.6	-191.4	
3	850	0.9	0.638	0.92	0.5104	-0.13	1	1	850	542.3	850	433.84	-108.46	
4	230	0.7	1.914	0.76	1.5312	-0.38	2	1	460	880.44	230	352.176	-528.264	Conifer/Meadow 1
5	1610	0.8	1.276	0.91	0.5742	-0.70	2	2	3220	4108.72	3220	1848.924	-2259.796	Conifer/Shrub 1
6	1270	0.7	1.914	0.91	0.5742	-1.34	3	2	3810	7292.34	2540	1458.468	-5833.872	
7	320	0.8	1.276	0.88	0.7656	-0.51	3	3	960	1224.96	960	734.976	-489.984	
8	2080	0.8	1.276	0.83	1.0846	-0.19	4	3	8320	10616.32	6240	6767.904	-3848.416	Conifer/Shrub 2
9	710	0.8	1.276	0.8	1.276	0.00	5	4	3550	4529.8	2840	3623.84	-905.96	
10	670	0.7	1.914	0.8	1.276	-0.64	5	4	3350	6411.9	2680	3419.68	-2992.22	
11	620	0.8	1.276	0.8	1.276	0.00	5	4	3100	3955.6	2480	3164.48	-791.12	
12	330	0.6	2.552	0.8	1.276	-1.28	5	4	1650	4210.8	1320	1684.32	-2526.48	
13	1340	0.7	1.914	0.77	1.4674	-0.45	6	5	8040	15388.56	6700	9831.58	-5556.98	
14	2050	0.6	2.552	0.77	1.4674	-1.08	6	5	12300	31389.6	10250	15040.85	-16348.75	
15	370	0.3	4.466	0.36	4.0832	-0.38	7	6	2590	11566.94	2220	9064.704	-2502.236	geologic constraints
16	1900	0.4	3.828	0.36	4.0832	0.26	7	6	13300	50912.4	11400	46548.48	-4363.92	
17	1770	0.4	3.828	0.36	4.0832	0.26	8	6	14160	54204.48	10620	43363.584	-10840.896	
18	1070	0.4	3.828	0.35	4.147	0.32	8	7	8560	32767.68	7490	31061.03	-1706.65	
19	1860	0.4	3.828	0.7	1.914	-1.91	9	7	16740	64080.72	13020	24920.28	-39160.44	
20	2150	0.4	3.828	0.66	2.1692	-1.66	10	8	21500	82302	17200	37310.24	-44991.76	
21	180	0.1	5.742	0.76	1.5312	-4.21	10	8	1800	10335.6	1440	2204.928	-8130.672	Conifer/Meadow 1
								Total	**129,000**	**397,353**	**104,440**	**243,212**	**-154,141**	**-39**
														% Reduction

Table 19. Existing and Potential Solar Loads for Anderson Creek.

Reach #	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)	Anderson
1	1230	0.6	2.552	0.76	1.5312	-1.02	1	1	1230	3138.96	1230	1883.376	-1255.584	Conifer/Meadow 1
2	2120	0.8	1.276	0.71	1.8502	0.57	2	2	4240	5410.24	4240	7844.848	2434.608	
3	5410	0.7	1.914	0.88	0.7656	-1.15	3	3	16230	31064.22	16230	12425.688	-18638.532	Conifer/Shrub 1
4	920	0.6	2.552	0.8	1.276	-1.28	4	4	3680	9391.36	3680	4695.68	-4695.68	Conifer/Shrub 2
5	340	0.4	3.828	0.8	1.276	-2.55	4	4	1360	5206.08	1360	1735.36	-3470.72	
6	1110	0.4	3.828	0.77	1.4674	-2.36	5	5	5550	21245.4	5550	8144.07	-13101.33	
7	230	0.5	3.19	0.77	1.4674	-1.72	5	5	1150	3668.5	1150	1687.51	-1980.99	
8	560	0.4	3.828	0.77	1.4674	-2.36	5	5	2800	10718.4	2800	4108.72	-6609.68	
9	1840	0.4	3.828	0.72	1.7864	-2.04	6	6	11040	42261.12	11040	19721.856	-22539.264	
10	880	0.4	3.828	0.7	1.914	-1.91	7	7	6160	23580.48	6160	11790.24	-11790.24	
11	700	0.5	3.19	0.7	1.914	-1.28	7	7	4900	15631	4900	9378.6	-6252.4	
12	150	0.4	3.828	0.7	1.914	-1.91	7	7	1050	4019.4	1050	2009.7	-2009.7	
13	2440	0.4	3.828	0.66	2.1692	-1.66	8	8	19520	74722.56	19520	42342.784	-32379.776	
14	310	0.5	3.19	0.66	2.1692	-1.02	8	8	2480	7911.2	2480	5379.616	-2531.584	
15	260	0.3	4.466	0.66	2.1692	-2.30	8	8	2080	9289.28	2080	4511.936	-4777.344	
16	2050	0.5	3.19	0.63	2.3606	-0.83	9	9	18450	58855.5	18450	43553.07	-15302.43	
17	490	0.3	4.466	0.63	2.3606	-2.11	9	9	4410	19695.06	4410	10410.246	-9284.814	
18	1290	0.3	4.466	0.6	2.552	-1.91	10	10	12900	57611.4	12900	32920.8	-24690.6	
19	420	0.5	3.19	0.6	2.552	-0.64	10	10	4200	13398	4200	10718.4	-2679.6	
20	690	0.5	3.19	0.34	4.2108	1.02	10	10	6900	22011	6900	29054.52	7043.52	Shrub
21	1550	0.2	5.104	0.34	4.2108	-0.89	10	10	15500	79112	15500	65267.4	-13844.6	
								Total	**145,830**	**517,941**	**145,830**	**329,584**	**-188,357**	**-36** **% Reduction**

Table 20. Existing and Potential Solar Loads for Stony Meadow Tributary.

Reach #	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)	Stony Meadow Tributary
1	890	0.9	0.638	0.95	0.319	-0.32	1	1	890	567.82	890	283.91	-283.91	Conifer 1
2	390	0.8	1.276	0.92	0.5104	-0.7656	1	1	390	497.64	390	199.056	-298.584	Conifer/Shrub 1
3	560	0.6	2.552	0.76	1.5312	-1.0208	1	1	560	1429.12	560	857.472	-571.648	Conifer/Meadow 1
4	160	0.8	1.276	0.92	0.5104	-0.7656	1	1	160	204.16	160	81.664	-122.496	Conifer/Shrub 1
5	1620	0.9	0.638	0.93	0.4466	-0.1914	2	2	3240	2067.12	3240	1446.984	-620.136	Conifer 1
6	640	0.8	1.276	0.93	0.4466	-0.8294	2	2	1280	1633.28	1280	571.648	-1061.632	
7	2940	0.9	0.638	0.91	0.5742	-0.0638	3	3	8820	5627.16	8820	5064.444	-562.716	
								Total	**15,340**	**12,026**	**15,340**	**8,505**	**-3,521**	**-29** **% Reduction**

Table 21. Existing and Potential Solar Loads for MF Scriver Creek.

Reach #	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)	MF Scriver
1	370	0.9	0.638	0.88	0.7656	0.13	1	1	370	236.06	370	283.272	47.212	Conifer/Shrub 2
2	1590	0.8	1.276	0.88	0.7656	-0.51	1	1	1590	2028.84	1590	1217.304	-811.536	
3	950	0.7	1.914	0.86	0.8932	-1.02	2	2	1900	3636.6	1900	1697.08	-1939.52	
4	1490	0.8	1.276	0.83	1.0846	-0.19	3	3	4470	5703.72	4470	4848.162	-855.558	
5	150	0.7	1.914	0.83	1.0846	-0.83	3	3	450	861.3	450	488.07	-373.23	
6	280	0.9	0.638	0.84	1.0208	0.38	4	4	1120	714.56	1120	1143.296	428.736	Conifer 2
7	1040	0.8	1.276	0.8	1.276	0.00	4	4	4160	5308.16	4160	5308.16	0	Conifer/Shrub 2
8	880	0.8	1.276	0.84	1.0208	-0.26	4	4	3520	4491.52	3520	3593.216	-898.304	Conifer 2
								Total	**17,580**	**22,981**	**17,580**	**18,579**	**-4,402**	**-19** **% Reduction**

Table 22. Existing and Potential Solar Loads for Scriver Creek.

Reach #	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)	Scriver
1	520	0.6	2.552	0.88	0.7656	-1.79	1	1	520	1327.04	520	398.112	-928.928	Conifer/Shrub 2
2	770	0.8	1.276	0.88	0.7656	-0.51	1	1	770	982.52	770	589.512	-393.008	
3	500	0.6	2.552	0.86	0.8932	-1.66	2	2	1000	2552	1000	893.2	-1658.8	
4	550	0.7	1.914	0.86	0.8932	-1.02	2	2	1100	2105.4	1100	982.52	-1122.88	
5	300	0.6	2.552	0.86	0.8932	-1.66	2	2	600	1531.2	600	535.92	-995.28	
6	220	0.8	1.276	0.83	1.0846	-0.19	3	3	660	842.16	660	715.836	-126.324	
7	1130	0.5	3.19	0.69	1.9778	-1.21	3	3	3390	10814.1	3390	6704.742	-4109.358	Shrub
8	1380	0.6	2.552	0.8	1.276	-1.28	4	4	5520	14087.04	5520	7043.52	-7043.52	Conifer/Shrub 2
9	770	0.5	3.19	0.77	1.4674	-1.72	5	5	3850	12281.5	3850	5649.49	-6632.01	
10	100	0.8	1.276	0.83	1.0846	-0.19	5	5	500	638	500	542.3	-95.7	Conifer 2
11	510	0.6	2.552	0.77	1.4674	-1.08	5	5	2550	6507.6	2550	3741.87	-2765.73	Conifer/Shrub 2
12	1730	0.4	3.828	0.48	3.3176	-0.51	6	6	10380	39734.64	10380	34436.688	-5297.952	Shrub
13	460	0.6	2.552	0.72	1.7864	-0.77	6	6	2760	7043.52	2760	4930.464	-2113.056	Conifer/Shrub 2
14	2580	0.8	1.276	0.7	1.914	0.64	7	7	18060	23044.56	18060	34566.84	11522.28	Conifer 2
15	3050	0.6	2.552	0.66	2.1692	-0.38	8	8	24400	62268.8	24400	52928.48	-9340.32	Conifer/Shrub 2
16	260	0.5	3.19	0.63	2.3606	-0.83	9	9	2340	7464.6	2340	5523.804	-1940.796	
17	1280	0.3	4.466	0.37	4.0194	-0.45	9	9	11520	51448.32	11520	46303.488	-5144.832	Shrub
								Total	**89,920**	**244,673**	**89,920**	**206,487**	**-38,186**	**-16** **% Reduction**

Figure 2. Target Shade for MF Payette River.

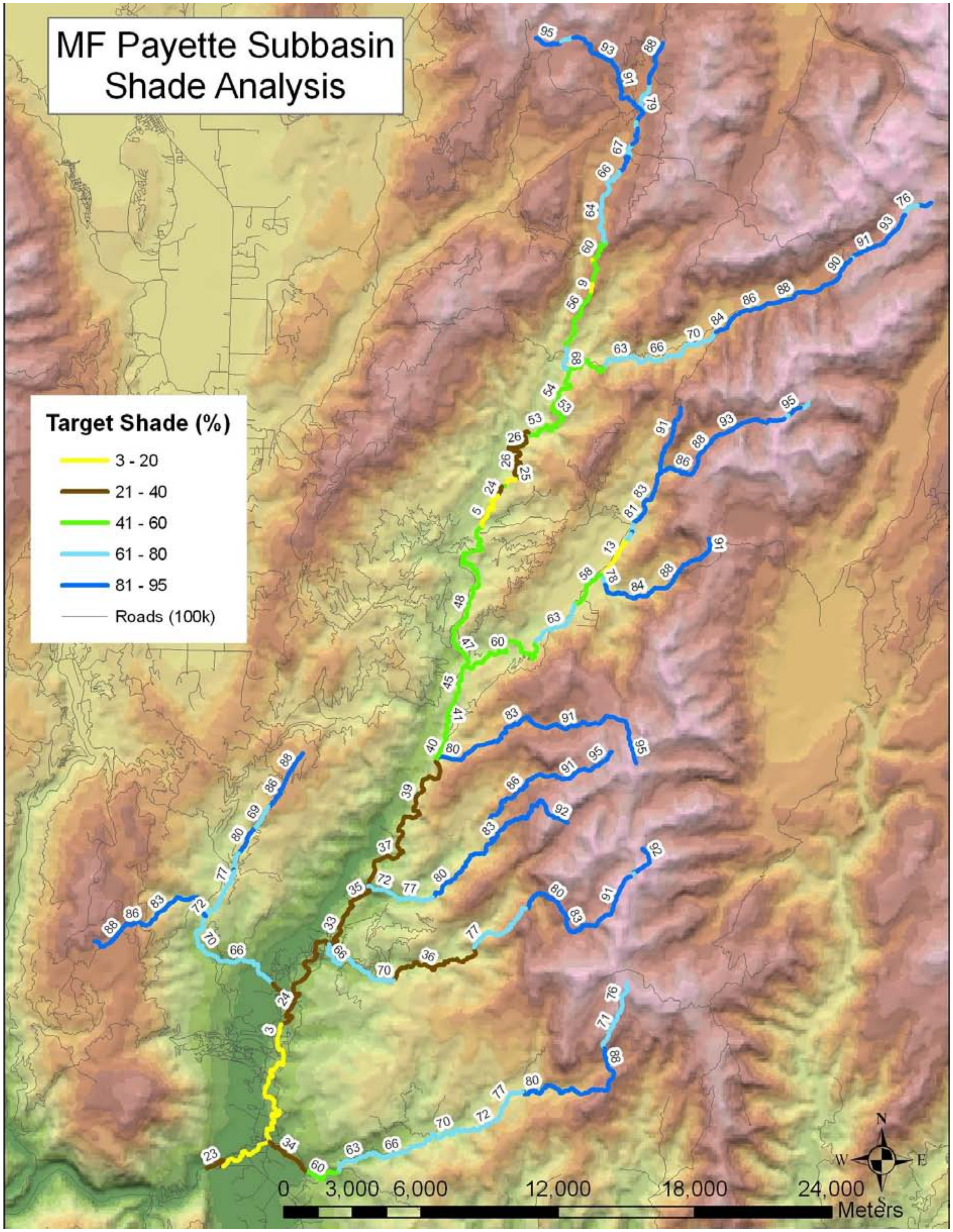


Figure 3. Existing Cover Estimated for MF Payette River by Aerial Photo Interpretation.

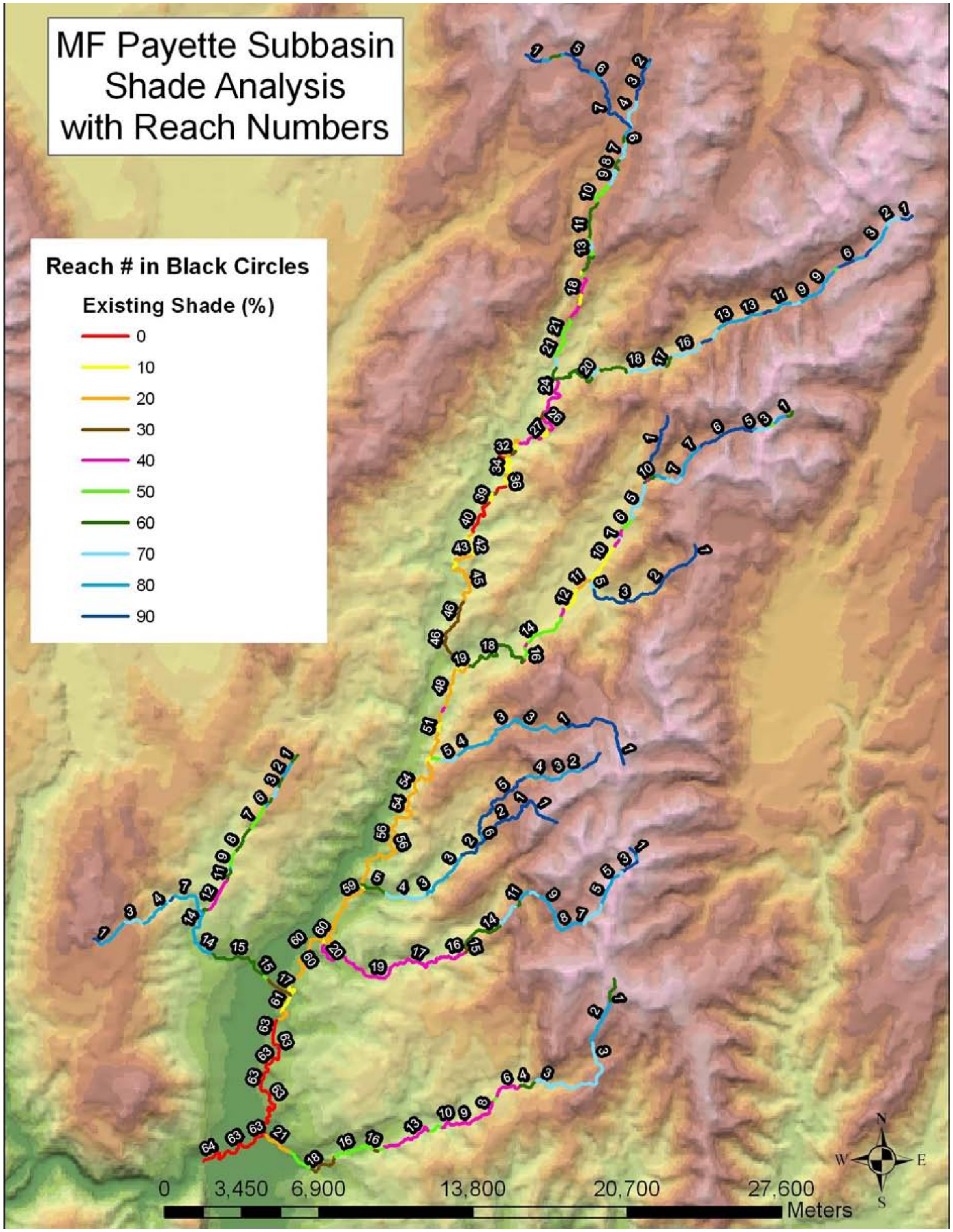
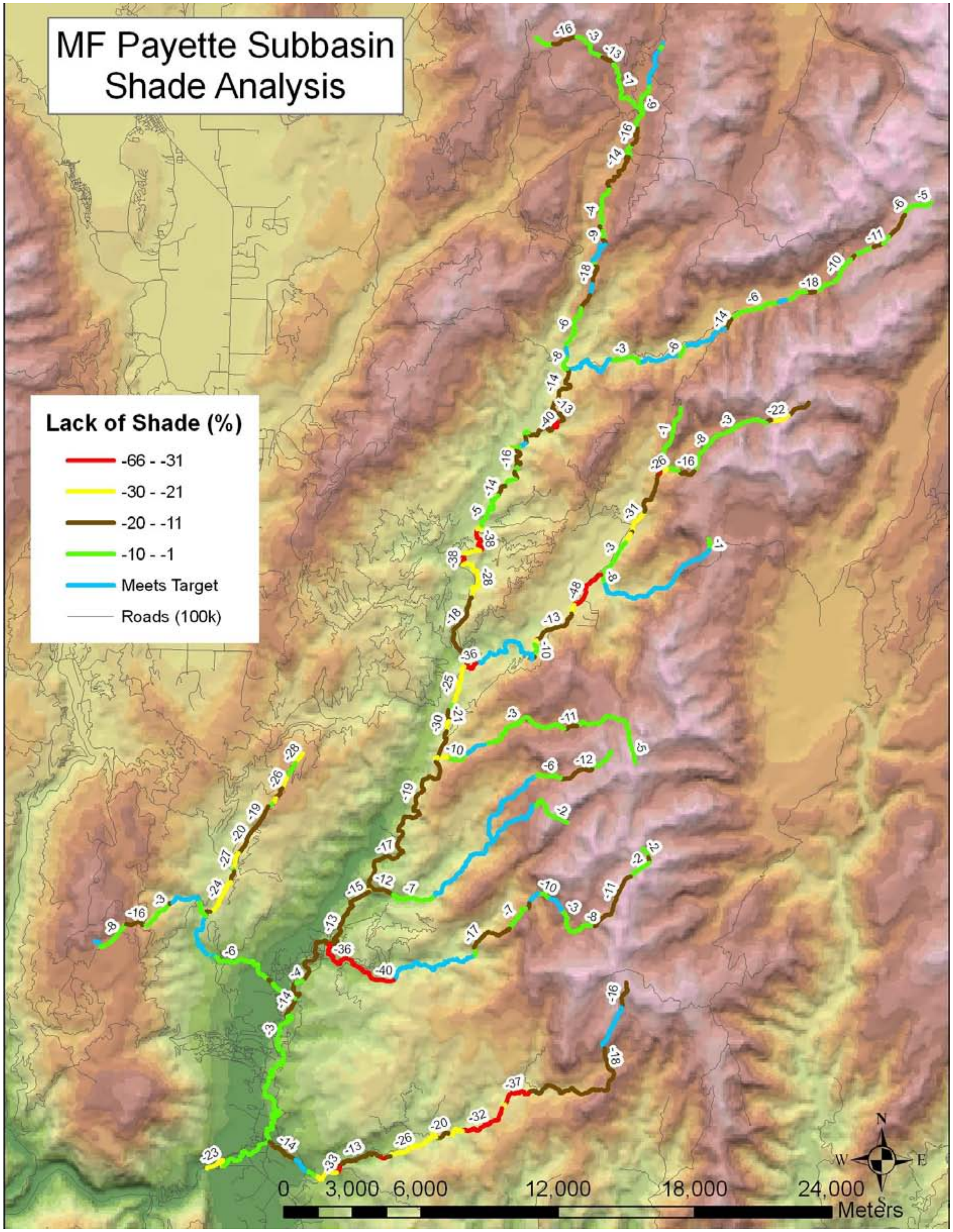


Figure 4. Lack of Shade (Difference Between Existing and Target) for MF Payette River.



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 10 through 22 show the target or potential shade, which is converted to a potential summer load by multiplying the inverse fraction (1-shade fraction) by the average loading to a flat plate collector for the months of April through September. That is the loading capacity of the stream and it is necessary to achieve background conditions. There is no opportunity to further remove shade from the stream by any activity without exceeding its loading capacity. Additionally, because this TMDL is dependent upon background conditions for achieving WQS, all tributaries to the waters examined here need to be in natural conditions in order to prevent excess heat loads to the system.

Although the following analysis dwells on total heat loads for streams in this TMDL, it is important to note that differences between existing shade and target shade, as depicted in Figure 4, are the key to successfully restoring these waters to achieving WQS. Target shade levels for individual reaches should be the goal managers strive for with future implementation plans. Managers should key in on the largest differences between existing and target shade as locations to prioritize implementation efforts.

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. Table 23 lists 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. Percent reductions vary considerably from 0 to 48%.

Table 23. Excess Solar Loads and Percent Reductions for All Tributaries.

Water Body	Excess Load (kWh/day)	Percent Reduction
MF Payette River	1,356,689	18%
Anderson Creek	188,357	36%
Lightning Creek	154,141	39%
Silver Creek	124,312)	26%
Scriver Creek	38,186	16%
Bull Creek	20,291	9%
Long Fork Silver	13,748	48%
Rattlesnake Creek	10,397	27%
Big Bulldog Creek	4,863	0 %
MF Scriver Creek	4,402	19%

Stony Meadow tributary	3,521	29%
Bulldog Creek	63	0%
Peace Creek	0	0%

Table 23 shows 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 MF Payette River had the highest excess load, near 1.3 million kWh/day, consistent with its size as the largest water body in the analysis. Although percent reductions to achieve potential load levels were relatively low (less than 20%) for the river. Lightning Creek, Anderson Creek and Silver Creek had moderately high excess loads and needed percent reductions that were higher than the river itself. These three streams are likely candidates for any implementation to improve riparian shading. Smaller streams had low excess loads and low percent reductions needed after the MD is taken into account. Bull Creek, Big Bulldog Creek, Bulldog Creek, and Peace Creek all had existing loads that were smaller than their MD loads, hence these streams are essentially at target conditions.

Wasteload Allocation

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

Margin of Safety

The margin of safety in this TMDL is considered implicit in the design. Because the target is essentially background conditions, loads (shade levels) are allocated to lands adjacent to these streams at natural background levels. Because shade levels are established at natural background or system potential levels, it is unrealistic to set shade targets at higher, or more conservative, levels. Additionally, existing shade levels are reduced to the next lower 10% class interval, which likely underestimates actual shade in the loading analysis. Although the loading analysis used in this TMDL involves gross estimations that are likely to have large variances, 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.

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

Since water quality improvement activities will hinge upon improving shading, realistically the time frame for improvement ranges from 5-25 years because of the dependence on shrub establishment.

Approach

Following this TMDL submission, in accordance with approved state schedules and protocols, a detailed implementation plan will be prepared for pollutant sources. Implementation strategies will be decided upon by designated agencies and individual landowners to best suit the particular watershed. Implementation typically includes activities like bank stabilization, riparian improvements, grazing management plans, conservation planning, fencing, off-site watering, and road improvements.

For nonpoint sources, DEQ also expects that implementation plans be implemented as soon as practicable. However, DEQ recognizes that it may take some time, from several years to **several decades**, to fully implement the appropriate management practices. DEQ also recognizes that it may take additional time after implementation has been accomplished before the management practices identified in the implementation plans become fully effective in reducing and controlling pollution.

In addition, DEQ recognizes that it is possible that after application of all reasonable best management practices, some TMDLs or their associated targets and surrogates cannot be achieved as originally established. DEQ will review monitoring data every five years after implementation commences and make determinations regarding whether the TMDL targets need to be modified. Nevertheless, it is DEQ's expectation that nonpoint sources make a good faith effort to achieving their respective load allocations in the shortest practicable time. DEQ recognizes that expedited implementation of TMDLs will be socially and economically challenging.

Further, there is a desire to *minimize* economic impacts as much as possible when protecting water quality and beneficial uses. DEQ will rely on landowners and designated agencies to select best management practices that are effective and economically feasible for the watershed. DEQ further recognizes that, despite the best and most sincere efforts, natural events beyond the control of humans may interfere with or delay attainment of the TMDL and/or its associated targets and surrogates. Such events could be, but are not limited to floods, fire, insect infestations, and drought. Should such events occur that negate all BMP activities, the appropriateness of re-implementing BMPs will be addressed on a case by case basis. In any case, post event conditions should not be exacerbated by management activities that would hinder the natural recovery of the system.

Responsible Parties

Responsible parties include local landowners, Boise and Valley Counties, the USFS, and the Idaho Department of Lands. Agencies involved in water quality improvement projects include the NRCS, Idaho Association of Soil Conservation Districts, Idaho Fish and Game, the Idaho Soil Conservation Commission, the Idaho Department of Agriculture and DEQ.

Monitoring Strategy

Monitoring for temperature can occur with aerial photo analysis or on the ground shading measurements using a solar pathfinder. The actual monitoring schedule and monitoring plan will be outlined in more detail in the implementation plan once BMPs are selected and a timeline for implementation is developed.

Public Participation

A watershed advisory group for this TMDL was formed in June 2007. The group first met on August 31, 2007 and subsequently on September 17, 2007. The public comment period extended from October 1, 2007 through November 5, 2007.

5.6 Conclusions

In the MF Payette River subbasin, only the MF Payette River is 303d listed for temperature. We examined the MF Payette River along with 12 of its tributaries and produced temperature TMDLs based on meeting riparian shade targets as a surrogate for temperature. Targets were derived from shade curves produced for other TMDLs in Idaho and Oregon. Existing shade levels for the MF Payette River and the 12 tributaries were estimated from aerial photos and were field verified with solar pathfinders during the summer of 2007.

A majority of the streams examined show at least some impacts from a lack of riparian shade. After taking into account the method difference, several of the larger streams examined have percent reductions between 20% and 40%, while most of the smaller streams have percent reductions needed below 20%. The MF Payette River has an excess solar load around 1.3 million kWh/day and has near 18% reductions needed. Lightning Creek and Anderson Creek have excess solar loads of near 150,000 kWh/day and greater than 30% percent reductions needed. Silver Creek also has a high excess load and shade loss in some areas. Peace Creek and Bulldog Creek have 0% reductions needed. Peace Creek, which is an inventoried roadless area, has no excess solar load, while Bulldog Creek has a negligible excess solar load.

In addition to the MF Payette River, Lightning Creek, Anderson Creek, Silver Creek, and Long Fork Silver Creek should be prioritized for any implementation due to their relatively larger excess solar loads and higher percent reductions needed. Target shade levels for individual reaches should be the goal managers strive for with future implementation plans. Managers should key in on the largest differences between existing and target shade as locations to prioritize implementation efforts while pursuing the overall goal of meeting target shade throughout the reach. Those areas that meet or exceed shade conditions should be protected from degradation.

DEQ focused on the larger tributaries because volume plays a large role in the influence of tributary water temperature on mainstem temperatures. However, additional information on tributaries not covered in this TMDL would be valuable for inclusion in the implementation plan or five year TMDL review to help landowners and land managers prioritize additional water quality improvement projects in the watershed. DEQ will do an analysis of shade on other tributaries as time and funding permits. Implementation plan development can incorporate any further analysis on additional tributaries and refine existing data using solar pathfinder ground truthed measurements.

Table 24. Summary of assessment outcomes.

Water Body Segment/ AU	Pollutant	TMDL(s) Completed	Recommended Changes to §303(d) List	Justification
MF Payette River/ ID17050121SW005_02 ID17050121SW005_03 ID17050121SW005_04 ID17050121SW001_04	Temperature	Yes	n.a.	Excess Solar Load
Stony Meadow Tributary/ ID17050121SW005_02	Temperature	Yes	n.a.	Excess Solar Load
Bull Creek/ ID17050121SW009_02 ID17050121SW009_03	Temperature	Yes	n.a.	Excess Solar Load
Long Fork Silver Creek/ ID17050121SW007_02	Temperature	Yes	n.a.	Excess Solar Load
Silver Creek/ ID17050121SW007_02 ID17050121SW007_03	Temperature	Yes	n.a.	Excess Solar Load
Peace Creek/ ID17050121SW008_02 ID17050121SW005_03	Temperature	Yes	n.a.	Excess Solar Load
Rattlesnake Creek/ ID17050121SW006_02	Temperature	Yes	n.a.	Excess Solar Load
Bulldog Creek/ ID17050121SW004_02	Temperature	Yes	n.a.	Excess Solar Load
Big Bulldog Creek/ ID17050121SW004_02	Temperature	Yes	n.a.	Excess Solar Load
Lightning Creek/ ID17050121SW003_02 ID17050121SW003_03	Temperature	Yes	n.a.	Excess Solar Load
Anderson Creek/ ID17050121SW002_02 ID17050121SW002_03	Temperature	Yes	n.a.	Excess Solar Load
Scriver Creek/ ID17050121SW010_02 ID17050121SW010_03	Temperature	Yes	n.a.	Excess Solar Load
MF Scriver Creek/ ID17050121SW010_02	Temperature	Yes	n.a.	Excess Solar Load

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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.

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.

Ambient

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

Anthropogenic

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

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.

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.

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

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

Best Management Practices (BMPs)
Structural, nonstructural, and managerial techniques that are effective and practical means to control nonpoint source pollutants.

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

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).
Clean Water Act (CWA)	The Federal Water Pollution Control Act (commonly known as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987, establishes a process for states to use to develop information on, and control the quality of, the nation's water resources.
Criteria	In the context of water quality, numeric or descriptive factors taken into account in setting standards for various pollutants. These factors are used to determine limits on allowable concentration levels, and to limit the number of violations per year. The U.S. Environmental Protection Agency develops criteria guidance; states establish criteria.
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.
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).
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.

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.

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.

Exceedance

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

Existing Beneficial Use or Existing Use

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

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.

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 exiting beneficial uses as determined through the *Water Body Assessment Guidance* (Grafe et al. 2002).

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

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 geo-referenced database.

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.

Habitat
The living place of an organism or community.

Headwater
The origin or beginning of a stream.

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.

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

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

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

Margin of Safety (MOS)

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

Method Difference

The method difference (MD) load is the amount of excess load created by the margin of safety in the loading analysis.

Monitoring

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

Mouth

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

Natural Condition

The condition that exists with little or no anthropogenic influence.

Nonpoint Source

A dispersed source of pollutants, generated from a geographical area when pollutants are dissolved or suspended in runoff and then delivered into waters of the state. Nonpoint sources are without a discernable point or origin. They include, but are not limited to, irrigated and non-irrigated lands used for grazing, crop production, and silviculture; rural roads; construction and mining sites; log storage or rafting; and recreation sites.

Not Assessed (NA)

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

Not 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.

Perennial Stream

A stream that flows year-around in most years.

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.

Protocol

A series of formal steps for conducting a test or survey.

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.

Resident

A term that describes fish that do not migrate.

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.

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.

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. Under Strahler's (1957) system, higher order streams result from the joining of two streams of the same order.

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 4^{th} 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 6^{th} field hydrologic units.

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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.

Total Maximum Daily Load (TMDL)

A TMDL is a water body's load capacity after it has been allocated among pollutant sources. It can be expressed on a time basis other than daily if appropriate. Sediment loads, for example, are often calculated on an annual bases. A TMDL is equal to the load capacity, such that load capacity = margin of safety + natural background + load allocation + wasteload allocation = TMDL. In common usage, a TMDL also refers to the written document that contains the statement of loads and supporting analyses, often incorporating TMDLs for several water bodies and/or pollutants within a given watershed.

Tributary

A stream feeding into a larger stream or lake.

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.

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.

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 = 35.31cfs	3 ft^3/sec = 0.09 m^3/sec 3 m^3/sec = 105.94 ft^3/sec
Concentration	Parts per Million (ppm)	Milligrams per Liter (mg/L)	1 ppm = 1 mg/L[b]	3 ppm = 3 mg/L
Weight	Pounds (lbs)	Kilograms (kg)	1 lb = 0.45 kg 1 kg = 2.20 lbs	3 lb = 1.36 kg 3 kg = 6.61 lb
Temperature	Fahrenheit (°F)	Celsius (°C)	°C = 0.55 (F - 32) °F = (C x 1.8) + 32	3 °F = -15.95 °C 3 °C = 37.4 °F

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

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

Appendix B. State and Site-Specific Standards and Criteria

Water Quality Standards Applicable to Salmonid Spawning Temperature

Water quality standards for temperature are specific numeric values not to be exceeded during the salmonid spawning and egg incubation period, which varies with species. For spring spawning salmonids, the default spawning and incubation period recognized by DEQ is generally from March 15th to July 1st each year (Grafe et al., 2002). Fall spawning can occur as early as August 15th and continue with incubation on into the following spring up to June 1st. As per IDAPA 58.01.02.250.02.e.ii., the water quality criteria that need to be met during that time period are:

13^{o}C as a daily maximum water temperature,

9^{o}C as a daily average water temperature.

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

Natural Background Provisions

For potential natural vegetation temperature TMDLs, it is assumed that natural temperatures may exceed these criteria during these time periods. If potential natural vegetation targets are achieved yet stream temperatures are warmer than these criteria, it is assumed that the stream's temperature is natural (provided there are no point sources or human induced ground water sources of heat) and natural background provisions of Idaho water quality standards apply. As per IDAPA 58.01.02.200.09:

> *When natural background conditions exceed any applicable water quality criteria set forth in Sections 210, 250, 251, 252, or 253, the applicable water quality criteria shall not apply; instead, pollutant levels shall not exceed the natural background conditions, except that temperature levels may be increased above natural background conditions when allowed under Section 401.*

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

Appendix C. Data Sources

Table C-1. Data sources for the MF Payette River TMDLs.

Water Body	Data Source	Type of Data	When Collected
MF Payette River, Silver Creek, Lightning Creek, Scriver Creek, Rattlesnake Creek	DEQ Regional Office	Pathfinder effective shade and stream width	Summer 2007
MF Payette River and 12 tributaries	DEQ State Technical Services Office	Aerial Photo Interpretation of existing shade and stream width estimation	January 2007
MF Payette River	DEQ IDASA Database, McCall Satellite Office	Temperature	2005, 2006

Appendix D. Distribution List

Middle Fork Payette River Watershed Advisory Group

Garden Valley Public Library

Squaw Creek Soil Conservation District

Idaho Department of Lands

Boise National Forest

Appendix E. Public Comments

Table E-1 Public Comments

Comments	DEQ Response
US EPA **Water quality standards**. This addendum should either include more site-specific information on the temperature water quality standards that apply to Middle Fork Payette River and its major tributaries specifically. Appendix B only includes salmonid spawning temperature criterion and natural condition provisions but fails to provide bull trout temperature criterion or information specific to this watershed. Table A is unclear that the bull trout temperature criterion pertains to the MF Payette River above Fool Creek (at approximately 1400 meters). Although the executive summary shows the state water quality criteria, it does not show any information specific to this River. Clarify exactly where cold water aquatic life and salmonid spawning criteria (including bull trout) apply in this watershed. Table B lists all the beneficial uses designated for the Middle Fork Payette River but there is no discussion or explanation on why on cold water aquatic life and salmonid spawning are the only uses discussed.	The water quality criteria are specifically for temperature as it relates to cold water aquatic life and salmonid spawning. These were the uses that were determined to be impaired. This will be clarified in the text.
Temperature data. The document should include a description and analysis of existing temperature data (or the lack of temperature data). In your response on EPA's comments on the preliminary draft TMDL, you said you included more information on ***when*** temperature violations occur. ***Where*** violations of water quality standards occur also should be described. The patterns of the temperature data and how this information can be used in the implementation of the TMDL should be explained. If some of the tributaries have temperature data showing that they do not meet the standards, this should be described as well. You can either	The document will include information on where temperature data applies. The patterns of temperature data are discussed but since it's seasonal and the most logical implementation measures will be riparian management, I'm unsure of how to describe the utility of this for implementation.

Comments	DEQ Response
explain in more detail where temperature violations occur on page xii and in a separate section describing existing temperature data. If the waters are not meeting standards and are covered by this TMDL, they would not need to be put on the 303(d) list, but would be included in Category 4a of the integrated report for waters with a TMDL.	
Map. The scale of the map on page 25, figure 4 is too coarse for landowners to easily determine targets that would apply on their land. Consider including a series of maps at a finer scale to facilitate implementation of the targets in your implementation plan. In your response, you noted "Still has one map but added numbers so that readers could match up reaches to the solar heat tables." I could not see any difference between the August 3 and September 25 versions of this map.	The map with reach numbers is actually Figure 3. Additional maps that are easier to read will be included in the implementation plan.
Potential Natural Vegetation (PNV) Shade Targets for Tributaries. EPA applauds your inclusion of the 12 tributaries to MF Payette River in your temperature analysis and of the importance of collecting additional information and conducting further analysis on the smaller tributaries in the "Conclusion" section of the TMDL. There could be cumulative impacts from the numerous smaller tributaries which occur basin-wide. Due to the cumulative effects of temperature increases and the potential impacts of these smaller tributaries on the temperature of MF Payette River, PNV shade targets should be set for the tributaries or the tributaries to ensure natural stream temperatures will be achieved in the MF Payette River. Please consider the idea of a gross allocation to smaller tributaries in this TMDL to send the message that riparian vegetation should be in a natural state along all the streams. Specific shade targets for specific reaches on smaller streams could be identified at a later	The following statement is in the load allocation section and is meant to address the gross allocation issue: "Additionally, because this TMDL is dependent upon background conditions for achieving WQS, all tributaries to the waters examined here need to be in natural conditions in order to prevent excess heat loads to the system."

Comments	DEQ Response
implementation phase. **Shade curves.** During the five year review, consider using USFS's Potential Vegetation Groups (if there are available) for this subbasin to further refine the shade targets, as this information may provide more appropriate potential vegetation groupings than the shade curves from other basins or states because they were specifically developed for this ecosystem.	We will certainly consider using USFS Potential Vegetation Groups if they are available
On page 13, Table 9 "Shade Targets for Meadow Vegetation Type at Various Stream Widths," the shade curves result in exceedingly low shade targets. Are these meadows are natural in origin? Are these meadows a result of historically clearing trees and shrubs? If so, the target should be based on other shade curves. Your response "The Graminoid/Willow curve" is one of the few grass/willow curves available" implies that there are other curves available and you chose this one. This shade curve is designed for above 7,200 feet and this area clearly is not at that high of an elevation. Please describe why you believe this curve (as well as the other curves) is appropriate for this area by providing vegetation community specifics (i.e., height, canopy cover).	Based on the information that we had, DEQ determined that these are truly meadows. The response regarding the graminoid/willow curves was meant to imply that we chose the most suitable grass/willow curve out there, not that we ignored potentially better curves. The document states the height and canopy cover dimensions for that curve, which are appropriate for the MF Payette watershed.
The assessment methodology and target selection processes are problematic. Areas identified as having existing shade above target levels should be considered as critical areas for protection to ensure natural temperature conditions, not just as a credit against areas with deficient shade. Your method averages out the problem by providing targets over the entire stream (uses these healthy shade areas to average out impacted areas along other reaches of the stream). For example, on pages 16-21, Tables 10-22, the tables average heat load reductions needed by giving credit for areas	The tables and maps adequately identify those areas that are in need of restoration. Practically speaking, land managers will look at the maps to discern which areas to investigate for TMDL implementation not Table 23. The methodology accurately reflects current conditions and the pollutant reductions needed to attain water quality standards.

Comments	DEQ Response
of "excess shade" with the result of diluting out areas of needed restoration. For example, Table 17: If reaches in excess are treated as neutral in the analysis rather than crediting "excess shade," heat load reduction changes from 8% to 17% for the reach or for Table 22 the heat load reduction for the reach changes from 16% to 20%. On the positive side, the range of reductions needed is shown in Table 23, and allocations by reach are identified clearly as the targets.	
Areas where existing shade is greater than target shade. Areas identified as having existing shade above target levels should be considered as critical areas for protection to ensure natural temperature conditions. Providing a map showing reach specific values of lack of shade (as you do now) is good. It is reasonable to suggest that land managers might want to initially target restoration on areas with the greatest departure from natural shade. However, it should be made clear, that to meet water quality standards, all areas which show any deviation from natural would need improvement.	These sentences are now in the TMDL: "Managers should key in on the largest differences between existing and target shade as locations to prioritize implementation efforts while pursuing the overall goal of meeting target shade throughout the reach. Those areas that meet or exceed shade conditions should be protected from degradation."
Liked the discussion on how to prioritize overall implementation efforts by which streams had the largest difference between existing and target shade. However, there can be large differences in MD within the same stream as shown on your tables. In several places, especially in the conclusion on pages 30-31, you imply that certain streams do not need any future riparian improvements. Please correct and include reference to reach specific allocations in the tables to the conclusion section.	DEQ has decided to stop displaying the method difference as it is too confusing. The TMDL has been revised accordingly.
Margin of Safety (MOS). Consider elaborating in the "margin of safety" discussion on page 26 on where you used conservative assumptions when assessing	DEQ considers the discussion of margin of safety sufficient.

Comments	DEQ Response
existing shade levels, selecting natural channel widths, vegetation height and density etc. **Fires** (page 27): The section on "fires" appears without any context and with a heading of bold italic so that it seems like it is part of seasonable variation. Consider including a section on sources of the temperature impairment with this paragraph on "fire" as a description of one of the sources. **Editorial Revisions and Clarifications** ix: Explain how the 12 tributaries were selected to be examined as sources of solar heating. Are they the major tributaries? Have all major tributaries by included? Xii: 4th line from the bottom of the 1st paragraph: Incorrect symbol used for degrees after the number 19. 42: The text under "Method Difference" needs to be indented to match the other definitions	This section was moved to the Subbasin at a Glance section This has been clarified that it was based on volume. These are the major tributaries. The symbol has been corrected Correction made
US Forest Service **Melissa Yenko, Hydrologist, Emmett Ranger District** It appears that most of the tributaries you analyzed and developed for a temperature TMDL are on the east side of the MFPR and many have a portion of the subwatershed in the Peace Rock Roadless area. It may be worth looking at some of the major drainages besides Scriver Creek on the West side of the MFPR (Sixmile, Wet Foot or West Fork Creek) as those subwatersheds have very high road densities, particularly within riparian areas. From a management perspective on USFS land, we do very little vegetation management within Riparian	**Comments** These are good observations. Much of this can be worked out in implementation (i.e. further monitoring of west side tributaries to determine additional areas for implementation). DEQ or the USFS can analyze these areas for shade as part of developing the implementation plan.

Comments	DEQ Response
areas and it seems that the effects to stream shading from our management (current and historic) would be mostly from roads within the riparian areas.	
A couple of the MF Payette River tributaries that the TMDL lists are requiring an increase in stream shading concern me a little bit. Bull Creek requires a 0-9% increase—that watershed is entirely within the Peace Creek Roadless Area and we do not actively manage it except for recreation interests. 2. Long Fork of Silver Creek requires a 23-48% increase in stream shading—again almost the entire drainage is within Peace Rock IRA and it may have been managed in the past but it's currently managed for recreation interests. Isn't it possible that the shading in these subwatersheds is actually the natural vegetative condition and there isn't a need to do active restoration. 3. Anderson Creek and Lightning Creek—both of these drainages burned in the 1986 Anderson Creek Fire—this may be a major contributing factor in existing conditions being different from the modeled expected conditions. These drainages burned again in 2006 and/or 2007.	DEQ chose to use established shade curves, which we did not have specifically for the Boise National Forest. We did, however, use potential vegetation group information from the Boise National Forest. DEQ refined the shade curve estimates using groundtruthed solar pathfinder measurements in the watershed. Given this information, it may be prudent to ground truth the Long Fork Reach of Silver Creek during implementation to doublecheck our results or it may be that while it is on an upward trend in terms of riparian shade, that it hasn't reached potential natural vegetation. The results for Bull Creek indicate that it is very close to target shade. Anderson and Lightning Creek may still be recovering from fires and management actions can take that into account. It may also be the case where the prescriptive management measure that will work is simply passive restoration (protecting the area and letting the riparian area grow undisturbed) if in fact the riparian area is already showing an improving trend. During the implementation process, the USFS can certainly make decisions about implementation based on their data and best professional judgment.