Upper Snake River/Rock Creek Subbasin Temperature Total Maximum Daily Loads

Addendum to the Upper Snake Rock Watershed Management Plan

Draft

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Acknowledgments

Cover photo (McMullen Creek, July 18, 2005) courtesy of Jennifer Claire.

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Abbreviations, Acronyms, and Symbols

§303(d)	Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section
AU	assessment unit
BMP	best management practice
BURP	Beneficial Use Reconnaissance Program
C	Celsius
CFR	Code of Federal Regulations
CGP	Construction General Permit
DEQ	Department of Environmental Quality
DMA	designated management agency
EPA	United States Environmental Protection Agency
GIS	geographic information systems
IDAPA	Refers to citations of Idaho administrative rules
kWh	kilowatt-hour
LA	load allocation
LC	load capacity
m	meter
mi	mile
MOS	margin of safety
NB	natural background
NPDES	National Pollutant Discharge Elimination System
NREL	National Renewable Energy Laboratory
PNV	potential natural vegetation
PVG	potential vegetation group
SWPPP	Stormwater Pollution Prevention Plan
TMDL	total maximum daily load
US	United States
USC.	United States Code
WAG	watershed advisory group
WLA	wasteload allocation

Executive Summary

The federal Clean Water Act requires that states and tribes restore and maintain the chemical, physical, and biological integrity of the nation's waters. States and tribes, pursuant to Section 303 of the Clean Water Act, are to adopt water quality standards necessary to protect fish, shellfish, and wildlife while providing for recreation in and on the nation's waters whenever possible. Section 303(d) of the Clean Water Act establishes requirements for states and tribes to identify and prioritize water bodies that are water quality limited (i.e., water bodies that do not meet water quality standards). States and tribes must periodically publish a priority list (a "§303(d) list") of impaired waters. Currently this list must be published every 2 years and is included as the list of Category 5 waters in the Integrated Report. For waters identified on this list, states and tribes must develop a total maximum daily load (TMDL) for the pollutants, set at a level to achieve water quality standards.

This document addresses 8 water bodies (11 assessment units [AUs]) in the Upper Snake River/Rock Creek subbasin that have been placed in Category 5 of Idaho's most recent federally approved Integrated Report (DEQ 2011). This document only addresses the temperature TMDLs for these AUs. For more information about these watersheds and the subbasin as a whole, see the *Upper Snake Rock Watershed Management Plan* (DEQ 1999).

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

Subbasin at a Glance

The Upper Snake River/Rock Creek subbasin (hydrologic unit code 17040212) is located in the Twin Falls/Magic Valley region of south-central Idaho (Figure A). The subbasin includes that portion of the Snake River from Milner Dam to King Hill and several important tributaries, including Rock Creek, Dry Creek, Cedar Draw Creek, and Clover Creek. Listed in Category 5 of the current Integrated Report for temperature pollution were 12 AUs that included portions of Clover Creek, Calf Creek, Mud Creek, Cedar Draw Creek, Cottonwood Creek, McMullen Creek, Dry Creek, and the Snake River; 11 of these AU are addressed in this document (Table A). The section of the Snake River from Milner Dam to Twin Falls (AU# ID17040212SK020_07) will be addressed separately in the future. Pioneer Reservoir, one of the listed AUs, is addressed by examining the heat load to the Clover Creek watershed above it.

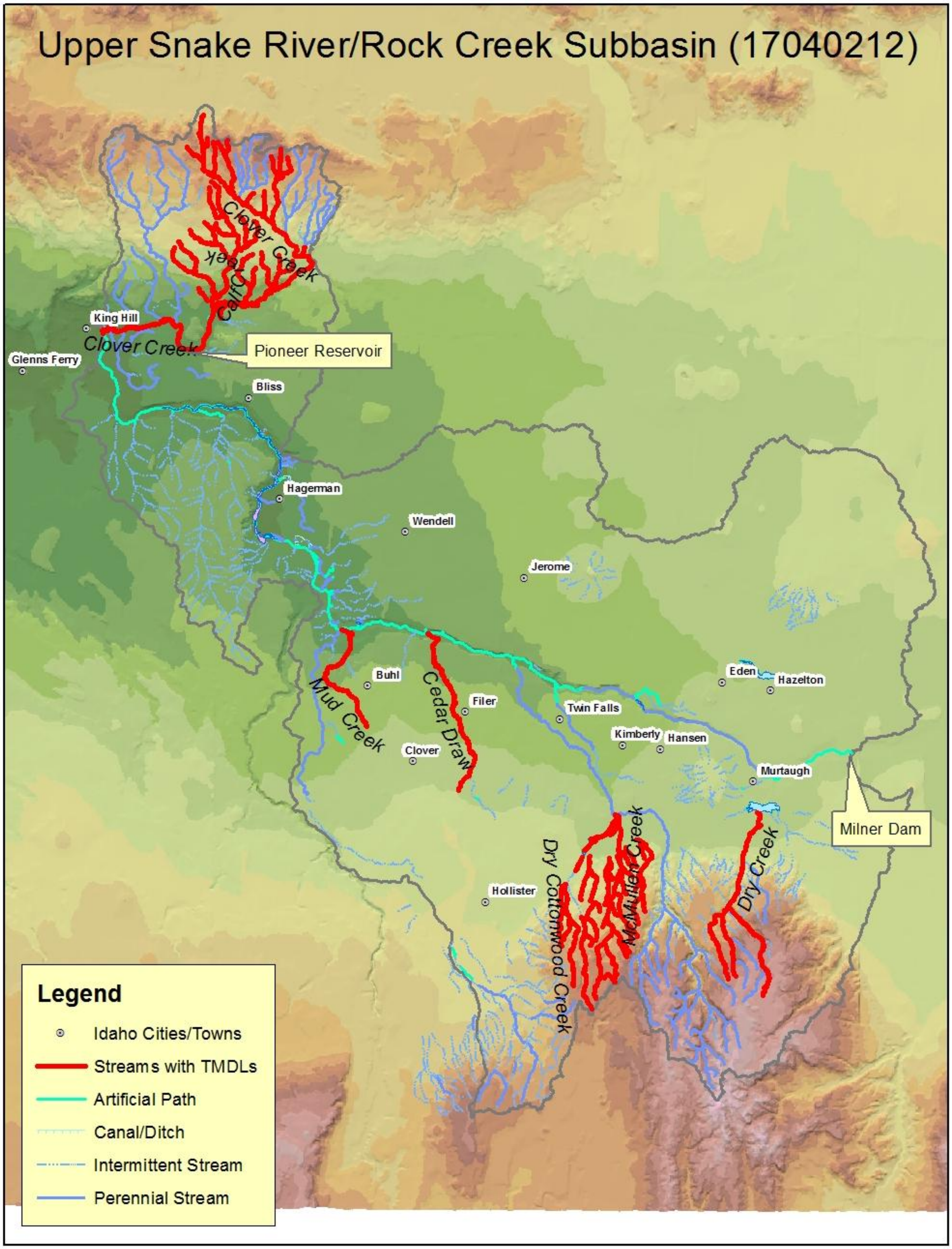

Figure A. Subbasin at a glance.

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

Stream	Pollutant(s)
Mud Creek (ID17040212SK010_03)	Temperature
Cedar Draw Creek (ID17040212SK012_03)	Temperature
Cottonwood Creek (ID17040212SK014_02)	Temperature
McMullen Creek (ID17040212SK015_02 and _03)	Temperature
Dry Creek (ID17040212SK022_03)	Temperature
Clover Creek (ID17040212SK034_04)	Temperature
Clover Creek (ID17040212SK036_02)	Temperature
Pioneer Reservoir (ID17040212SK035_04)	Temperature
Calf Creek (ID17040212SK040_02 and _03)	Temperature

Key Findings

Portions of seven creeks and one reservoir (11 AUs) were placed on the 1998 §303(d) list of impaired waters, or subsequent lists, for reasons associated with temperature criteria violations, and the Idaho Department of Environmental Quality (DEQ) has developed temperature TMDLs for these waters (Table A). Additionally, other portions (10 other AUs) of these same named streams were included in the TMDL analysis to address entire stream lengths rather than just pieces of streams.

Effective target shade levels were established for the 21 AUs based on the concept of maximum shading under potential natural vegetation resulting in natural background temperature levels. Shade targets were derived from effective shade curves developed for similar vegetation types in Idaho. Existing shade was determined from aerial photo interpretation that was partially field verified with Solar Pathfinder data. Target and existing shade levels were compared to determine the amount of shade needed to bring water bodies into compliance with Idaho's water quality standards (IDAPA 58.01.02). A summary of assessment outcomes for listed AUs, including recommended changes to listing status in the next Integrated Report, is presented in Table B.

Most streams lacked shade and had excess heat loads, although tributaries to major stream systems were in overall better condition than main stems. Streams in lowland areas experience the most excess heat due to their highly modified systems and impacts. Excess heat loads to Pioneer Reservoir result from the lack of shade and heat loading of Clover and Calf Creeks above it.

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

Table B. Summary of assessment outcomes.

Water Body Segment/ Assessment Unit	Pollutant	TMDL(s) Completed	Recommended Changes to 2012 Integrated Report	Justification
Mud Creek ID17040212SK010_03	Temperature	Yes	Move to Category 4a	Excess solar load from a lack of existing shade
Cedar Draw Creek ID17040212SK012_03	Temperature	Yes	Move to Category 4a	Excess solar load from a lack of existing shade
Cottonwood Creek ID17040212SK014_02	Temperature	Yes	Move to Category 4a	Excess solar load from a lack of existing shade
McMullen Creek ID17040212SK015_02 ID17040212SK015_03	Temperature	Yes	Move to Category 4a	Excess solar load from a lack of existing shade
Dry Creek ID17040212SK022_03	Temperature	Yes	Move to Category 4a	Excess solar load from a lack of existing shade
Clover Creek ID17040212SK034_04 ID17040212SK036_02	Temperature	Yes	Move to Category 4a	Excess solar load from a lack of existing shade
Pioneer Reservoir ID17040212SK035_04	Temperature	Yes	Move to Category 4a	Excess solar load from a lack of existing shade
Calf Creek ID17040212SK040_02 ID17040212SK040_03	Temperature	Yes	Move to Category 4a	Excess solar load from a lack of existing shade

Public Participation

The Mid-Snake Watershed Advisory Group provided DEQ with local knowledge of the watersheds, reviewed beneficial use designations and applicable surface water standards, and also provided comments on the draft documents. Public meetings were held the third Wednesday of the month on a quarterly basis (February, May, August, and November) or as needed. The meetings are open to the public and are posted to the DEQ webpage and in the DEQ Twin Falls Regional Office. Nine meetings have been held to date and meetings will continue into the future to discuss TMDL implementation.

The general public will be able to comment on this draft document during the public comment period.

Introduction

This total maximum daily load (TMDL) is an addendum to the *Upper Snake Rock Watershed Management Plan* (DEQ 1999). That document does not follow the TMDL template adopted for use for all Idaho TMDL documents since 2001 that combine a subbasin assessment with a TMDL determination. That template has five sections: the first four comprise the subbasin assessment and the fifth establishes TMDLs. This document contains only an addendum to the TMDL determination, so the section 5 numbering has been retained to mimic how TMDLs are currently developed and organized. This addendum, however, is based on the original subbasin assessment and characteristics from the *Upper Snake Rock Watershed Management Plan*.

The Upper Snake River/Rock Creek subbasin (hydrologic unit code 17040212) is located in the Twin Falls/Magic Valley region of Idaho. The subbasin includes that portion of the Snake River from Milner Dam to King Hill and several important tributaries, including Rock Creek, Dry Creek, Cedar Draw Creek, and Clover Creek. This document addresses water bodies in 11 assessment units (AUs) of the Upper Snake River/Rock Creek subbasin that have been placed in Category 5 on Idaho's most recent federally approved Integrated Report (DEQ 2011). Pioneer Reservoir, one of the listed AUs, is addressed by examining the heat load to the Clover Creek watershed above it. Effective shade targets were established for the 11 AUs based on the concept of maximum shading under potential natural vegetation (PNV) resulting in natural background temperatures. To maintain continuity and avoid breaking streams up into pieces, 10 additional AUs were included in the TMDL analysis.

5. Total Maximum Daily Loads

A TMDL prescribes an upper limit (i.e., load capacity) on discharge of a pollutant from all sources so as to ensure water quality standards are met. It further allocates this load capacity among the various sources of the pollutant. Pollutant sources fall into two broad classes: point sources, each of which receives a wasteload allocation, and nonpoint sources, each of which receives a load allocation. Natural background contributions, when present, are considered part of the load allocation but are often treated separately because they represent a part of the load not subject to control. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, the rules regarding TMDLs (Water Quality Planning and Management, 40 CFR Part 130) require a margin of safety be a part of the TMDL. Practically, the margin of safety and natural background are both reductions in the load capacity available for allocation to pollutant sources.

Load capacity can be summarized by the following equation:

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

Where:

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

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

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

Another step in a load analysis is quantifying current pollutant loads by source. This step allows the specification of load reductions as percentages from current conditions, considers equities in load reduction responsibility, and is necessary for pollutant trading to occur. A load is fundamentally a quantity of pollutant discharged over some period of time and is the product of concentration and flow. Due to the diverse nature of various pollutants, and the difficulty of strictly dealing with loads, the federal rules allow for "other appropriate measures" to be used when necessary. These "other measures" must still be quantifiable and relate to water quality standards, but they allow flexibility to deal with pollutant 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, as is the case in this temperature TMDL. For certain pollutants whose effects are long term, such as temperature, the US Environmental Protection Agency (EPA) allows for seasonal or annual loads. However, in most cases TMDL loads must also be quantified in daily terms pursuant to federal court decisions.

5.1 Instream Water Quality Targets

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

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

5.1.1 Factors Controlling Water Temperature in Streams

There are several important contributors of heat to a stream, including ground water temperature, air temperature, and direct solar radiation (Poole and Berman 2001). Of these, direct solar radiation is the source of heat that is most controllable. The parameters that affect the amount of solar radiation hitting a stream throughout its length are shade and stream morphology. Shade is provided by the surrounding vegetation and other physical features such as hillsides, canyon walls, terraces, and high banks. Stream morphology (i.e., structure) affects riparian vegetation density and water storage in the alluvial aquifer. Riparian vegetation and channel morphology are the factors influencing shade that are most likely to have been influenced by anthropogenic activities and can be most readily corrected and addressed by a TMDL.

Riparian vegetation provides a substantial amount of shade on a stream by virtue of its proximity. However, depending on how much vertical elevation surrounds the stream, vegetation further away from the riparian corridor can also provide shade. We can measure the amount of shade that a stream receives in a number of ways. Effective shade (i.e., that shade provided by all objects that intercept the sun as it makes its way across the sky) can be measured in a given location with a Solar Pathfinder or with other optical equipment similar to a fish-eye lens on a camera. Effective shade can also be modeled using detailed information about riparian plants and their communities, topography, and stream aspect.

In addition to shade, canopy cover is a similar parameter that affects solar radiation. Canopy cover is the vegetation that hangs directly over the stream and can be measured using a densiometer or estimated visually either on-site or using aerial photography. All of these methods provide information about how much of the stream is covered and how much is exposed to direct solar radiation.

5.1.2 Potential Natural Vegetation for Temperature TMDLs

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

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

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

PNV shade and the associated solar loads are assumed to be the natural condition; thus, stream temperatures under PNV conditions are assumed to be natural (so long as no point sources or other anthropogenic sources of heat exist in the watershed) and are considered to be consistent with the Idaho water quality standards, even if they exceed numeric criteria by more than 0.3 °C.[1]

5.1.2.1 Existing Shade Estimates

Existing shade was estimated for the streams from visual interpretation of aerial photos. Estimates of existing shade based on plant type and density were marked out as stream segments on a 1:100,000 or 1:250,000 hydrography taking into account natural breaks in vegetation density. Stream segment length for each estimate of existing shade varies depending on the land use or landscape that has affected that shade level. Each segment was assigned a single value representing the bottom of a 10% shade class (adapted from the cumulative watershed effects process, IDL 2000). For example, if shade for a particular stream segment was estimated somewhere between 50% and 59%, we assigned a 50% shade class to that segment. The estimate is based on a general intuitive observation about the kind of vegetation present, its density, and stream width. Streams where the banks and water are clearly visible are usually in low shade classes (10%, 20%, or 30%). Streams with dense forest or heavy brush where no portion of the stream is visible are usually in high shade classes (70%, 80%, or 90%). More open canopies where portions of the stream may be visible usually fall into moderate shade classes (40%, 50%, or 60%).

Visual estimates made from aerial photos are strongly influenced by canopy cover and do not always take into account topography or any shading that may occur from physical features other than vegetation. It is not always possible to visualize or anticipate shade characteristics resulting from topography and landform. However, research has shown that shade and canopy cover measurements are remarkably similar (OWEB 2001), reinforcing the idea that riparian vegetation and objects proximal to the stream provide the most shade. The visual estimates of shade in this TMDL were partially field verified with a Solar Pathfinder, which measures effective shade and takes into consideration other physical features that block the sun from hitting the stream surface (e.g., hillsides, canyon walls, terraces, and man-made structures).

Solar Pathfinder Field Verification

The Solar Pathfinder is a device that allows one to trace the outline of shade-producing objects on monthly solar path charts. The percentage of the sun's path covered by these objects is the effective shade on the stream at the location where the tracing is made. To adequately

[1] A unit conversion chart is provided in Appendix B.

characterize the effective shade on a stream segment, ten traces are taken at systematic or random intervals along the length of the stream in question.

At each sampling location, the Solar Pathfinder was placed in the middle of the stream at about the bank-full water level. Ten traces were taken following the manufacturer's instructions (i.e., orient to south and level). Systematic sampling was used because it is easiest to accomplish without biasing the sampling location. For each sampled segment, the sampler started at a unique location, such as 50 to 100 meters (m) from a bridge or fence line, and proceeded upstream or downstream taking additional traces at fixed intervals (e.g., every 50 m, 50 paces, etc.). Alternatively, one can randomly locate points of measurement by generating random numbers to be used as interval distances.

When possible, the sampler also measured bank-full widths, took notes, and photographed the landscape of the stream at several unique locations while taking traces. Special attention was given to changes in riparian plant communities and what kinds of plant species (the large, dominant, shade-producing ones) were present. One can also take densiometer readings at the same location as Solar Pathfinder traces. These readings provide the potential to develop relationships between canopy cover and effective shade for a given stream.

Existing shade was field verified with a Solar Pathfinder at 12 sites throughout the subbasin (see Figure C-9 in Appendix C) in an attempt to sample different existing shade classes from the aerial photo interpretation work (Table 1). Of those 12 sites, aerial photo interpretation matched the Solar Pathfinder data at 3 sites, was within one 10% class interval at another 5 sites, was within two 10% class intervals at 3 sites, and was off by three 10% shade classes at 1 site. The majority of the sites where shade levels did not match resulted from the aerial photo interpretation estimating shade levels lower than the actual shade. The average difference between aerial photo interpretation levels and actual levels was -5% ± 7.3 (mean ± 95% confidence interval). We interpreted this difference to mean that our aerial photo interpretation levels were generally underestimating by one 10% class interval. As a result, we have made further adjustments to existing shade levels based on recalibration of our visual estimates. Substantially more field verification needs to be done on individual streams slated for implementation. Shade levels should be field verified and loading tables adjusted accordingly before substantial investment in any rehabilitation work.

Table 1. Solar Pathfinder verification of aerial interpretations of shade (%) at various sites.

Aerial Class	Pathfinder Measurement	Pathfinder Class	Difference between Classes	
50	42.5	40	10	
20	3.5	0	20	
0	6.1	0	0	
60	84.4	80	-20	
70	68.7	60	10	
30	66.1	60	-30	
10	12.1	10	0	
10	32.4	30	-20	
10	24.3	20	-10	
20	33.2	30	-10	
10	17.6	10	0	
60	77.2	70	-10	
			-5	average
			14.46	standard deviation
			7.32	95% confidence interval

5.1.2.2 Target Shade Determination

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

Natural Bank-full Widths

Stream width must be known to calculate target shade since the width of a stream affects the amount of shade the stream receives. Bank-full width is used because it best approximates the width between the points on either side of the stream where riparian vegetation starts. Measures of current bank-full width may not reflect widths present under PNV (i.e., natural widths). As impacts to streams and riparian areas occur, width-to-depth ratios tend to increase such that streams become wider and shallower. Shade produced by vegetation covers a lower percentage of the water surface in wider streams, and widened streams can also have less vegetative cover if shoreline vegetation has eroded away.

Since, existing bank-full width may not be discernible from aerial photo interpretation and may not reflect natural bank-full widths, this parameter must be estimated from available information.

We used regional curves for the major basins in Idaho—developed from data compiled by Diane Hopster of the Idaho Department of Lands—to estimate natural bank-full width (Figure 1).

For each stream evaluated in the load analysis, natural bank-full width was estimated based on the drainage area of the Upper Snake Basin curve from Figure 1. The Upper Snake Basin curve was chosen because of its proximity to the Upper Snake River/Rock Creek subbasin. Existing width data should also be evaluated and compared to these curve estimates if such data are available. However, for the Upper Snake River/Rock Creek subbasin, only a few Beneficial Use Reconnaissance Program (BURP) sites exist, and bank-full width data from those sites represent only spot data (e.g., only three measured widths in a reach just several hundred meters long) that are not always representative of the stream as a whole.

In general, we found BURP bank-full width data to disagree with natural bank-full width estimates from the Upper Snake basin curve and chose to make natural widths slightly smaller than these Upper Snake basin curve estimates. Tables containing natural bank-full width estimates for each stream in this analysis are presented in Appendix C (Table C-2). The load analysis tables contain a natural bank-full width and an existing bank-full width for every stream segment in the analysis based on the bank-full width results presented in Appendix C, Table C-2. Existing widths and natural widths are the same in load analysis tables when there are no data to support making them differ.

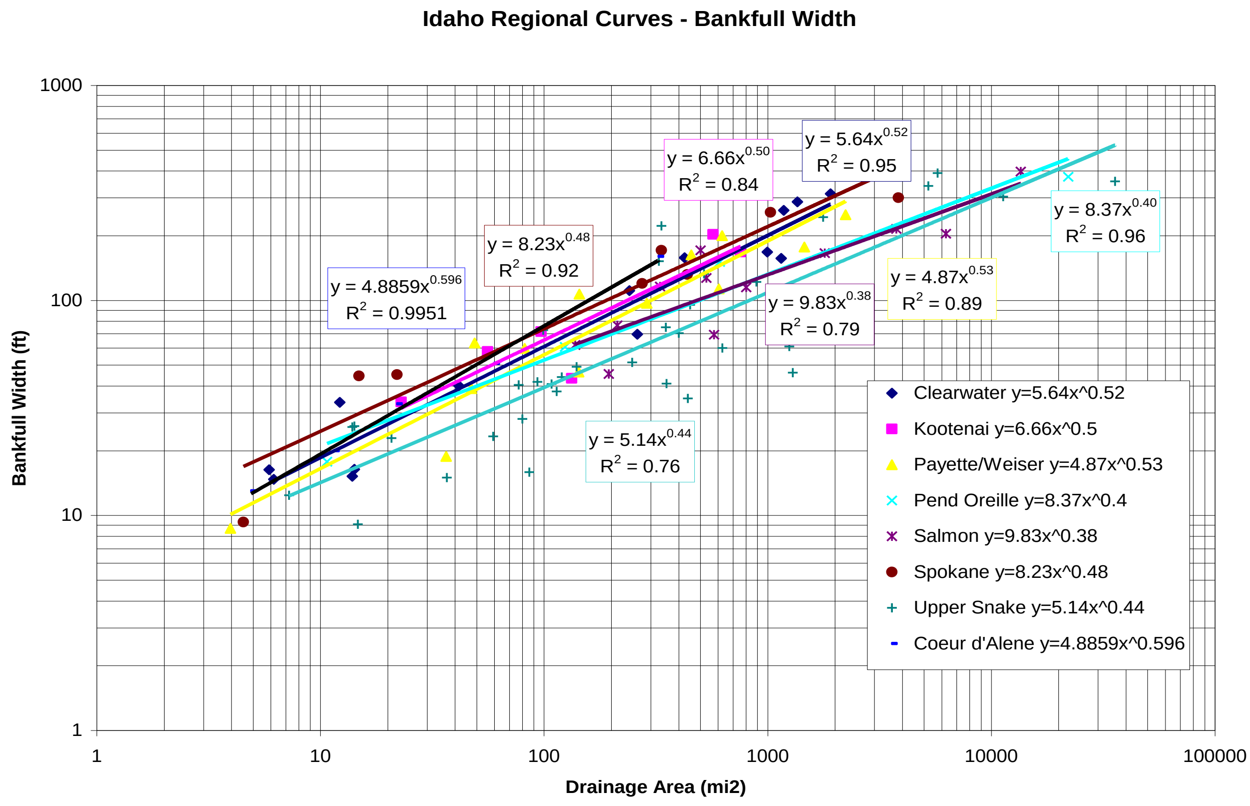

Figure 1. Bank-full width as a function of drainage area.

Design Conditions

Determining potential natural riparian vegetation along tributaries in this subbasin is complex due to changes in elevation and history of land use. In general, those streams that drain north from the South Hills descend from over 7,000 feet in elevation to the agricultural lowland near 4,000 feet. Along the way, they may pass through a variety of riparian vegetation types from conifer-dominated woodlands and alpine-like shrub meadows, through aspen, willow, and hawthorn communities, to water birch and a rich diversity of riparian shrubs. At lower elevations, smaller foothill streams may be surrounded by various shrubs such as hawthorns, yellow willow, or sandbar (coyote) willow. Once streams reach the agricultural plain, they tend to be dominated by Russian olive gallery forest. To capture the potential natural riparian plant communities for such a diverse area, some basic suppositions had to be made, which vary depending on where in the subbasin a stream is located.

Those streams that drain north from the South Hills (the three forks of Dry Creek, North Cottonwood Creek, McMullen Creek, and Donahue Creek) begin in the Sawtooth National Forest. Thus, the Sawtooth National Forest potential vegetation groups (PVGs) overlay, as described in Shumar and De Varona (2009), informed which shade curve would be used on streams in that area. Generally, streams originated in persistent lodgepole pine (PVG 10) stands and then alternated through aspen (*Populus tremuloides*), willow, and hawthorn nonforest-type vegetation. In this area, we used a Geyer willow (*Salix geyeriana*)/sedge community for nonforested areas above 5,000 feet elevation and hawthorn (*Crataegus douglasii*) vegetation type below that elevation. Once these streams reached wider floodplains as they approached the Snake River Plain, we switched the vegetation type to water birch (*Betula occidentalis*)—a community dominated by small trees similar to the present-day cottonwood and Russian olive communities found along these streams. These present-day riparian plant communities may contain no water birch; however, Russian olive, which is quite common, is very similar in size and stature.

Further west, Cedar Draw and Mud Creeks drain north from sagebrush desert highlands near Berger Butte. These drainages are dry, ephemeral washes until they reach the lowlands of the Snake River Plain. Today, most of these streams originate as drainage water or canal conveyance from the High Line and Low Line Canal system. Thus, the extent and character of the original riparian plant community along these streams is vague and perhaps debatable. We have chosen to place narrow portions of these streams (those upper sections with bank-full widths smaller than 5 m) into a yellow willow (*Salix lutea*) riparian type. Wider portions (5 m or greater) are placed into a water birch community type similar to the South Hill drainages to the east.

Continuing westward down the Snake River towards King Hill, the Clover Creek/Pioneer Reservoir complex is on the north side of the river. Clover Creek is mostly perennial flow drainage joined by numerous ephemeral washes. The lower portion of Calf Creek is at least intermittent and may retain flow year-round in wet years. Again, we have chosen to use a yellow willow plant community for upper portions of these streams and a water birch community for lower, wider sections. The Clover/Calf Creek area has an intermediate zone where sandbar willow (*Salix exigua*) dominates the flood-prone sections in agricultural areas.

Shade Curve Selection

To determine PNV shade targets for tributaries in the Upper Snake River/Rock Creek subbasin, effective shade curves from Shumar and De Varona (2009) were examined (see Appendix C for curves). These curves were produced using vegetation community modeling of Idaho plant communities. Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis.

As described above, the following shade curves from Shumar and De Varona (2009) were employed:

- Persistent lodgepole (PVG 10)—from the Sawtooth National Forest group
- Aspen—from the southern Idaho nonforest group
- Geyer willow/sedge—from the southern Idaho nonforest group
- Black hawthorn—from the southern Idaho nonforest group
- Water birch—from the southern Idaho nonforest group
- Yellow willow—from the southern Idaho nonforest group
- Sandbar willow—from the southern Idaho nonforest group

5.2 Load Capacity

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

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

Tables C-3 through C-15 in Appendix C and Figures 5, and 8 show the PNV shade targets. The tables also show corresponding target summer loads (in kilowatt-hours per square meter per day [kWh/m^2/day] and kWh/day) that serve as the load capacities for the streams. Existing and target loads in kWh/day can be summed for the entire stream or portion of stream examined in a single load analysis table. These total loads are shown at the bottom of their respective columns in each table. Because load calculations involve stream segment area calculations, the segment's channel width, which typically only has one or two significant figures, dictates the level of significance of the corresponding loads. Having only one significant figure in the resulting load can create rounding errors when existing and target loads are subtracted. The totals row of each load table represents total loads with two significant figures in an attempt to reduce apparent rounding errors.

The water body with the largest target load (i.e., load capacity) was contributions to Pioneer Reservoir (AU# ID17040212SK035_04) with 1.1 million kWh/day (Table 2). Cottonwood Creek with reservoirs included has a larger target load because of the reservoir surface areas; however, that was included in Table 2 for demonstrative purposes. The smallest target load was in the North Cottonwood Creek tributaries (AU# ID17040212SK014_02) with 42,000 kWh/day (Table C-11).

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 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 (Figures 3, 6, and 9). There are currently 19 permitted point sources in the affected AUs. Like target shade, existing shade was converted to a solar load by multiplying the fraction of open stream by the solar radiation measured on a flat-plate collector at the NREL Boise and Pocatello weather stations. Existing shade data are presented in Tables C-3 through C-15 in Appendix C. Like load capacities (target loads), existing loads in these tables are presented on an area basis (kWh/m^2/day) and as a total load (kWh/day). Existing loads in kWh/day are also summed for the entire stream or portion of stream examined in a single load analysis table. The difference between target and existing load is also summed for the entire table. Should existing load exceed target load, this difference becomes the excess load (i.e., lack of shade) to be discussed next in the load allocation section and as depicted in the lack-of-shade figures (Figures 4, 7, and 10).

The water body with the largest existing load was Cottonwood Creek with the reservoir load included (AU# ID 17040212SK014_02, _03, and _04) with 2,700,000 kWh/day (Table C-10). If the reservoirs are not included in Cottonwood Creek, then contributions to Pioneer Reservoir at 1.5 million kWh/day (Table 2) becomes the largest existing load. The smallest existing load was in the North Cottonwood Creek tributaries AU (AU# ID17040212SK014_02) with 54,000 kWh/day (Table C-11).

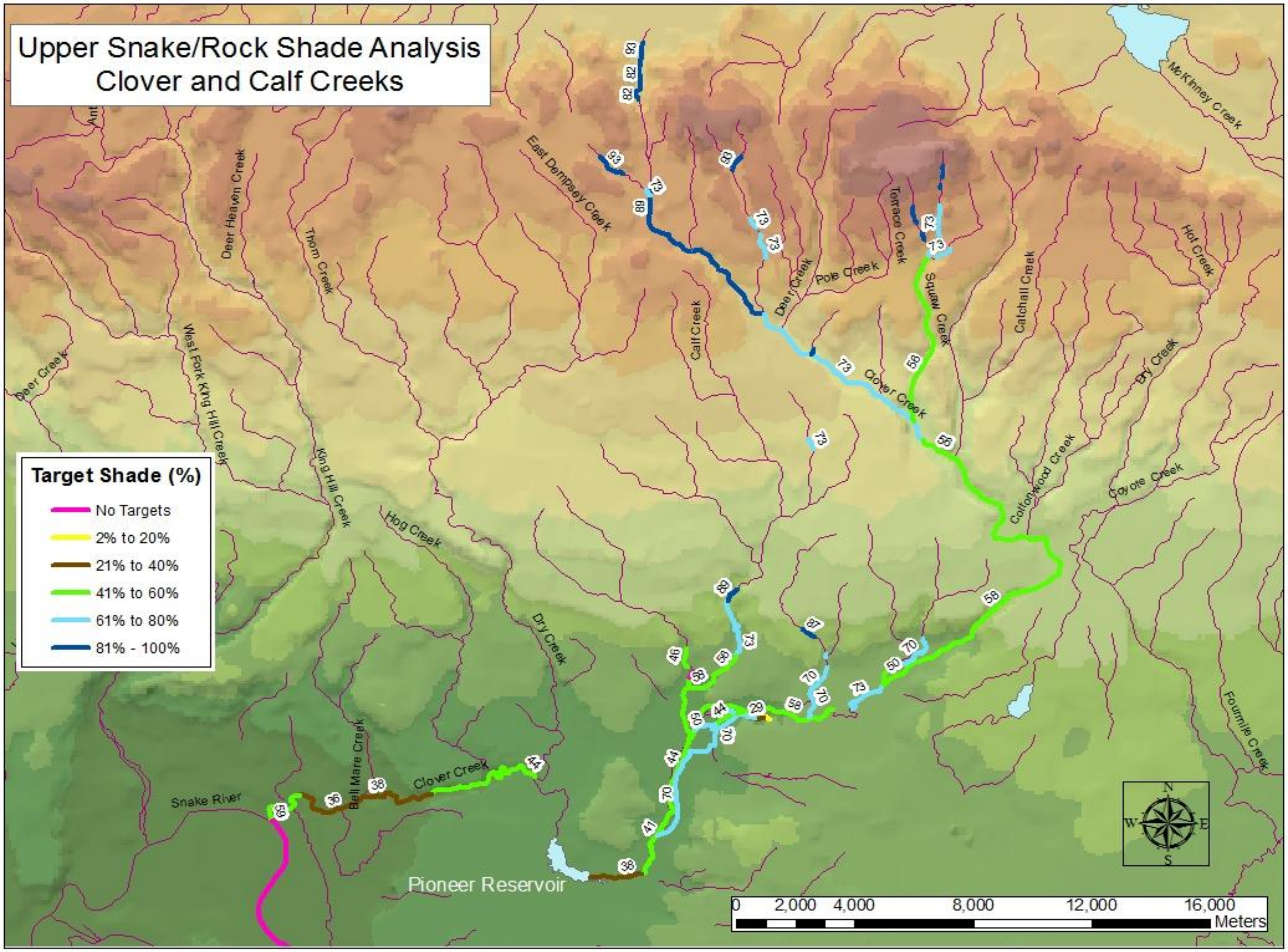

Figure 2. Target shade for Clover and Calf Creeks.

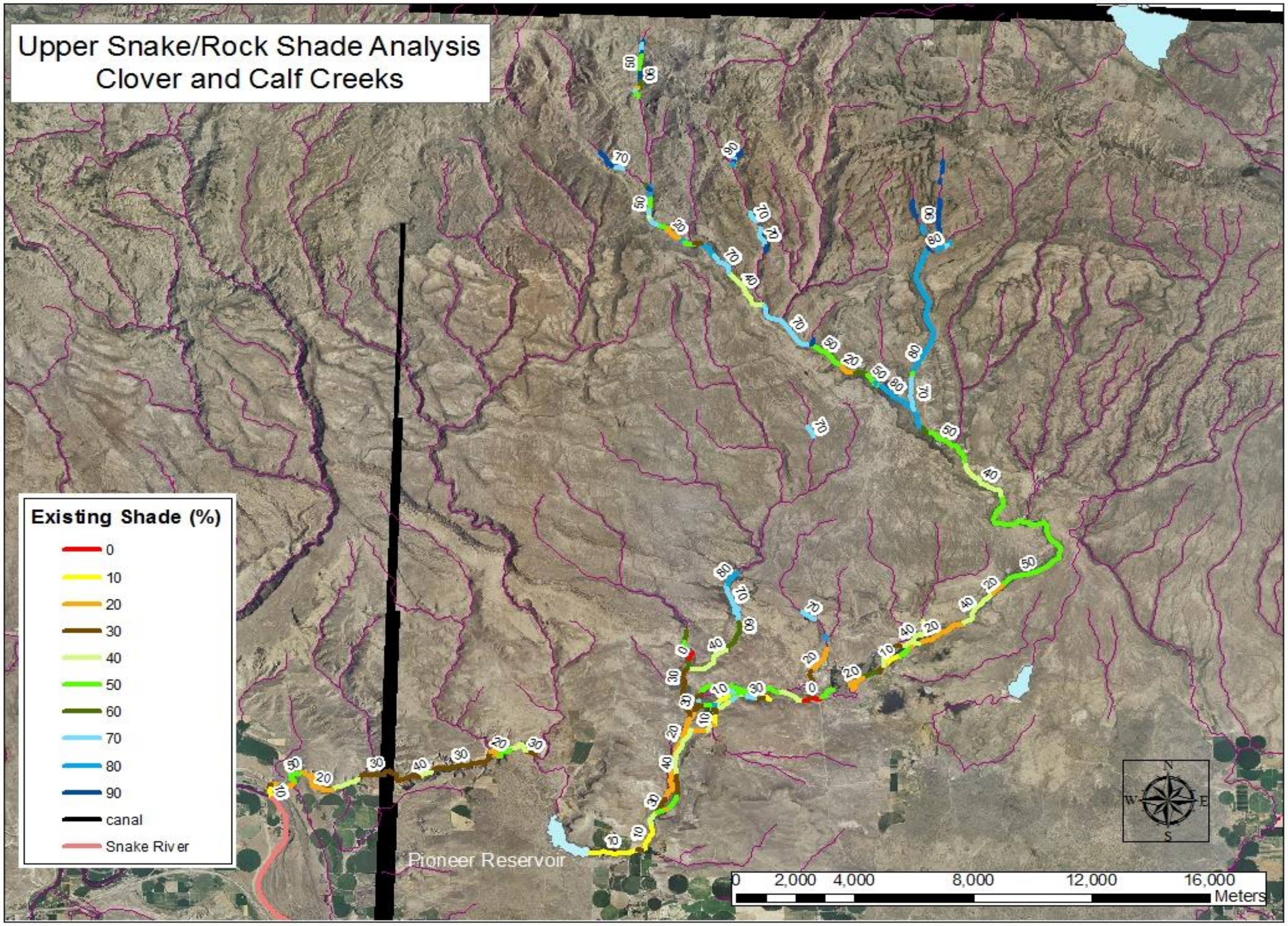

Figure 3. Existing shade estimated for Clover and Calf Creeks by aerial photo interpretation.

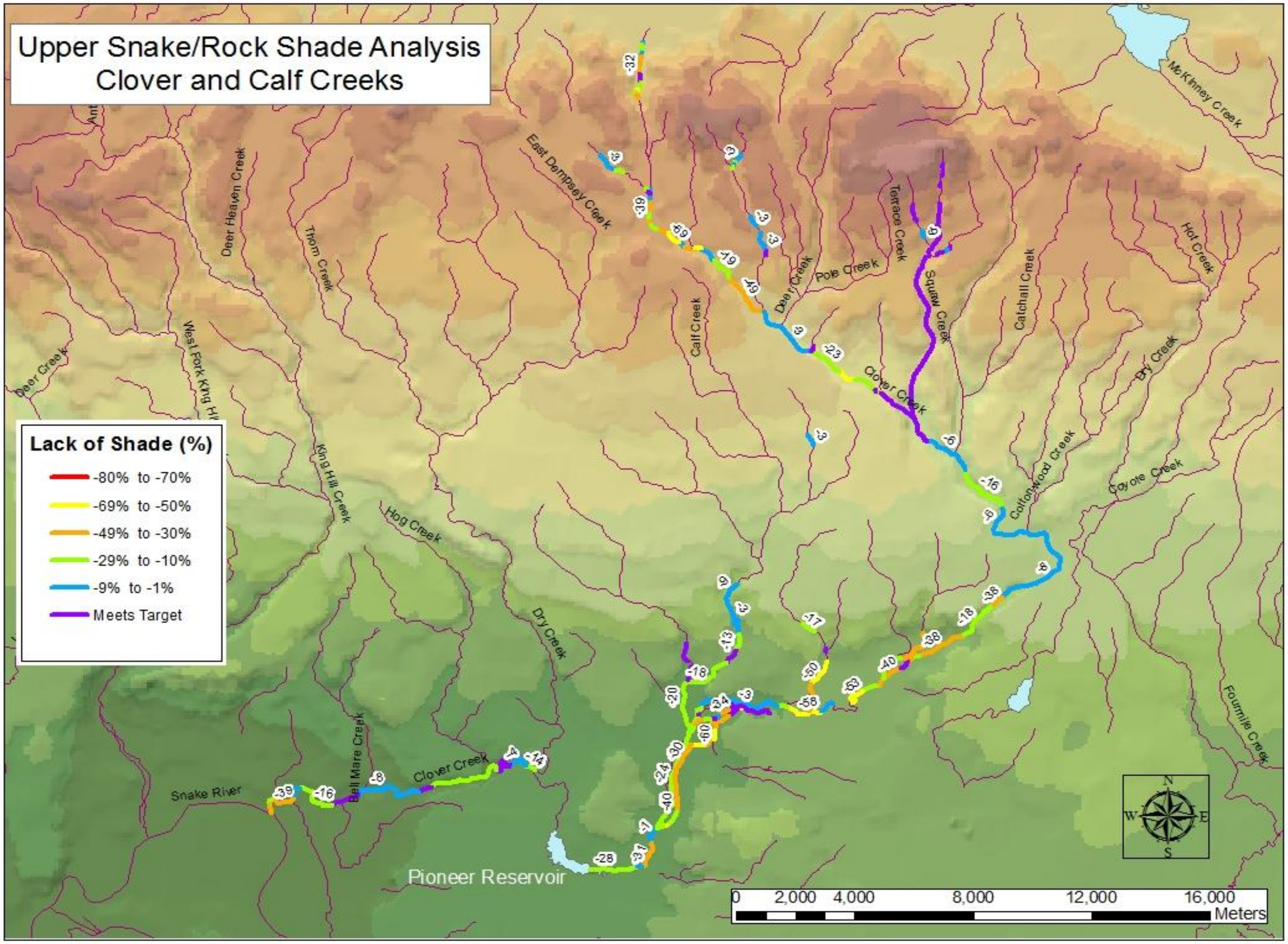

Figure 4. Lack of shade (difference between existing and target) for Clover and Calf Creeks.

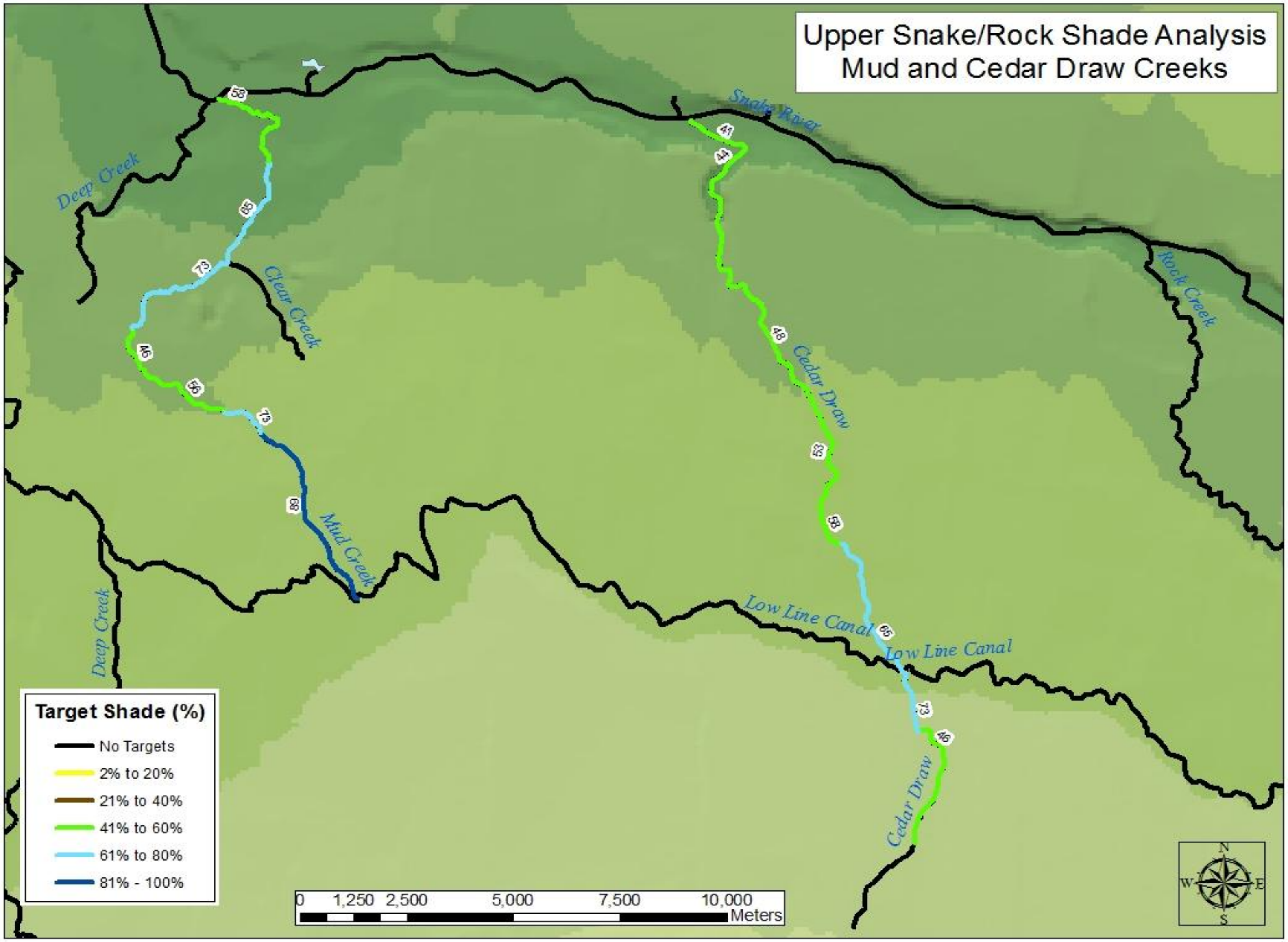

Figure 5. Target shade for Mud and Cedar Draw Creeks.

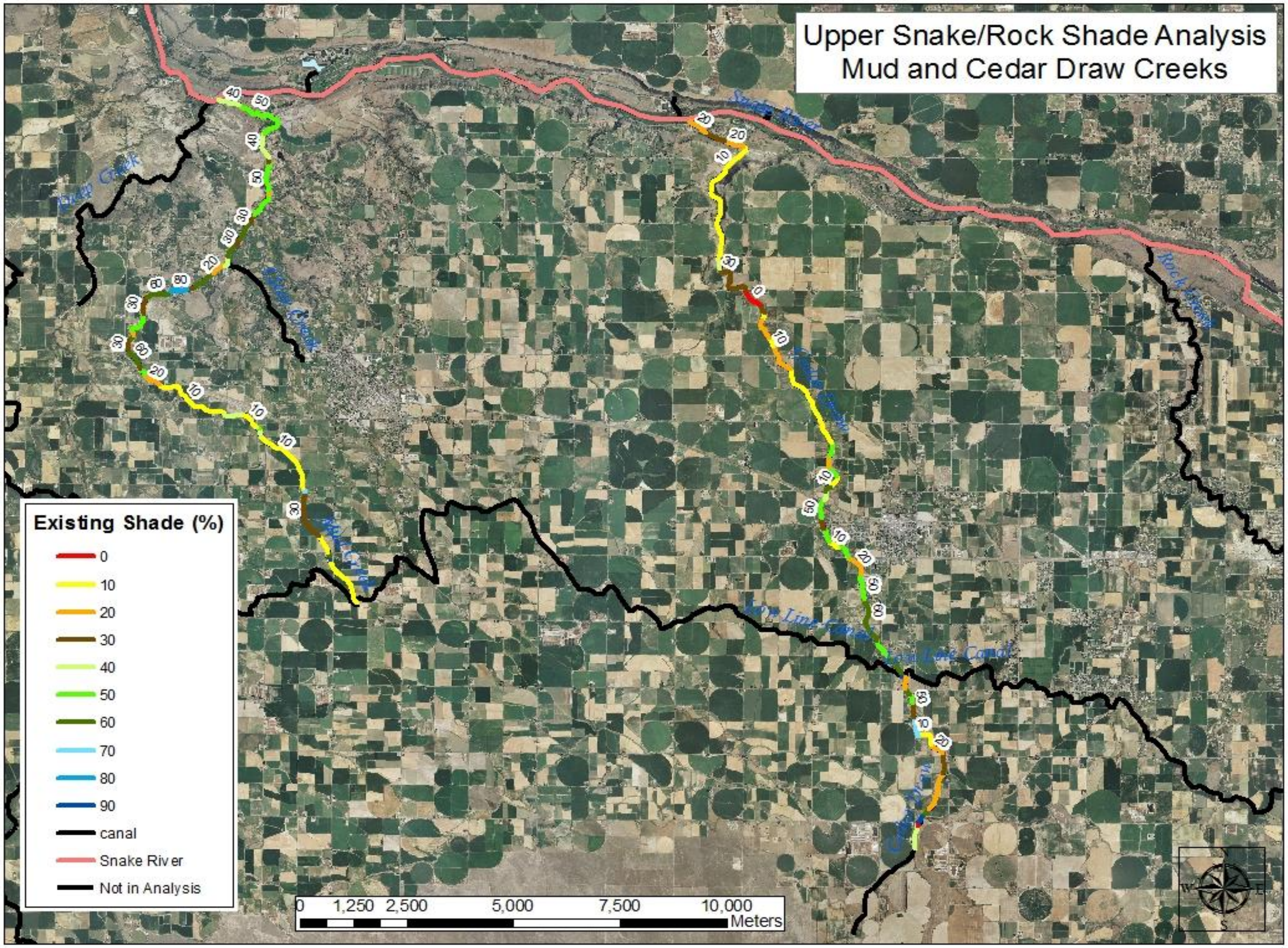

Figure 6. Existing shade estimated for Mud and Cedar Draw Creeks by aerial photo interpretation.

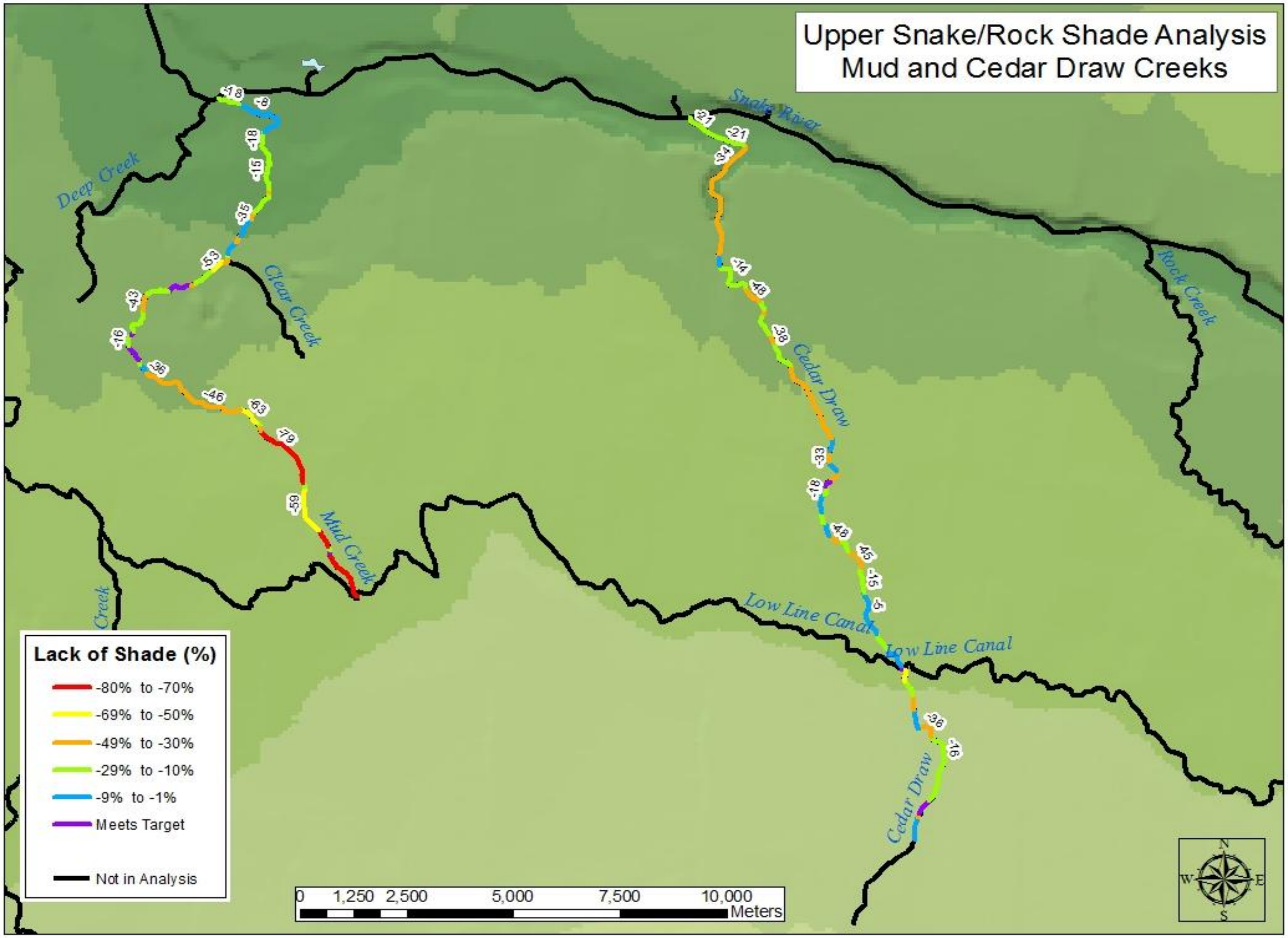

Figure 7. Lack of shade (difference between existing and target) for Mud and Cedar Draw Creeks.

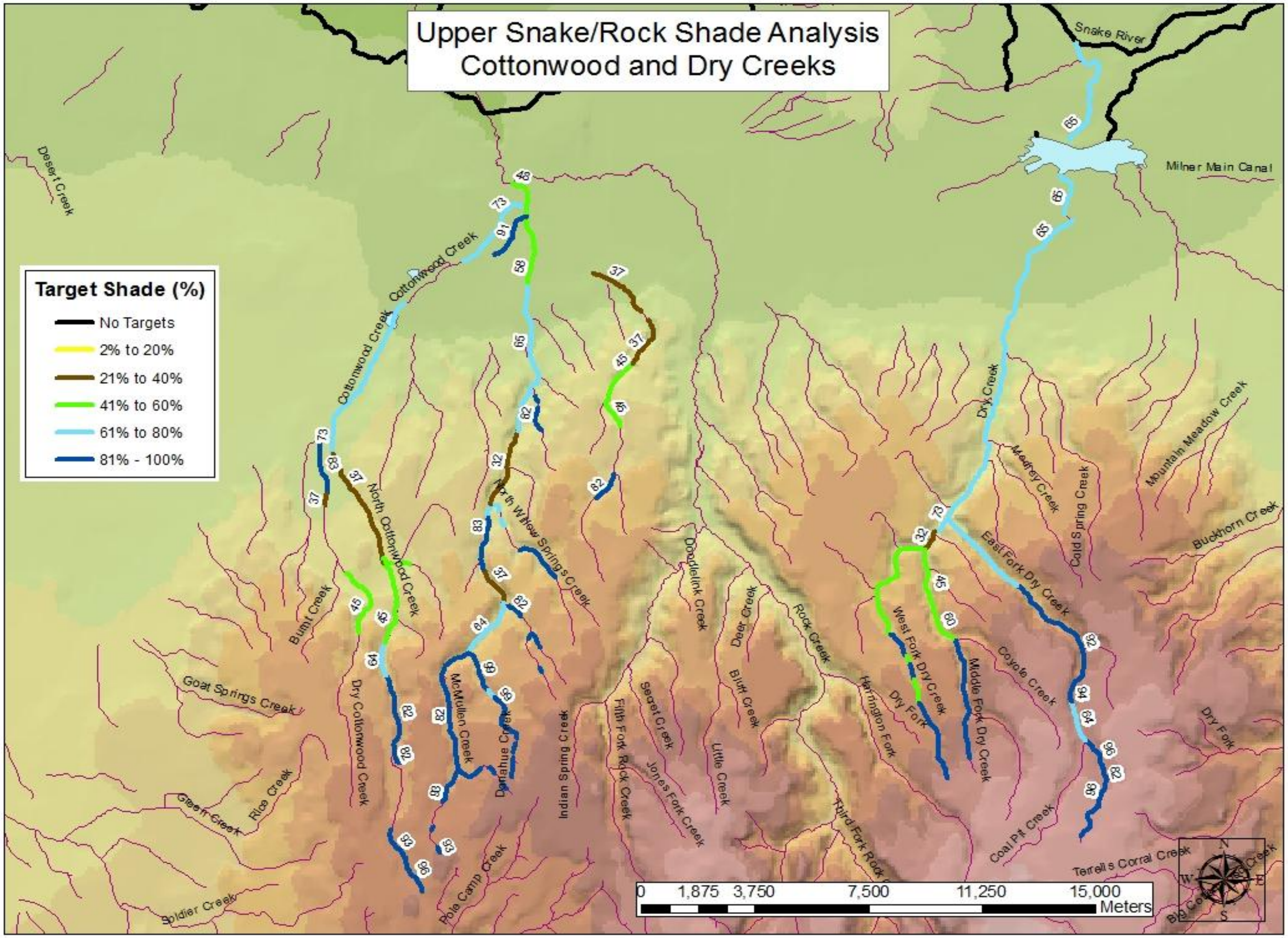

Figure 8. Target shade for Cottonwood, McMullen, and Dry Creeks.

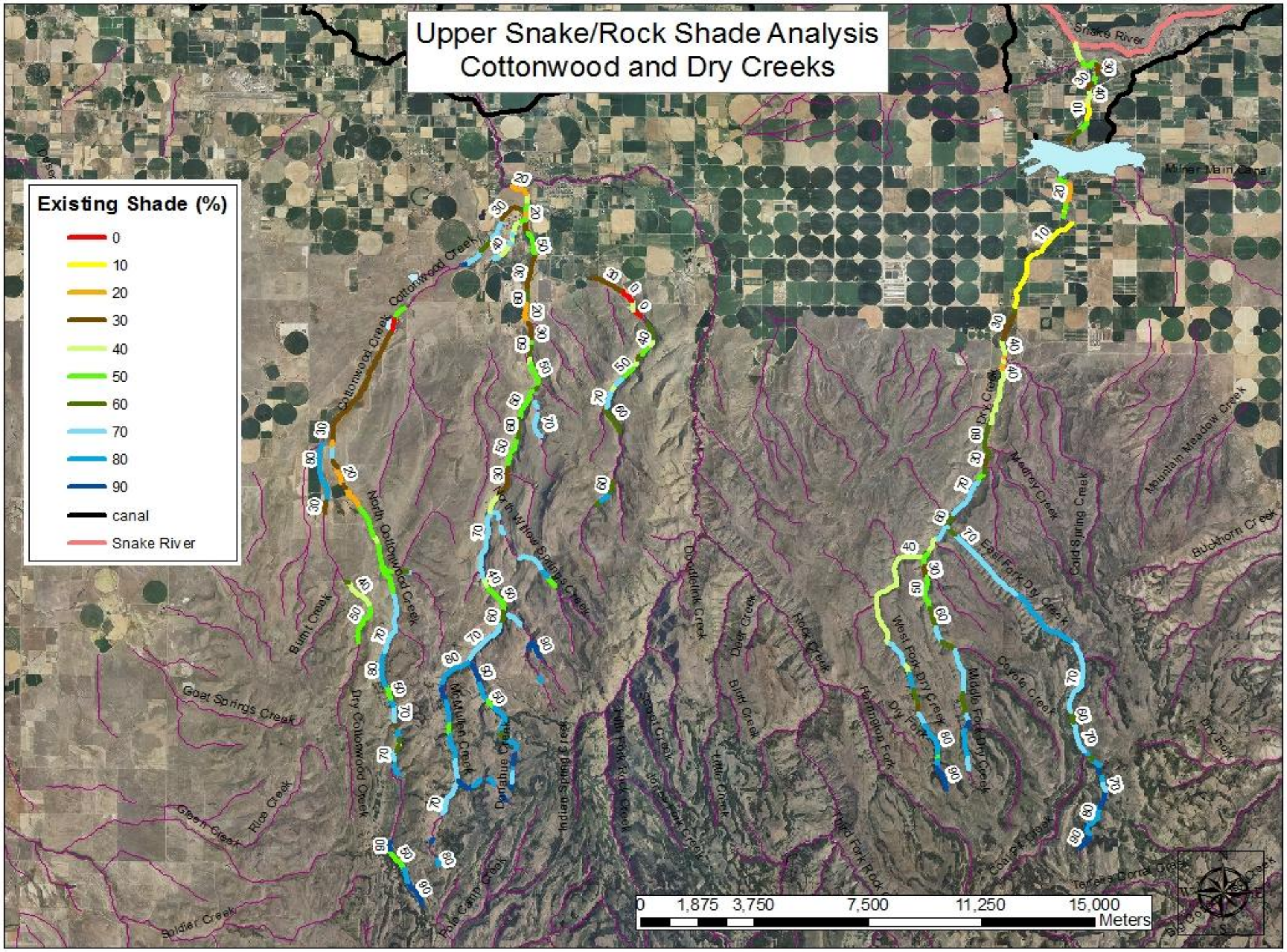

Figure 9. Existing shade estimated for Cottonwood, McMullen, and Dry Creeks by aerial photo interpretation.

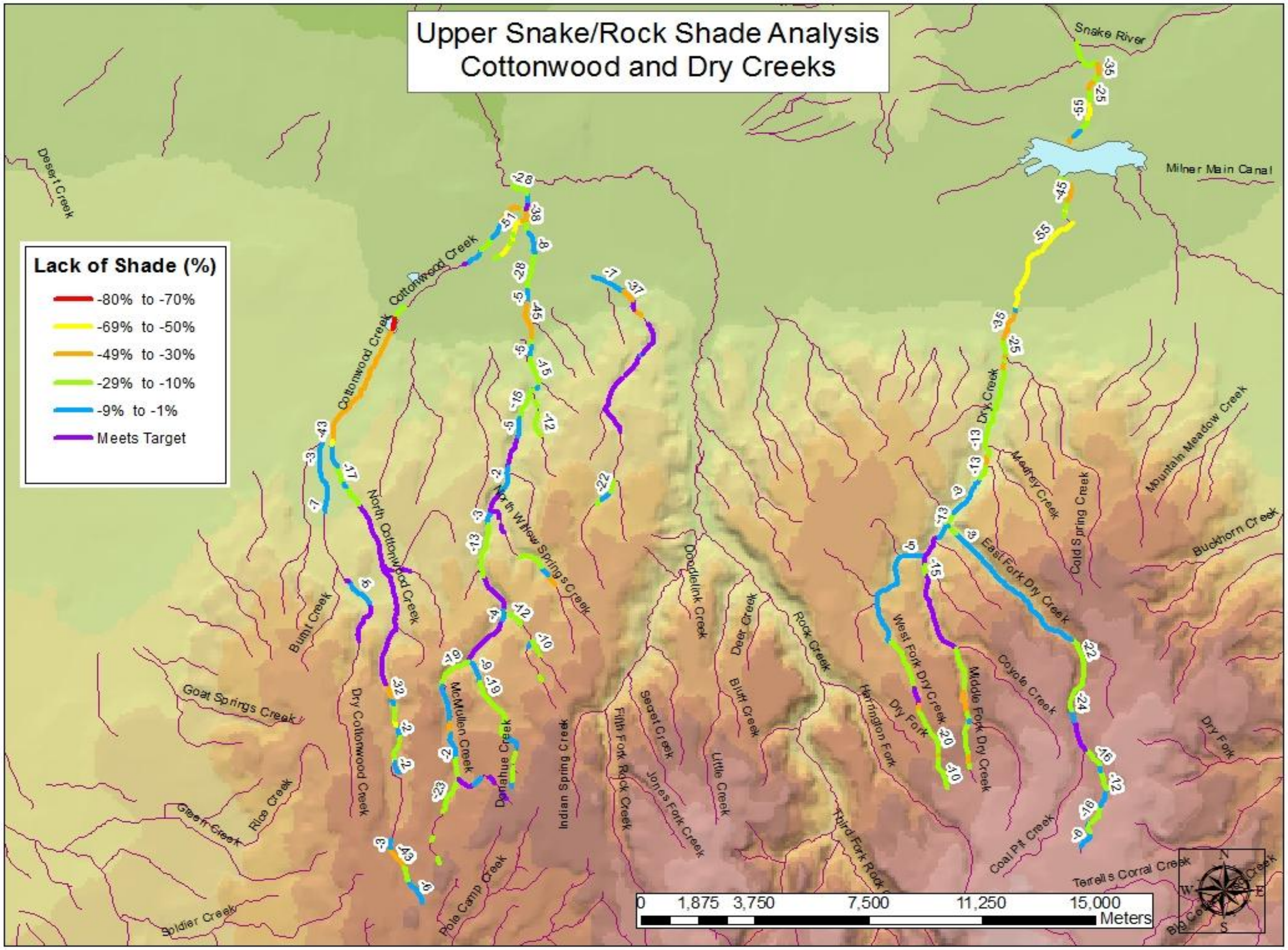

Figure 10. Lack of shade (difference between existing and target) for Cottonwood, McMullen, and Dry Creeks.

5.4 Load Allocation

Because this TMDL is based on PNV, 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 nonpoint source activities that have affected or may affect riparian vegetation and shade as a whole. Therefore, load allocations are stream segment specific and dependent upon the target load for a given segment. Tables C-3 through C-15 in Appendix C show the target shade and corresponding target summer load. This target load (i.e., load capacity) is necessary to achieve background conditions. There is no opportunity to further remove shade from the stream by any activity without exceeding its load capacity. Additionally, because this TMDL is dependent upon background conditions for achieving water quality standards, all tributaries to the waters examined here need to be in natural conditions to prevent excess heat loads to the system.

Table 2 shows the total existing, target, and excess loads and the average lack of shade for each water body examined. The size of a stream influences the size of the excess load. Large streams have higher existing and target loads by virtue of their larger channel widths. Table 2 lists the tributaries in order of their excess loads, from highest to lowest. Therefore, large tributaries tend to be listed first and small tributaries last.

Although this TMDL analysis focuses on total solar loads, it is important to note that differences between existing and target shade, as depicted in the lack-of-shade figures (Figures 4, 7, and 10), are the key to successfully restoring these waters to achieving water quality standards. Target shade levels for individual reaches should be the goal managers strive for with future implementation plans. Managers should focus on the largest differences between existing and target shade as locations to prioritize implementation efforts. Each load analysis table contains a column that lists the lack of shade on the stream segment. This value is derived from subtracting target shade from existing shade for each segment. Thus, stream segments with the largest lack of shade are in the worst shape. The average lack of shade derived from the last column in each load analysis table is also listed in Table 2 and provides a general level of comparison among streams.

Table 2. Total solar loads and average lack of shade for all waters.

Water Body/ Assessment Unit	Total Existing Load (kWh/day)	Total Target Load (kWh/day)	Excess Load (% Reduction) (kWh/day)	Average Lack of Shade (%)
Contribution to Pioneer Reservoir (ID17040212SK035_04)	1,500,000	1,100,000	420,000 (28%)	-19
Upper Clover Creek (ID17040212SK036_02, _03* and _04*)	980,000	650,000	340,000 (35%)	-24
Cedar Draw Creek (ID17040212SK012_02* and _03)	830,000	530,000	290,000 (35%)	-22
Dry Creek (ID17040212SK022_03)	440,000	230,000	210,000 (48%)	-24
Mud Creek (ID17040212SK011_02*, 010_02* and _03)	280,000	160,000	120,000 (43%)	-29
Lower Clover Creek (ID17040212SK034_04)	640,000	530,000	110,000 (17%)	-16
McMullen Creek (ID17040212SK015_02 and _03)	340,000	250,000	81,000 (24%)	-13
Cottonwood Creek (w/ reservoirs) (ID17040212SK014_02, _03* and _04*)	2,700,000	2,700,000	73,000 (3%)	-16
Cottonwood Creek (w/out reservoirs) (ID17040212SK014_02, _03* and _04*)	300,000	230,000	73,000 (24%)	-17
Dry Creek Tributaries (ID17040212SK022_02*, 023_02* and 024_02*)	170,000	120,000	61,000 (36%)	-15
Upper Clover Creek Tributaries (ID17040212SK036_02)	270,000	210,000	56,000 (21%)	-14
Calf Creek (ID17040212SK040_02 and _03)	83,000	59,000	23,000 (28%)	-11
McMullen Creek Tributaries (ID17040212SK015_02)	130,000	110,000	22,000 (17%)	-13
N. Cottonwood Creek Tributaries (ID17040212SK014_02)	54,000	42,000	12,000 (22%)	-2
Calf Creek Tributaries (ID17040212SK040_02)	180,000	180,000	0 (0%)	-1

Note: Load data are rounded to two significant figures, which may present rounding errors. AUs identified by an asterisk (*) are nonlisted AU portions that were included in the analysis.

All streams in this analysis lacked shade and had excess heat loads to their systems with the exception of tributaries to Calf Creek. Excess loads varied from 3% of the total existing load in Cottonwood Creek (with reservoir loads included) to as much as 48% in Dry Creek. When the heat load to the reservoir surface area is included in the load calculation, Cottonwood Creek has the highest existing and target loads at 2.7 million kWh/day. Without the reservoir, the remainder of the stream has existing and target loads of 300,000 and 230,000 kWh/day, respectively demonstrating that ponds, lakes, and impoundments can have a substantial contribution to a stream's heat load.

In general, tributaries to the major streams in this subbasin are in relatively good condition with respect to heat loading. Calf Creek tributaries had no excess load. Cottonwood Creek, McMullen Creek, and Clover Creek had tributaries with excess loads only 17 to 22% of total existing loads, likely due to the fact that many of these tributary systems are dry washes where the riparian community is patchy, related to spring seeps, and often found in small canyons where, with the exception of fire, disturbance is low. Most main stem streams had slightly higher necessary reductions (17–48%). Cedar Draw, Mud, and Dry Creeks had some of the highest excess loads and necessary percent reductions. These streams are highly manipulated by canals, water diversion, and streambank use.

Pioneer Reservoir (AU# ID17040212SK035_04) separates upper Clover Creek from lower Clover Creek. As such, all of the water in the reservoir accumulates from the watersheds above, including three AUs of upper Clover Creek (ID17040212SK036_02, _03, and _04) and two AUs that comprise the Calf Creek watershed (ID17040212SK040_02 and _03). Additionally, there may be substantial agricultural return flow from various canals and drains in the area. The reservoir itself is broad and shallow and has no natural shade. There is likely a substantial direct heat load to this reservoir from sun exposure that cannot be reduced. Therefore, for the purposes of setting a load allocation for the reservoir AU, it is assumed that the excess load (and necessary reductions) to the Clover and Calf Creeks AUs above it will suffice as necessary load reductions for the reservoir. The “Contribution to Pioneer Reservoir” AU, which has the largest excess load in the table, does not represent heat load to the reservoir surface itself but the addition of upper Clover Creek loads, upper Clover Creek tributaries loads, Calf Creek loads, and Calf Creek tributaries loads. Combined, these streams provide the excess heat load to the reservoir that would need to be reduced in order for the Pioneer Reservoir AU to meet temperature standards. The reservoir itself does not create an excess load as there is no shade target prescribed for it.

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

5.4.1 Water Diversion

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

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

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

Additionally, Idaho water quality standards indicate the following:

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

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

5.4.2 Wasteload Allocation

There are 19 known National Pollutant Discharge Elimination System (NPDES) permitted point sources in the affected watersheds; however, no wasteload allocations are suggested at this time. Temperature data need to be collected to determine if point source influences exist on these waters. Background provisions in Idaho water quality standards addressing such discharges (IDAPA 58.01.02.200.09; IDAPA 58.01.02.401.01) will be involved (see Appendix A).

5.4.2.1 Construction Stormwater

The Clean Water Act requires operators of construction sites to obtain permit coverage to discharge stormwater to a water body or municipal storm sewer. In the past, stormwater was treated as a nonpoint source of pollutants. However, because stormwater can be managed on-site through management practices or when discharged through a discrete conveyance such as a storm sewer, it now requires an NPDES permit.

In Idaho, EPA has issued a general permit for stormwater discharges from construction sites. If a construction project disturbs more than 1 acre of land (or is part of a larger common development that will disturb more than 1 acre), the operator is required to apply for a Construction General Permit (CGP) from EPA after developing a site-specific Stormwater Pollution Prevention Plan (SWPPP). Operators must document the erosion, sediment, and pollution controls they intend to use; inspect the controls periodically; and maintain best management practices (BMPs) throughout the life of the project.

When a stream is in Category 5 of the Integrated Report and DEQ develops a TMDL, DEQ may incorporate a gross wasteload allocation for anticipated construction stormwater activities. TMDLs developed in the past that did not have a wasteload allocation for construction stormwater activities or new TMDLs will also be considered in compliance with provisions of the TMDL if they obtain a CGP under the NPDES program and implement appropriate BMPs.

Typically there are specific requirements operators must follow to be consistent with any local pollutant allocations. Many communities throughout Idaho are currently developing rules for post construction stormwater management. Sediment is usually the main pollutant of concern in stormwater from construction sites. Applying BMPs from Idaho's *Catalog of Stormwater Best Management Practices for Idaho Cities and Counties* is generally sufficient to meet the standards and requirements of the CGP, unless local ordinances have more stringent and site-specific standards that are applicable (DEQ 2005).

5.4.3 Margin of Safety

The margin of safety in this TMDL is considered implicit in the design. Because the target is essentially background conditions, loads (shade levels) are allocated to lands adjacent to these streams at natural background levels. Because shade levels are established at natural background or system potential levels, it is unrealistic to set shade targets at higher, or more conservative, levels. Additionally, existing shade levels are reduced to the next lower 10% shade class, which likely underestimates actual shade in the loading analysis. Although the loading analysis used in this TMDL involves gross estimations that are likely to have large variances, load allocations are applied to the stream and its riparian vegetation rather than specific nonpoint source activities and can be adjusted as more information is gathered from the stream environment.

5.4.4 Seasonal Variation

This TMDL is based on average summer loads. All loads have been calculated to be inclusive of the 6-month period from April through September. This time period is when the combination of increasing air and water temperatures coincide with increasing solar inputs and vegetative shade. The critical time periods are April through June when spring salmonid spawning occurs, July and August when maximum temperatures may exceed cold water aquatic life criteria, and September when fall salmonid spawning is most likely to be affected by higher temperatures. Water temperature is not likely to be a problem for beneficial uses outside of this time period because of cooler weather and lower sun angle.

5.5 Implementation Strategies

Implementation strategies for TMDLs produced using PNV-based shade and solar loads should incorporate the load analysis tables presented in this TMDL (Appendix C, Tables C-3 through C-15). These tables need to be updated, first to field verify the remaining existing shade levels and second to monitor progress toward achieving reductions and TMDL goals. Using the Solar Pathfinder to measure existing shade levels in the field is important to achieving both objectives. It is likely that further field verification will find discrepancies with reported existing shade levels in the load analysis tables. Due to the inexact nature of the aerial photo interpretation technique, these tables should not be viewed as complete until verified. Implementation strategies should include Solar Pathfinder monitoring to simultaneously field verify the TMDL and mark progress toward achieving desired load reductions.

DEQ recognizes that implementation strategies for TMDLs may need to be modified if monitoring shows that TMDL goals are not being met or significant progress is not being made toward achieving the goals. There may be a variety of reasons that individual stream segments do not meet shade targets, including natural phenomena (e.g., beaver ponds, springs, wet meadows, and past natural disturbances) and/or historic land-use activities (e.g., logging, grazing, and mining). It is important that existing shade for each stream segment be field verified to determine if shade differences are real and result from activities that are controllable. Information within this TMDL (maps and load analysis tables) should be used to guide and prioritize implementation investigations. The information in this TMDL may need further adjustment to reflect new information and conditions in the future.

5.5.1 Time Frame

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

DEQ and the designated watershed advisory group (WAG) will continue to reevaluate TMDLs on a 5-year cycle. During the 5-year review, implementation actions completed, in progress, and planned will be reviewed, and pollutant load allocations will be reassessed accordingly.

5.5.2 Approach

TMDLs will be implemented through the continuation of ongoing pollution control activities in the subbasin. The designated WAG, designated management agencies (DMAs), local organizations, and other appropriate public process participants are expected to do the following:

- Develop BMPs to achieve load allocations.
- Give reasonable assurance that management actions will meet load allocations through both quantitative and qualitative analysis of management measures.
- Adhere to measurable milestones for progress.
- Develop a timeline for implementation, including cost and funding.
- Develop a monitoring plan to determine if BMPs are being implemented, if individual BMPs are effective, and if load allocations are being met.

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

5.5.3 Responsible Parties

In addition to the DMAs, the public—through the WAG and other equivalent organizations or processes—will have opportunities to be involved in developing the implementation plan. The following Idaho agencies are responsible for management activities:

- Idaho Soil and Water Conservation Commission for grazing and agricultural activities

- Idaho Transportation Department for public road construction
- Idaho State Department of Agriculture for aquaculture
- Idaho Department of Environmental Quality for all other activities

5.5.4 Monitoring Strategy

Effective shade monitoring can take place on any segment throughout the 11 AUs identified in this analysis and be compared to existing shade estimates seen in Figures 3, 6, and 9 and described in Tables C-3 through C-15. Those areas with the largest disparity between existing and target shade should be monitored with Solar Pathfinders to verify existing shade levels and determine progress toward meeting shade targets. Since many existing shade estimates have not been field verified, they may require adjustment during the implementation process. Stream segment length for each estimate of existing shade varies depending on the land use or landscape that has affected that shade level. It is appropriate to monitor within a given existing shade segment to see if that segment has increased its existing shade toward target levels. Ten equally spaced Solar Pathfinder measurements averaged together within that segment should suffice to determine new shade levels in the future.

5.6 Public Participation

The Mid-Snake Watershed Advisory Group (WAG) provided DEQ with local knowledge of the watersheds, reviewed beneficial use designations and applicable surface water standards, and also provided comments on the draft documents. Public meetings were held the third Wednesday of the month on a quarterly basis (February, May, August, and November) or as needed. The meetings are open to the public and are posted to the DEQ webpage and in the DEQ Twin Falls Regional Office. Nine meetings have been held to date, and meetings will continue into the future to discuss TMDL implementation.

The general public will have the opportunity to comment on this draft document during the public comment period. In the final version of this addendum, a distribution list and summary of public comments will be included as Appendices D and E, respectively.

5.7 Conclusions

Effective shade targets were established for seven stream systems (11 AUs) based on the concept of maximum shading under PNV resulting in natural background temperature levels; 11 AUs that were §303(d)-listed as impaired by temperature are specifically identified as those having TMDLs for EPA approval. Shade targets were derived from effective shade curves developed for similar vegetation types in Idaho. Existing shade was determined from aerial photo interpretation and partially field verified with Solar Pathfinder data. Target and existing shade levels were compared to determine the amount of shade needed to bring water bodies into compliance with Idaho's water quality standards (IDAPA 58.01.02). A summary of assessment outcomes, including recommended changes to listing status in the next Integrated Report, is presented in Table 3.

Most streams lacked shade and had excess heat loads, although tributaries to major stream systems were in better condition overall than main stems. Streams in lowland areas experience the most excess heat due to their highly modified systems and land-use impacts. Excess heat loads to Pioneer Reservoir result from the shade deficits on Clover and Calf Creeks above it.

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

Table 3. Summary of assessment outcomes.

Water Body Segment/ Assessment Unit	Pollutant	TMDL(s) Completed	Recommended Changes to 2012 Integrated Report	Justification
Mud Creek ID17040212SK010_03	Temperature	Yes	Move to Category 4a	Excess solar load from a lack of existing shade
Cedar Draw Creek ID17040212SK012_03	Temperature	Yes	Move to Category 4a	Excess solar load from a lack of existing shade
Cottonwood Creek ID17040212SK014_02	Temperature	Yes	Move to Category 4a	Excess solar load from a lack of existing shade
McMullen Creek ID17040212SK015_02 ID17040212SK015_03	Temperature	Yes	Move to Category 4a	Excess solar load from a lack of existing shade
Dry Creek ID17040212SK022_03	Temperature	Yes	Move to Category 4a	Excess solar load from a lack of existing shade
Clover Creek ID17040212SK034_04 ID17040212SK036_02	Temperature	Yes	Move to Category 4a	Excess solar load from a lack of existing shade
Pioneer Reservoir ID17040212SK035_04	Temperature	Yes	Move to Category 4a	Excess solar load from a lack of existing shade
Calf Creek ID17040212SK040_02 ID17040212SK040_03	Temperature	Yes	Move to Category 4a	Excess solar load from a lack of existing shade

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GIS Coverages

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Glossary

§305(b)

Refers to section 305 subsection “b” of the Clean Water Act. The term “305(b)” generally describes a report of each state’s water quality and is the principle means by which the US Environmental Protection Agency, Congress, and the public evaluate whether US 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. Section 303(d) requires states to develop a list of water bodies that do not meet water quality standards. This section also requires total maximum daily loads (TMDLs) be prepared for listed waters. Both the list and the TMDLs are subject to US Environmental Protection Agency approval.

Acre-foot

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

Adfluvial

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

Algae

Nonvascular (without water-conducting tissue) aquatic plants that occur as single cells, colonies, or filaments.

Alluvium

Unconsolidated recent stream deposition.

Ambient

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

Anadromous

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

Anthropogenic

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

Aquatic

Occurring, growing, or living in water.

Aquifer

An underground, water-bearing layer or stratum of permeable rock, sand, or gravel capable of yielding water to wells or springs.

Assemblage (aquatic)

An association of interacting populations of organisms in a given water body; for example, a fish assemblage or a benthic macroinvertebrate assemblage (also see Community) (EPA 1996).

Assessment 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.

Batholith

A large body of intrusive igneous rock that has more than 40 square miles of surface exposure and no known floor. A batholith usually consists of coarse-grained rocks such as granite.

Beneficial Use

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

Beneficial Use Reconnaissance Program (BURP)

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

Benthic

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

Best Management Practices (BMPs)

Structural, nonstructural, or 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 interpreting 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).

Biota

The animal and plant life of a given region.

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 develop information about, and control the quality of, the nation's water resources.

Community

A group of interacting organisms living together in a given place.

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 US Environmental Protection Agency develops criteria guidance; states establish criteria.

Cubic Feet per Second (cfs)

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, one 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).

Dissolved Oxygen (DO)

The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.

Disturbance

Any event or series of events that disrupts ecosystem, community, or population structure and alters the physical environment.

Ecosystem

The interacting system of a biological community and its nonliving (abiotic) environmental surroundings.

Effluent

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

Endangered Species

Animals, birds, fish, plants, or other living organisms threatened with imminent extinction. Requirements for declaring a species as endangered are contained in the Endangered Species Act.

Environment

The complete range of external conditions, physical and biological, that affect a particular organism or community.

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 (IDAPA 58.01.02).

Flow

See Discharge.

Fully Supporting

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

Geographic Information Systems (GIS)

A georeferenced 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 emerges again as streamflow.

Growth Rate

A measure of how quickly something living will develop and grow, such as the amount of new plant or animal tissue produced per a given unit of time or number of individuals added to a population.

Habitat

The living place of an organism or community.

Headwater

The origin or beginning of a stream.

Hydrologic Basin

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

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, and 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, 4th-field hydrologic units have been more commonly called subbasins; 5th- and 6th-field hydrologic units have since been delineated for much of the country and are known as watersheds and subwatersheds, respectively.

Hydrologic Unit Code (HUC)

The number assigned to a hydrologic unit. Often used to refer to 4th-field hydrologic units.

Instantaneous

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

Intermittent Stream

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

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

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

Load Allocation (LA)
A portion of a water body's load capacity for a given pollutant that is allocated 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)
How much pollutant a water body can receive over a given period without causing violations of state water quality standards. Upon allocation to various sources, a margin of safety, and natural background contributions, it becomes a total maximum daily load.

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

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

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

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

Metric

1) A discrete measure of something, such as an ecological indicator (e.g., number of distinct taxon). 2) The metric system of measurement.

Monitoring

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

Mouth

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

National Pollutant Discharge Elimination System (NPDES)

A national program established by the Clean Water Act for permitting point sources of pollution. Discharge of pollution from point sources is not allowed without a permit.

Natural Condition

The condition that exists with little or no anthropogenic influence.

Nonpoint Source

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

Not Assessed (NA)

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

Not Fully Supporting

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

Nutrient

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

Parameter
A variable, measurable property whose value is a determinant of the characteristics of a system (e.g., temperature, dissolved oxygen, and fish populations are parameters of a stream or lake).

Perennial Stream
A stream that flows year-around in most years.

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

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

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

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

Population
A group of interbreeding organisms occupying a particular space; the number of humans or other living creatures in a designated area.

Potential Natural Vegetation (PNV)
A.U. Küchler (1964) defined potential natural vegetation as vegetation that would exist without human interference and if the resulting plant succession were projected to its climax condition while allowing for natural disturbance processes such as fire. Our use of the term reflects Küchler's definition in that riparian vegetation at PNV would produce a system potential level of shade on streams and includes recognition of some level of natural disturbance.

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

Qualitative
Descriptive of kind, type, or direction.

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 Condition
1) A condition that fully supports applicable beneficial uses with little impact 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.

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 create streams.

Sediments
Deposits of fragmented materials from weathered rocks and organic material that were suspended in, transported by, and eventually deposited by water or air.

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.

Stream

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

Stream Order

Hierarchical ordering of streams based on the degree of branching. A 1st-order stream is an unforked or unbranched stream. Under Strahler's (1957) system, higher-order streams result from the joining of two streams of the same order.

Stormwater Runoff

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

Stressors

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

Subbasin

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

Subbasin Assessment (SBA)

A watershed-based problem assessment that is the first step in developing a total maximum daily load in Idaho. Also refers to the written document that contains the assessment.

Subwatershed

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

Surface Runoff

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

Surface Water

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

Suspended Sediments

Fine material (usually sand size or smaller) that remains suspended by turbulence in the water column until deposited in areas of weaker current. These sediments cause turbidity and, when deposited, reduce living space within streambed gravels and can cover fish eggs or alevins.

Threatened Species

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

Total Maximum Daily Load (TMDL)

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

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 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 water body suitable for its designated uses. Criteria are based on specific levels of pollutants that would make the water harmful if used for drinking, swimming, farming, or industrial processes.

Water Quality Limited

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

Water Quality Standards

State-adopted and US Environmental Protection Agency-approved ambient standards for water bodies. The standards prescribe the use of the water body and establish the water quality criteria that must be met to protect designated uses.

Water Table

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

Watershed

1) All the land that 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 that contributes water to a point of interest in a water body.

Water Body Identification Number (WBID)

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

Wetland

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

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

Water Quality Standards Applicable to Salmonid Spawning Temperature

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

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

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

Natural Background Provisions

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

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

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

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Appendix B. Unit Conversion Chart

Table B-1. Metric–English unit conversions.

	English Units	Metric Units	To Convert	Example
Distance	Miles (mi)	Kilometers (km)	1 mi = 1.61 km 1 km = 0.62 mi	3 mi = 4.83 km 3 km = 1.86 mi
Length	Inches (in) Feet (ft)	Centimeters (cm) Meters (m)	1 in = 2.54 cm 1 cm = 0.39 in 1 ft = 0.30 m 1 m = 3.28 ft	3 in = 7.62 cm 3 cm = 1.18 in 3 ft = 0.91 m 3 m = 9.84 ft
Area	Acres (ac) Square feet (ft^2) Square miles (mi^2)	Hectares (ha) Square meters (m^2) Square kilometers (km^2)	1 ac = 0.40 ha 1 ha = 2.47 ac 1 ft^2 = 0.09 m^2 1 m^2 = 10.76 ft^2 1 mi^2 = 2.59 km^2 1 km^2 = 0.39 mi^2	3 ac = 1.20 ha 3 ha = 7.41 ac 3 ft^2 = 0.28 m^2 3 m^2 = 32.29 ft^2 3 mi^2 = 7.77 km^2 3 km^2 = 1.16 mi^2
Volume	Gallons (gal) Cubic feet (ft^3)	Liters (L) Cubic meters (m^3)	1 gal = 3.78 L 1 L= 0.26 gal 1 ft^3 = 0.03 m^3 1 m^3 = 35.32 ft^3	3 gal = 11.35 L 3 L = 0.79 gal 3 ft^3 = 0.09 m^3 3 m^3 = 105.94 ft^3
Flow Rate	Cubic feet per second (cfs)[a]	Cubic meters per second (m^3/sec)	1 cfs = 0.03 m^3/sec 1 m^3/sec = 35.31 cfs	3 cfs = 0.09 m^3/sec 3 m^3/sec = 105.94 cfs
Concentration	Parts per million (ppm)	Milligrams per liter (mg/L)	1 ppm = 1 mg/L[b]	3 ppm = 3 mg/L
Weight	Pounds (lb)	Kilograms (kg)	1 lb = 0.45 kg 1 kg = 2.20 lb	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 = 1.55 cfs.
[b] The ratio of 1 ppm = 1 mg/L is approximate and is only accurate for water.

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Appendix C. Data Sources and Data

Data Sources

Bank-Full Width Estimates

Load Analysis Tables

Target Shade Curves

Solar Pathfinder Locations

Temperature Data

Table C-1. Data sources for Upper Snake River/Rock Creek subbasin water bodies.

Water Body	Data Source	Type of Data	Collection Date
Clover, Cedar Draw, Mud, Cottonwood, Dry	DEQ Twin Falls Regional Office	Solar Pathfinder effective shade and stream width	2005, 2006
Clover/Calf, Cottonwood/McMullen, Dry, Mud, Cedar Draw	DEQ State Technical Services Office	Aerial photo interpretation of existing shade and stream width estimation	2009, 2011
Dry, McMullen, Donahue, North Cottonwood, Cottonwood, Cedar Draw, Mud, Clover, East Fork Clover	DEQ IDASA Database	Temperature	1999, 2001, 2006, 2011

Table C-2. Bank-full width estimates for the Upper Snake River/Rock Creek subbasin streams based on the Upper Snake Basin regional curve.

Location	Area (square miles)	Upper Snake (meter)	BURP data in meters (year collected)
Clover Creek @ Pioneer Reservoir	163.81	15	
Clover Creek ab Calf Creek	100.94	12	6.1 (1997)
Clover Creek bl Cottonwood Creek	70.28	10	1.9 (2003)
Clover Creek bl Squaw Creek	40.48	8	3.3 (1997), 6.2 (1997), 4.8 (2003)
Clover Creek bl 4th tributary	16.52	5	1.9 (2007), 3.25 (1997)
Clover Creek bl 2nd tributary	7.59	4	
Clover Creek bl Monument Gulch	5.02	3	
Clover Creek ab Monument Gulch	0.62	1	
Clover Creek @ mouth (Snake River)	278.93	19	4.9 (2002), 13.1 (1995)
Clover Creek bl Pioneer Reservoir	165.71	15	18.7 (1995)
Monument Gulch @ mouth	4.4	3	
2nd tributary to Clover Creek	1.9	2	
3rd tributary to Clover Creek	2.26	2	
4th tributary to Clover Creek	2.89	2	
5th tributary to Clover Creek	0.66	1	
6th tributary to Clover Creek	2.11	2	
Squaw Creek @ mouth	6.88	4	
Squaw Creek bl tributaries	4.08	3	
Squaw Creek ab tributaries	2.09	2	
Tributary to Squaw Creek	1.99	2	2.7 (1997)
Tributary to Squaw tributary	0.61	1	
Lye Lake Complex @ mouth	9.17	4	
Lye Lake Complex ab 2nd tributary	6.2	3	
Lye Lake Complex left fork	1.26	2	
Lye Lake Complex right fork	1.48	2	
2nd tributary to Lye Lake Complex	2.34	2	
White Arrow Complex @ mouth	5.14	3	
White Arrow Complex ab Rattler trib	3.35	3	
Rattler tributary	1.14	2	
Calf Creek @ mouth	42.55	8	2.7 (1997)
Calf Creek bl 4th tributary	22.46	6	
Calf Creek bl 2nd tributary	7.12	4	
Calf Creek ab 1st tributary	2.05	2	
1st tributary to Calf Creek	3.16	3	
2nd tributary to Calf Creek	0.88	1	

Location	Area (square miles)	Upper Snake (meter)	BURP data in meters (year collected)
3rd tributary to Calf Creek	5.21	3	
3rd tributary to Calf ab tributary	2.8	2	
Tributary to 3rd tributary	2.24	2	
4th tributary to Calf Creek	7.23	4	
4th tributary to Calf ab tributary	3.84	3	
Tributary to 4th tributary	1.21	2	
5th tributary to Calf Creek	10.42	4	
5th tributary to Calf bl trib	7.5	4	
5th tributary to Calf ab trib	4.96	3	
Tributary to 5th tributary	2.5	2	
6th tributary to Calf Creek (un-attached)	0.88	1	
Cottonwood Creek @ mouth (Rock Cr)	82.35	11	
Cottonwood Creek ab McMullen Creek	55.22	9	
N. Cottonwood Creek bl 2nd tributary	11.24	5	
N. Cottonwood Creek ab 1st tributary	6.5	4	
N. Cottonwood Creek ab Williams Res.	2.61	2	
1st tributary to North Cottonwood Cr	0.71	1	
2nd tributary to N. Cottonwood Creek	3.1	3	
2nd tributary to N. Cottonwood ab trib	1.62	2	
Tributary to 2nd tributary	1.42	2	
Dry Cottonwood Cr @ end point	7.79	4	
Dry Cottonwood Cr ab Burnt Cr	4.45	3	
Burnt Creek @ mouth	1.11	2	
2nd tributary to Dry Cottonwood Cr	2.78	2	
4th tributary to N. Cottonwood Cr	0.2	1	
5th trib un-attached (left)	5.65	3	
Left fork 5th tributary	1.88	2	
Right fork 5th tributary	2.84	2	
6th trib un-attached @ endpoint	2.25	2	
Left fork 6th tributary	1.47	2	
Right fork 6th tributary	0.73	1	
McMullen Creek @ mouth	25.78	7	
McMullen Creek bl N. Willow Springs	17.51	6	
McMullen Creek bl Donahue Creek	8.05	4	2.8 (1997), 3.7 (2002) ab Donahue
McMullen Creek ab 1st tributary	1.55	2	1.6 (1997)
1st tributary to McMullen Creek	1.48	2	
Donahue Creek @ mouth	2.97	3	

Location	Area (square miles)	Upper Snake (meter)	BURP data in meters (year collected)
2nd tributary to McMullen Creek	2.29	2	
2nd tributary bl forks	1.83	2	
Left fork 2nd tributary	1.14	2	
Right fork 2nd tributary	0.69	1	
3rd tributary to McMullen Creek	0.28	1	
N. Willow Springs Creek @ mouth	4.13	3	
N. Willow Springs Creek ab tributary	1.02	2	
to North Willow Springs	0.72	1	
5th tributary to McMullen Creek	1.06	2	
6th tributary to McMullen Creek	1.45	2	
7th tributary to McMullen Creek	0.34	1	
8th tributary to McMullen Creek	0.88	1	
1st un-attached tributary nr McMullen	0.86	1	
Dry Gulch @ endpoint	7.83	4	
Dry Gulch ab 2nd tributary	4.41	3	
Dry Gulch ab 1st tributary	2.2	2	
1st tributary to Dry Gulch	1.05	2	
2nd tributary to Dry Gulch	0.64	1	
3rd tributary (un-attached) to Dry Gulch	0.51	1	
Dry Creek @ mouth (Snake River)	228.91	17	3.1 (1995)
Dry Creek ab Murtaugh Lake	61.88	10	
Dry Creek bl EF Dry Creek	35.37	8	
EF Dry Creek @ mouth	13.97	5	2.7 (2003)
WF Dry Creek @ mouth	9.87	4	
MF Dry Creek @ mouth	9.92	4	
Cedar Draw @ mouth (Snake River)	115.83	13	11.1 (1997)
Cedar Draw ab Lowline Canal	95.28	12	
Cedar Draw bl Desert Creek	91.11	11	
Cedar Draw ab Desert Creek	0.82	1	
Mud Creek @ mouth (Snake River)	66.13	10	6.7 (1997)
Mud Creek @ Hwy 30 bend	10.55	4	

Note: All assessment unit (AU) numbers start with ID17040212SK in all load tables (Tables C-3 through C-15). Significant figures are controlled by the lowest level in the calculation, typically that of the channel width. Some rounding errors may result.

Table C-3. Existing and target solar loads for Calf Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
040_03	Calf Creek	1	550	yellow willow	89%	0.69	1	600	400	80%	1.25	1	600	800	400	-9%
040_03	Calf Creek	2	1670		73%	1.69	2	3,000	5,000	70%	1.88	2	3,000	6,000	1,000	-3%
040_03	Calf Creek	3	610		73%	1.69	2	1,000	2,000	60%	2.51	2	1,000	3,000	1,000	-13%
040_03	Calf Creek	4	550		56%	2.76	3	2,000	6,000	60%	2.51	3	2,000	5,000	(1,000)	0%
040_03	Calf Creek	5	790		56%	2.76	3	2,000	6,000	40%	3.76	3	2,000	8,000	2,000	-16%
040_03	Calf Creek	6	890	sandbar willow	58%	2.63	4	4,000	10,000	40%	3.76	4	4,000	20,000	10,000	-18%
040_03	Calf Creek	7	2060		50%	3.14	5	10,000	30,000	30%	4.39	5	10,000	40,000	10,000	-20%
							Totals		59,000					83,000	23,000	

Table C-4. Existing and target solar loads for Calf Creek tributaries.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
040_02	trib to 3rd trib	1	400	yellow willow	73%	1.69	2	800	1,000	70%	1.88	2	800	2,000	1,000	-3%
040_02	5th trib to Calf	1	400	yellow willow	46%	3.39	4	2,000	7,000	60%	2.51	4	2,000	5,000	(2,000)	0%
040_02	5th trib to Calf	2	320	yellow willow	46%	3.39	4	1,000	3,000	50%	3.14	4	1,000	3,000	0	0%
040_02	5th trib to Calf	3	260	water	0%	6.27	100	26,000	163,000	0%	6.27	100	26,000	163,000	0	0%
040_02	5th trib to Calf	4	310	sandbar willow	58%	2.63	4	1,000	3,000	60%	2.51	4	1,000	3,000	0	0%
							Totals		180,000					180,000	-1,000	

Table C-5. Existing and target solar loads for upper Clover Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
036_02	Clover Creek	1	480	yellow williow	89%	0.69	1	500	300	80%	1.25	1	500	600	300	-9%
036_02	Clover Creek	2	410		89%	0.69	1	400	300	50%	3.14	1	400	1,000	700	-39%
036_02	Clover Creek	3	250		89%	0.69	1	300	200	70%	1.88	1	300	600	400	-19%
036_02	Clover Creek	4	150		89%	0.69	1	200	100	40%	3.76	1	200	800	700	-49%
036_02	Clover Creek	5	280		89%	0.69	1	300	200	70%	1.88	1	300	600	400	-19%
036_02	Clover Creek	6	410		89%	0.69	1	400	300	50%	3.14	1	400	1,000	700	-39%
036_02	Clover Creek	7	520		89%	0.69	1	500	300	20%	5.02	7	4,000	20,000	20,000	-69%
036_02	Clover Creek	8	250		89%	0.69	1	300	200	80%	1.25	1	300	400	200	-9%
036_02	Clover Creek	9	380		89%	0.69	1	400	300	50%	3.14	1	400	1,000	700	-39%
036_02	Clover Creek	10	250	beaver ponds	89%	0.69	1	300	200	30%	4.39	15	4,000	20,000	20,000	-59%
036_02	Clover Creek	11	610		89%	0.69	1	600	400	80%	1.25	1	600	800	400	-9%
036_02	Clover Creek	12	880		89%	0.69	1	900	600	70%	1.88	1	900	2,000	1,000	-19%
036_02	Clover Creek	13	1700		89%	0.69	1	2,000	1,000	40%	3.76	1	2,000	8,000	7,000	-49%
036_03	Clover Creek	1	930		73%	1.69	2	2,000	3,000	70%	1.88	2	2,000	4,000	1,000	-3%
036_04	Clover Creek	1	1400		73%	1.69	2	3,000	5,000	70%	1.88	2	3,000	6,000	1,000	-3%
036_04	Clover Creek	2	1200		73%	1.69	2	2,000	3,000	50%	3.14	2	2,000	6,000	3,000	-23%
036_04	Clover Creek	3	620		73%	1.69	2	1,000	2,000	20%	5.02	2	1,000	5,000	3,000	-53%
036_04	Clover Creek	4	450		73%	1.69	2	900	2,000	60%	2.51	2	900	2,000	0	-13%
036_04	Clover Creek	5	610		73%	1.69	2	1,000	2,000	50%	3.14	2	1,000	3,000	1,000	-23%
036_04	Clover Creek	6	2200		73%	1.69	2	4,000	7,000	80%	1.25	2	4,000	5,000	(2,000)	0%
036_04	Clover Creek	7	370		56%	2.76	3	1,000	3,000	60%	2.51	3	1,000	3,000	0	0%
036_04	Clover Creek	8	1800		56%	2.76	3	5,000	10,000	50%	3.14	3	5,000	20,000	10,000	-6%
036_04	Clover Creek	9	2000		56%	2.76	3	6,000	20,000	40%	3.76	3	6,000	20,000	0	-16%
036_04	Clover Creek	10	2200		56%	2.76	3	7,000	20,000	50%	3.14	3	7,000	20,000	0	-6%
036_04	Clover Creek	11	4300	sandbar willow	58%	2.63	4	20,000	50,000	50%	3.14	4	20,000	60,000	10,000	-8%
036_04	Clover Creek	12	430		58%	2.63	4	2,000	5,000	20%	5.02	6	3,000	20,000	20,000	-38%
036_04	Clover Creek	13	1700		58%	2.63	4	7,000	20,000	40%	3.76	4	7,000	30,000	10,000	-18%
036_04	Clover Creek	14	1700		58%	2.63	4	7,000	20,000	20%	5.02	6	10,000	50,000	30,000	-38%
036_04	Clover Creek	15	280		50%	3.14	5	1,000	3,000	40%	3.76	5	1,000	4,000	1,000	-10%
036_04	Clover Creek	16	150		50%	3.14	5	800	3,000	20%	5.02	5	800	4,000	1,000	-30%
036_04	Clover Creek	17	400		50%	3.14	5	2,000	6,000	50%	3.14	5	2,000	6,000	0	0%
036_04	Clover Creek	18	600		50%	3.14	5	3,000	9,000	10%	5.64	5	3,000	20,000	10,000	-40%
036_04	Clover Creek	19	160		50%	3.14	5	800	3,000	20%	5.02	5	800	4,000	1,000	-30%
036_04	Clover Creek	20	310	water birch	73%	1.69	5	2,000	3,000	30%	4.39	5	2,000	9,000	6,000	-43%
036_04	Clover Creek	21	500		73%	1.69	5	3,000	5,000	60%	2.51	5	3,000	8,000	3,000	-13%
036_04	Clover Creek	22	930		73%	1.69	5	5,000	8,000	20%	5.02	5	5,000	30,000	20,000	-53%
036_04	Clover Creek	23	570		58%	2.63	7	4,000	10,000	50%	3.14	6	3,000	9,000	(1,000)	-8%
036_04	Clover Creek	24	630		58%	2.63	7	4,000	10,000	0%	6.27	7	4,000	30,000	20,000	-58%
036_04	Clover Creek	25	1000		58%	2.63	7	7,000	20,000	40%	3.76	7	7,000	30,000	10,000	-18%
036_04	Clover Creek	26	3000		53%	2.95	8	20,000	60,000	50%	3.14	8	20,000	60,000	0	-3%
036_04	Clover Creek	27	700		48%	3.26	9	6,000	20,000	30%	4.39	9	6,000	30,000	10,000	-18%
036_04	Clover Creek	28	350		48%	3.26	9	3,000	10,000	20%	5.02	9	3,000	20,000	10,000	-28%
036_04	Clover Creek	29	3300		44%	3.51	10	33,000	120,000	20%	5.02	10	33,000	170,000	50,000	-24%
036_04	Clover Creek	30	600		41%	3.70	11	6,600	24,000	30%	4.39	11	6,600	29,000	5,000	-11%
036_04	Clover Creek	31	650		41%	3.70	11	7,200	27,000	40%	3.76	11	7,200	27,000	0	-1%
036_04	Clover Creek	32	1000		41%	3.70	11	11,000	41,000	10%	5.64	11	11,000	62,000	21,000	-31%
036_04	Clover Creek	33	180		38%	3.89	12	2,200	8,600	30%	4.39	12	2,200	9,700	1,100	-8%
036_04	Clover Creek	34	1680		38%	3.89	12	20,000	78,000	10%	5.64	12	20,000	110,000	32,000	-28%
							Totals		650,000					980,000	340,000	

Table C-6. Existing and target solar loads for upper Clover Creek tributaries.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
036_02	Monument Gulch	1	100	Geyers/sedge	93%	0.44	1	100	40	90%	0.63	1	100	60	20	-3%
036_02	Monument Gulch	2	290		93%	0.44	1	300	100	70%	1.88	1	300	600	500	-23%
036_02	Monument Gulch	3	130		93%	0.44	1	100	40	90%	0.63	1	100	60	20	-3%
036_02	Monument Gulch	4	630		82%	1.13	2	1,000	1,000	50%	3.14	2	1,000	3,000	2,000	-32%
036_02	Monument Gulch	5	300		82%	1.13	2	600	700	90%	0.63	2	600	400	(300)	0%
036_02	Monument Gulch	6	300		82%	1.13	2	600	700	60%	2.51	2	600	2,000	1,000	-22%
036_02	Monument Gulch	7	120		82%	1.13	2	200	200	20%	5.02	2	200	1,000	800	-62%
036_02	Monument Gulch	8	130		82%	1.13	2	300	300	70%	1.88	2	300	600	300	-12%
036_02	Monument Gulch	9	130		82%	1.13	2	300	300	50%	3.14	2	300	900	600	-32%
036_02	2nd tributary	1	760		93%	0.44	1	800	400	90%	0.63	1	800	500	100	-3%
036_02	2nd tributary	2	310		82%	1.13	2	600	700	70%	1.88	2	600	1,000	300	-12%
036_02	2nd tributary	3	160	yellow willow	73%	1.69	2	300	500	60%	2.51	2	300	800	300	-13%
036_02	2nd tributary	4	130		73%	1.69	2	300	500	90%	0.63	2	300	200	(300)	0%
036_02	3rd tributary	1	60		73%	1.69	2	100	200	80%	1.25	2	100	100	(100)	0%
036_02	4th tributary	1	310	Geyers/sedge	93%	0.44	1	300	100	90%	0.63	1	300	200	100	-3%
036_02	4th tributary	2	120		93%	0.44	1	100	40	70%	1.88	1	100	200	200	-23%
036_02	4th tributary	3	90		93%	0.44	1	90	40	90%	0.63	1	90	60	20	-3%
036_02	4th tributary	4	100		93%	0.44	1	100	40	80%	1.25	1	100	100	60	-13%
036_02	4th tributary	5	420	yellow willow	73%	1.69	2	800	1,000	70%	1.88	2	800	2,000	1,000	-3%
036_02	4th tributary	6	700		73%	1.69	2	1,000	2,000	70%	1.88	2	1,000	2,000	0	-3%
036_02	4th tributary	7	190		73%	1.69	2	400	700	90%	0.63	2	400	300	(400)	0%
036_02	5th tributary	1	210		89%	0.69	1	200	100	90%	0.63	1	200	100	0	0%
036_02	6th tributary	1	100		73%	1.69	2	200	300	80%	1.25	2	200	300	0	0%
036_02	Squaw Creek	1	150		73%	1.69	2	300	500	80%	1.25	2	300	400	(100)	0%
036_02	Squaw Creek	2	210		73%	1.69	2	400	700	70%	1.88	2	400	800	100	-3%
036_02	Squaw Creek	3	270		73%	1.69	2	500	800	80%	1.25	2	500	600	(200)	0%
036_02	Squaw Creek	4	4900		56%	2.76	3	10,000	30,000	80%	1.25	3	10,000	10,000	(20,000)	0%
036_02	Squaw Creek	5	180		46%	3.39	4	700	2,000	50%	3.14	4	700	2,000	0	0%
036_02	Squaw Creek	6	1200		46%	3.39	4	5,000	20,000	70%	1.88	4	5,000	9,000	(10,000)	0%
036_02	trib to Squaw Cr	1	120		89%	0.69	1	100	70	90%	0.63	1	100	60	(10)	0%
036_02	trib to Squaw Cr	2	50		89%	0.69	1	50	30	90%	0.63	1	50	30	0	0%
036_02	trib to Squaw Cr	3	90		89%	0.69	1	90	60	90%	0.63	1	90	60	0	0%
036_02	trib to Squaw Cr	4	100		89%	0.69	1	100	70	90%	0.63	1	100	60	(10)	0%
036_02	trib to Squaw Cr	5	1500		73%	1.69	2	3,000	5,000	90%	0.63	2	3,000	2,000	(3,000)	0%
036_02	trib to Squaw Cr	6	180		73%	1.69	2	400	700	80%	1.25	2	400	500	(200)	0%
036_02	trib to Squaw Cr	7	240		73%	1.69	2	500	800	90%	0.63	2	500	300	(500)	0%
036_02	trib to Squaw trib	1	360		89%	0.69	1	400	300	90%	0.63	1	400	300	0	0%
036_02	trib to Squaw trib	2	180		89%	0.69	1	200	100	90%	0.63	1	200	100	0	0%
036_02	trib to Squaw trib	3	230		89%	0.69	1	200	100	80%	1.25	1	200	300	200	-9%

Table C-6 (cont.). Existing and target solar loads for upper Clover Creek tributaries.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
036_02	Lye Lake tribs	1	1500	sandbar willow	70%	1.88	3	5,000	9,000	40%	3.76	3	5,000	20,000	10,000	-30%
036_02	Lye Lake tribs	2	700		58%	2.63	4	3,000	8,000	30%	4.39	4	3,000	10,000	2,000	-28%
036_02	Lye Lake tribs	3	370		58%	2.63	4	1,000	3,000	40%	3.76	4	1,000	4,000	1,000	-18%
036_02	White Arrow tribs	1	480		87%	0.82	2	1,000	800	70%	1.88	2	1,000	2,000	1,000	-17%
036_02	White Arrow tribs	2	120		70%	1.88	3	400	800	80%	1.25	3	400	500	(300)	0%
036_02	White Arrow tribs	3	970		70%	1.88	3	3,000	6,000	20%	5.02	3	3,000	20,000	10,000	-50%
036_02	White Arrow tribs	4	1200		70%	1.88	3	4,000	8,000	30%	4.39	3	4,000	20,000	10,000	-40%
036_02	Cold Spring Complex	1	250	meadow	8%	5.77	10	2,500	14,000	10%	5.64	10	2,500	14,000	0	0%
036_02	Cold Spring Complex	2	340	sandbar willow	29%	4.45	10	3,400	15,000	30%	4.39	10	3,400	15,000	0	0%
036_02	Cold Spring Complex	3	460		70%	1.88	3	1,000	2,000	70%	1.88	3	1,000	2,000	0	0%
036_02	Cold Spring Complex	4	300		44%	3.51	6	2,000	7,000	50%	3.14	6	2,000	6,000	(1,000)	0%
036_02	Cold Spring Complex	5	250		44%	3.51	6	2,000	7,000	50%	3.14	6	2,000	6,000	(1,000)	0%
036_02	Cold Spring Complex	6	430		44%	3.51	6	3,000	10,000	10%	5.64	6	3,000	20,000	10,000	-34%
036_02	Cold Spring Complex	7	190		44%	3.51	6	1,000	4,000	40%	3.76	6	1,000	4,000	0	-4%
036_02	Cold Spring Complex	8	220		70%	1.88	3	700	1,000	80%	1.25	3	700	900	(100)	0%
036_02	Cold Spring Complex	9	150		70%	1.88	3	500	900	50%	3.14	3	500	2,000	1,000	-20%
036_02	Cold Spring Complex	10	430		70%	1.88	3	1,000	2,000	30%	4.39	3	1,000	4,000	2,000	-40%
036_02	Cold Spring Complex	1	270		70%	1.88	3	800	2,000	70%	1.88	3	800	2,000	0	0%
036_02	Cold Spring Complex	2	50		70%	1.88	3	200	400	70%	1.88	3	200	400	0	0%
036_02	Cold Spring Complex	1	80		70%	1.88	3	200	400	80%	1.25	3	200	300	(100)	0%
036_02	Cold Spring Complex	2	150		70%	1.88	3	500	900	10%	5.64	3	500	3,000	2,000	-60%
036_02	Cold Spring Complex	3	370		70%	1.88	3	1,000	2,000	70%	1.88	3	1,000	2,000	0	0%
036_02	Cold Spring Complex	4	580		70%	1.88	3	2,000	4,000	40%	3.76	3	2,000	8,000	4,000	-30%
036_02	Cold Spring Complex	5	120		70%	1.88	3	400	800	50%	3.14	3	400	1,000	200	-20%
036_02	Cold Spring Complex	6	350		70%	1.88	3	1,000	2,000	30%	4.39	3	1,000	4,000	2,000	-40%
036_02	Cold Spring Complex	7	340		70%	1.88	3	1,000	2,000	10%	5.64	3	1,000	6,000	4,000	-60%
036_02	Cold Spring Complex	8	210		70%	1.88	3	600	1,000	20%	5.02	3	600	3,000	2,000	-50%
036_02	Cold Spring Complex	9	320		70%	1.88	3	1,000	2,000	40%	3.76	3	1,000	4,000	2,000	-30%
036_02	Cold Spring Complex	10	410		70%	1.88	3	1,000	2,000	20%	5.02	3	1,000	5,000	3,000	-50%
036_02	Cold Spring Complex	11	1800		70%	1.88	3	5,000	9,000	40%	3.76	3	5,000	20,000	10,000	-30%
036_02	Cold Spring Complex	12	770		70%	1.88	3	2,000	4,000	30%	4.39	3	2,000	9,000	5,000	-40%
036_02	Cold Spring Complex	13	560		70%	1.88	3	2,000	4,000	50%	3.14	3	2,000	6,000	2,000	-20%
036_02	Cold Spring Complex	14	170		70%	1.88	3	500	900	20%	5.02	3	500	3,000	2,000	-50%
036_02	Cold Spring Complex	15	190		70%	1.88	3	600	1,000	50%	3.14	3	600	2,000	1,000	-20%
							Totals		210,000					270,000	56,000	

Table C-7. Existing and target solar loads for lower Clover Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
034_04	Clover Creek	1	380	water birch	44%	3.51	10	3,300	12,000	30%	4.39	10	3,300	14,000	2,000	-14%
034_04	Clover Creek	2	780		44%	3.51	10	7,800	27,000	40%	3.76	10	7,800	29,000	2,000	-4%
034_04	Clover Creek	3	1020		44%	3.51	10	10,000	35,000	50%	3.14	10	10,000	31,000	(4,000)	0%
034_04	Clover Creek	4	320		44%	3.51	10	3,200	11,000	20%	5.02	10	3,200	16,000	5,000	-24%
034_04	Clover Creek	5	2400		41%	3.70	11	26,000	96,000	30%	4.39	11	26,000	110,000	14,000	-11%
034_04	Clover Creek	6	510		38%	3.89	12	6,100	24,000	40%	3.76	12	6,100	23,000	(1,000)	0%
034_04	Clover Creek	7	2600		38%	3.89	12	31,000	120,000	30%	4.39	12	31,000	140,000	20,000	-8%
034_04	Clover Creek	8	1000		36%	4.01	13	13,000	52,000	40%	3.76	13	13,000	49,000	(3,000)	0%
034_04	Clover Creek	9	1500		36%	4.01	13	20,000	80,000	20%	5.02	13	20,000	100,000	20,000	-16%
034_04	Clover Creek	10	660	cottonwood	59%	2.57	14	9,200	24,000	50%	3.14	14	9,200	29,000	5,000	-9%
034_04	Clover Creek	11	950		59%	2.57	14	13,000	33,000	20%	5.02	14	13,000	65,000	32,000	-39%
034_04	Clover Creek	12	180		59%	2.57	14	2,500	6,400	30%	4.39	14	2,500	11,000	4,600	-29%
034_04	Clover Creek	13	340		59%	2.57	14	4,800	12,000	10%	5.64	14	4,800	27,000	15,000	-49%
							Totals		530,000					640,000	110,000	

Table C-8. Existing and target solar loads for Mud Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/ day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/ day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
011_02	Mud Creek	1	1300	yellow willow	89%	0.69	1	1,000	700	10%	5.64	1	1,000	6,000	5,000	-79%
011_02	Mud Creek	2	90		89%	0.69	1	90	60	90%	0.63	1	90	60	0	0%
011_02	Mud Creek	3	120		89%	0.69	1	100	70	60%	2.51	1	100	300	200	-29%
011_02	Mud Creek	4	480		89%	0.69	1	500	300	10%	5.64	1	500	3,000	3,000	-79%
011_02	Mud Creek	5	1150		89%	0.69	1	1,000	700	30%	4.39	1	1,000	4,000	3,000	-59%
011_02	Mud Creek	6	180		89%	0.69	1	200	100	70%	1.88	1	200	400	300	-19%
011_02	Mud Creek	7	1780		89%	0.69	1	2,000	1,000	10%	5.64	1	2,000	10,000	9,000	-79%
011_02	Mud Creek	8	100		73%	1.69	2	200	300	40%	3.76	2	200	800	500	-33%
011_02	Mud Creek	9	90		73%	1.69	2	200	300	10%	5.64	2	200	1,000	700	-63%
011_02	Mud Creek	10	80		73%	1.69	2	200	300	50%	3.14	2	200	600	300	-23%
011_02	Mud Creek	11	520		73%	1.69	2	1,000	2,000	10%	5.64	2	1,000	6,000	4,000	-63%
011_02	Mud Creek	12	410		73%	1.69	2	800	1,000	40%	3.76	2	800	3,000	2,000	-33%
011_02	Mud Creek	13	1840		56%	2.76	3	6,000	20,000	10%	5.64	3	6,000	30,000	10,000	-46%
011_02	Mud Creek	14	400		56%	2.76	3	1,000	3,000	20%	5.02	3	1,000	5,000	2,000	-36%
011_02	Mud Creek	15	210		56%	2.76	3	600	2,000	50%	3.14	3	600	2,000	0	-6%
011_02	Mud Creek	16	50		56%	2.76	3	200	600	10%	5.64	3	200	1,000	400	-46%
010_02	Mud Creek	1	120		46%	3.39	4	500	2,000	30%	4.39	4	500	2,000	0	-16%
010_02	Mud Creek	2	440		46%	3.39	4	2,000	7,000	60%	2.51	4	2,000	5,000	(2,000)	0%
010_02	Mud Creek	3	290		46%	3.39	4	1,000	3,000	30%	4.39	4	1,000	4,000	1,000	-16%
010_02	Mud Creek	4	130		46%	3.39	4	500	2,000	60%	2.51	4	500	1,000	(1,000)	0%
010_02	Mud Creek	5	110		46%	3.39	4	400	1,000	20%	5.02	4	400	2,000	1,000	-26%
010_02	Mud Creek	6	580	water birch	73%	1.69	5	3,000	5,000	50%	3.14	5	3,000	9,000	4,000	-23%
010_02	Mud Creek	7	460		73%	1.69	5	2,000	3,000	30%	4.39	5	2,000	9,000	6,000	-43%
010_02	Mud Creek	8	550		73%	1.69	5	3,000	5,000	60%	2.51	5	3,000	8,000	3,000	-13%
010_02	Mud Creek	9	600		73%	1.69	5	3,000	5,000	80%	1.25	5	3,000	4,000	(1,000)	0%
010_02	Mud Creek	10	140		73%	1.69	5	700	1,000	30%	4.39	5	700	3,000	2,000	-43%
010_02	Mud Creek	11	540		73%	1.69	5	3,000	5,000	60%	2.51	5	3,000	8,000	3,000	-13%
010_02	Mud Creek	12	350		73%	1.69	5	2,000	3,000	20%	5.02	5	2,000	10,000	7,000	-53%
010_02	Mud Creek	13	150		73%	1.69	5	800	1,000	40%	3.76	5	800	3,000	2,000	-33%
010_02	Mud Creek	14	130		65%	2.19	6	800	2,000	40%	3.76	6	800	3,000	1,000	-25%
010_02	Mud Creek	15	370		65%	2.19	6	2,000	4,000	60%	2.51	6	2,000	5,000	1,000	-5%
010_02	Mud Creek	16	200		65%	2.19	6	1,000	2,000	30%	4.39	6	1,000	4,000	2,000	-35%
010_02	Mud Creek	17	500		65%	2.19	6	3,000	7,000	60%	2.51	6	3,000	8,000	1,000	-5%
010_02	Mud Creek	18	220		65%	2.19	6	1,000	2,000	30%	4.39	6	1,000	4,000	2,000	-35%
010_02	Mud Creek	19	640		65%	2.19	6	4,000	9,000	50%	3.14	6	4,000	10,000	1,000	-15%
010_02	Mud Creek	20	80		65%	2.19	6	500	1,000	20%	5.02	6	500	3,000	2,000	-45%
010_02	Mud Creek	21	810		65%	2.19	6	5,000	10,000	50%	3.14	6	5,000	20,000	10,000	-15%
010_02	Mud Creek	22	120		58%	2.63	7	800	2,000	30%	4.39	7	800	4,000	2,000	-28%
010_02	Mud Creek	23	660		58%	2.63	7	5,000	10,000	40%	3.76	7	5,000	20,000	10,000	-18%
010_02	Mud Creek	24	460		58%	2.63	7	3,000	8,000	50%	3.14	7	3,000	9,000	1,000	-8%
010_03	Mud Creek	1	1210		58%	2.63	7	8,000	20,000	50%	3.14	7	8,000	30,000	10,000	-8%
010_03	Mud Creek	2	520		58%	2.63	7	4,000	10,000	40%	3.76	7	4,000	20,000	10,000	-18%
							Totals		160,000					280,000	120,000	

Table C-9. Existing and target solar loads for Cedar Draw Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/ day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/ day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
012_02	Cedar Draw	1	580	yellow willow	46%	3.39	4	2,000	7,000	40%	3.76	4	2,000	8,000	1,000	-6%
012_02	Cedar Draw	2	90		46%	3.39	4	400	1,000	0%	6.27	60	5,000	30,000	30,000	-46%
012_02	Cedar Draw	3	190		46%	3.39	4	800	3,000	90%	0.63	4	800	500	(3,000)	44%
012_02	Cedar Draw	4	280		46%	3.39	4	1,000	3,000	60%	2.51	4	1,000	3,000	0	0%
012_02	Cedar Draw	5	960		46%	3.39	4	4,000	10,000	20%	5.02	4	4,000	20,000	10,000	-26%
012_02	Cedar Draw	6	510		46%	3.39	4	2,000	7,000	30%	4.39	4	2,000	9,000	2,000	-16%
012_02	Cedar Draw	7	320		46%	3.39	4	1,000	3,000	20%	5.02	4	1,000	5,000	2,000	-26%
012_02	Cedar Draw	8	520		46%	3.39	4	2,000	7,000	10%	5.64	4	2,000	10,000	3,000	-36%
012_02	Cedar Draw	9	470	water birch	73%	1.69	5	2,000	3,000	70%	1.88	5	2,000	4,000	1,000	-3%
012_02	Cedar Draw	10	360		73%	1.69	5	2,000	3,000	30%	4.39	5	2,000	9,000	6,000	-43%
012_02	Cedar Draw	11	180		73%	1.69	5	900	2,000	50%	3.14	5	900	3,000	1,000	-23%
012_02	Cedar Draw	12	60		73%	1.69	5	300	500	10%	5.64	5	300	2,000	2,000	-63%
012_02	Cedar Draw	13	180		73%	1.69	5	900	2,000	60%	2.51	5	900	2,000	0	-13%
012_02	Cedar Draw	14	310		73%	1.69	5	2,000	3,000	20%	5.02	5	2,000	10,000	7,000	-53%
012_02	Cedar Draw	15	180		73%	1.69	5	900	2,000	90%	0.63	5	900	600	(1,000)	0%
012_02	Cedar Draw	16	520		65%	2.19	6	3,000	7,000	60%	2.51	6	3,000	8,000	1,000	-5%
012_02	Cedar Draw	17	490		65%	2.19	6	3,000	7,000	50%	3.14	6	3,000	9,000	2,000	-15%
012_02	Cedar Draw	18	1150		65%	2.19	6	7,000	20,000	60%	2.51	6	7,000	20,000	0	-5%
012_02	Cedar Draw	19	640		65%	2.19	6	4,000	9,000	50%	3.14	6	4,000	10,000	1,000	-15%
012_02	Cedar Draw	20	550		65%	2.19	6	3,000	7,000	20%	5.02	6	3,000	20,000	10,000	-45%
012_02	Cedar Draw	21	410		65%	2.19	6	2,000	4,000	50%	3.14	6	2,000	6,000	2,000	-15%
012_02	Cedar Draw	22	280		58%	2.63	7	2,000	5,000	10%	5.64	7	2,000	10,000	5,000	-48%
012_02	Cedar Draw	23	350		58%	2.63	7	2,000	5,000	50%	3.14	7	2,000	6,000	1,000	-8%
012_02	Cedar Draw	24	270		58%	2.63	7	2,000	5,000	30%	4.39	7	2,000	9,000	4,000	-28%
012_02	Cedar Draw	25	470		58%	2.63	7	3,000	8,000	50%	3.14	7	3,000	9,000	1,000	-8%
012_02	Cedar Draw	26	230		58%	2.63	7	2,000	5,000	40%	3.76	7	2,000	8,000	3,000	-18%
012_02	Cedar Draw	27	150		58%	2.63	7	1,000	3,000	60%	2.51	7	1,000	3,000	0	0%
012_02	Cedar Draw	28	350		58%	2.63	7	2,000	5,000	10%	5.64	7	2,000	10,000	5,000	-48%
012_02	Cedar Draw	29	300		58%	2.63	7	2,000	5,000	50%	3.14	7	2,000	6,000	1,000	-8%
012_02	Cedar Draw	30	270		53%	2.95	8	2,000	6,000	20%	5.02	8	2,000	10,000	4,000	-33%
012_02	Cedar Draw	31	130		53%	2.95	8	1,000	3,000	50%	3.14	8	1,000	3,000	0	-3%
012_02	Cedar Draw	32	90		53%	2.95	8	700	2,000	10%	5.64	8	700	4,000	2,000	-43%
012_02	Cedar Draw	33	150		53%	2.95	8	1,000	3,000	50%	3.14	8	1,000	3,000	0	-3%
012_02	Cedar Draw	34	2120		53%	2.95	8	20,000	60,000	10%	5.64	8	20,000	100,000	40,000	-43%
012_02	Cedar Draw	35	730		48%	3.26	9	7,000	20,000	20%	5.02	9	7,000	40,000	20,000	-28%
012_02	Cedar Draw	36	260		48%	3.26	9	2,000	7,000	10%	5.64	9	2,000	10,000	3,000	-38%
012_02	Cedar Draw	37	520		48%	3.26	9	5,000	20,000	20%	5.02	9	5,000	30,000	10,000	-28%
012_02	Cedar Draw	38	160		48%	3.26	9	1,000	3,000	10%	5.64	9	1,000	6,000	3,000	-38%
012_02	Cedar Draw	39	270		48%	3.26	9	2,000	7,000	30%	4.39	9	2,000	9,000	2,000	-18%
012_02	Cedar Draw	40	500		48%	3.26	9	5,000	20,000	0%	6.27	9	5,000	30,000	10,000	-48%
012_02	Cedar Draw	41	240		48%	3.26	9	2,000	7,000	30%	4.39	9	2,000	9,000	2,000	-18%
012_02	Cedar Draw	42	970		44%	3.51	10	9,700	34,000	30%	4.39	10	9,700	43,000	9,000	-14%
012_02	Cedar Draw	43	200		44%	3.51	10	2,000	7,000	40%	3.76	10	2,000	7,500	500	-4%
012_03	Cedar Draw	1	3310		44%	3.51	10	33,000	120,000	10%	5.64	10	33,000	190,000	70,000	-34%
012_03	Cedar Draw	2	460		41%	3.70	11	5,100	19,000	20%	5.02	11	5,100	26,000	7,000	-21%
012_03	Cedar Draw	3	490		41%	3.70	11	5,400	20,000	30%	4.39	11	5,400	24,000	4,000	-11%
012_03	Cedar Draw	4	560		41%	3.70	11	6,200	23,000	20%	5.02	11	6,200	31,000	8,000	-21%
							Totals		530,000					830,000	290,000	

Table C-10. Existing and target solar loads for Cottonwood Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
014_02	N. Cottonwood Cr	1	920	PVG 10	96%	0.25	1	900	200	90%	0.63	1	900	600	400	-6%
014_02	N. Cottonwood Cr	2	1000		96%	0.25	1	1,000	300	80%	1.25	1	1,000	1,000	700	-16%
014_02	N. Cottonwood Cr	3	1300	Geyer/sedge	93%	0.44	1	1,000	400	50%	3.14	1	1,000	3,000	3,000	-43%
014_02	N. Cottonwood Cr	4	320		93%	0.44	1	300	100	90%	0.63	1	300	200	100	-3%
014_02	N. Cottonwood Cr	5	950	water	0%	6.27	320	304,000	1,910,000	0%	6.27	320	304,000	1,910,000	0	0%
014_02	N. Cottonwood Cr	6	480	Geyer/sedge	82%	1.13	2	1,000	1,000	80%	1.25	2	1,000	1,000	0	-2%
014_02	N. Cottonwood Cr	7	120		82%	1.13	2	200	200	30%	4.39	2	200	900	700	-52%
014_02	N. Cottonwood Cr	8	280		82%	1.13	2	600	700	70%	1.88	2	600	1,000	300	-12%
014_02	N. Cottonwood Cr	9	230		82%	1.13	2	500	600	60%	2.51	2	500	1,000	400	-22%
014_02	N. Cottonwood Cr	10	140		82%	1.13	2	300	300	40%	3.76	2	300	1,000	700	-42%
014_02	N. Cottonwood Cr	11	140		82%	1.13	2	300	300	60%	2.51	2	300	800	500	-22%
014_02	N. Cottonwood Cr	12	390		82%	1.13	2	800	900	80%	1.25	2	800	1,000	100	-2%
014_02	N. Cottonwood Cr	13	200		82%	1.13	2	400	500	30%	4.39	2	400	2,000	2,000	-52%
014_02	N. Cottonwood Cr	14	530		82%	1.13	2	1,000	1,000	70%	1.88	2	1,000	2,000	1,000	-12%
014_02	N. Cottonwood Cr	15	290		82%	1.13	2	600	700	80%	1.25	2	600	800	100	-2%
014_02	N. Cottonwood Cr	16	470		82%	1.13	2	900	1,000	50%	3.14	2	900	3,000	2,000	-32%
014_02	N. Cottonwood Cr	17	1220		64%	2.26	3	4,000	9,000	80%	1.25	3	4,000	5,000	(4,000)	0%
014_02	N. Cottonwood Cr	18	2240	hawthorn	45%	3.45	3	7,000	20,000	70%	1.88	3	7,000	10,000	(10,000)	0%
014_02	N. Cottonwood Cr	19	810		45%	3.45	3	2,000	7,000	50%	3.14	3	2,000	6,000	(1,000)	0%
014_03	N. Cottonwood Cr	1	1060		37%	3.95	4	4,000	20,000	50%	3.14	4	4,000	10,000	(10,000)	0%
014_03	N. Cottonwood Cr	2	250		37%	3.95	4	1,000	4,000	40%	3.76	4	1,000	4,000	0	0%
014_03	N. Cottonwood Cr	3	1170		37%	3.95	4	5,000	20,000	50%	3.14	4	5,000	20,000	0	0%
014_03	N. Cottonwood Cr	4	780		37%	3.95	4	3,000	10,000	20%	5.02	4	3,000	20,000	10,000	-17%
014_03	N. Cottonwood Cr	5	160		37%	3.95	4	600	2,000	30%	4.39	4	600	3,000	1,000	-7%
014_03	N. Cottonwood Cr	6	610		37%	3.95	4	2,000	8,000	20%	5.02	4	2,000	10,000	2,000	-17%
014_03	N. Cottonwood Cr	7	320		37%	3.95	4	1,000	4,000	30%	4.39	4	1,000	4,000	0	-7%
014_03	N. Cottonwood Cr	8	510	water birch	73%	1.69	5	3,000	5,000	70%	1.88	5	3,000	6,000	1,000	-3%
014_03	N. Cottonwood Cr	9	150		73%	1.69	5	800	1,000	20%	5.02	5	800	4,000	3,000	-53%
014_03	N. Cottonwood Cr	10	2000		73%	1.69	5	10,000	20,000	30%	4.39	5	10,000	40,000	20,000	-43%
014_04	N. Cottonwood Cr	1	2400		73%	1.69	5	10,000	20,000	30%	4.39	5	10,000	40,000	20,000	-43%
014_04	N. Cottonwood Cr	2	460	water	0%	6.27	180	82,800	519,000	0%	6.27	180	82,800	519,000	0	0%
014_04	N. Cottonwood Cr	3	530		73%	1.69	5	3,000	5,000	50%	3.14	5	3,000	9,000	4,000	-23%
014_04	N. Cottonwood Cr	4	80		73%	1.69	5	400	700	90%	0.63	5	400	300	(400)	0%
014_04	N. Cottonwood Cr	5	730		73%	1.69	5	4,000	7,000	70%	1.88	5	4,000	8,000	1,000	-3%
014_04	N. Cottonwood Cr	6	550		73%	1.69	5	3,000	5,000	60%	2.51	5	3,000	8,000	3,000	-13%
014_04	N. Cottonwood Cr	7	760		73%	1.69	5	4,000	7,000	70%	1.88	5	4,000	8,000	1,000	-3%
014_04	N. Cottonwood Cr	8	810		73%	1.69	5	4,000	7,000	30%	4.39	5	4,000	20,000	10,000	-43%
014_04	N. Cottonwood Cr	9	210		73%	1.69	5	1,000	2,000	60%	2.51	5	1,000	3,000	1,000	-13%
014_04	N. Cottonwood Cr	10	180		48%	3.26	9	2,000	7,000	50%	3.14	9	2,000	6,000	(1,000)	0%
014_04	N. Cottonwood Cr	11	380		48%	3.26	9	3,000	10,000	40%	3.76	9	3,000	10,000	0	-8%
014_04	N. Cottonwood Cr	12	640		48%	3.26	9	6,000	20,000	20%	5.02	9	6,000	30,000	10,000	-28%
							Totals		2,700,000					2,700,000	73,000	

Table C-11. Existing and target solar loads for Cottonwood Creek tributaries.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
014_02	Curtis Res trib	1	50	hawthorn	60%	2.51	2	100	300	70%	1.88	2	100	200	(100)	0%
014_02	Curtis Res trib	2	210		60%	2.51	2	400	1,000	60%	2.51	2	400	1,000	0	0%
014_02	Curtis Res trib	3	450		45%	3.45	3	1,000	3,000	50%	3.14	3	1,000	3,000	0	0%
014_02	Dry Cottonwood Cr	1	1400		45%	3.45	3	4,000	10,000	50%	3.14	3	4,000	10,000	0	0%
014_02	Dry Cottonwood Cr	2	1200		45%	3.45	3	4,000	10,000	40%	3.76	3	4,000	20,000	10,000	-5%
014_02	Dry Cottonwood Cr	3	90		45%	3.45	3	300	1,000	60%	2.51	3	300	800	(200)	0%
014_02	Dry Cottonwood Cr	4	410		37%	3.95	4	2,000	8,000	30%	4.39	4	2,000	9,000	1,000	-7%
014_02	Dry Cottonwood Cr	5	2100	water birch	83%	1.07	4	8,000	9,000	80%	1.25	4	8,000	10,000	1,000	-3%
							Totals		42,000					54,000	12,000	

Table C-12. Existing and target solar loads for McMullen Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/ day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/ day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
015_02	McMullen Creek	1	250	Geyer/sedge	93%	0.44	1	300	100	80%	1.25	1	300	400	300	-13%
015_02	McMullen Creek	2	150	aspen	100%	0.00	1	200	0	90%	0.63	1	200	100	100	-10%
015_02	McMullen Creek	3	1380	Geyer/sedge	93%	0.44	1	1,000	400	70%	1.88	1	1,000	2,000	2,000	-23%
015_02	McMullen Creek	4	710		82%	1.13	2	1,000	1,000	70%	1.88	2	1,000	2,000	1,000	-12%
015_02	McMullen Creek	5	930		82%	1.13	2	2,000	2,000	80%	1.25	2	2,000	3,000	1,000	-2%
015_02	McMullen Creek	6	390		82%	1.13	2	800	900	50%	3.14	2	800	3,000	2,000	-32%
015_02	McMullen Creek	7	810		82%	1.13	2	2,000	2,000	80%	1.25	2	2,000	3,000	1,000	-2%
015_02	McMullen Creek	8	520	aspen	99%	0.06	2	1,000	60	90%	0.63	2	1,000	600	500	-9%
015_02	McMullen Creek	9	800		99%	0.06	3	2,000	100	80%	1.25	3	2,000	3,000	3,000	-19%
015_02	McMullen Creek	10	1700	Geyer/sedge	64%	2.26	3	5,000	10,000	70%	1.88	3	5,000	9,000	(1,000)	0%
015_02	McMullen Creek	11	480		64%	2.26	3	1,000	2,000	60%	2.51	3	1,000	3,000	1,000	-4%
015_03	McMullen Creek	1	1100	hawthorn	37%	3.95	4	4,000	20,000	50%	3.14	4	4,000	10,000	(10,000)	0%
015_03	McMullen Creek	2	320		37%	3.95	4	1,000	4,000	40%	3.76	4	1,000	4,000	0	0%
015_03	McMullen Creek	3	1900	water birch	83%	1.07	4	8,000	9,000	70%	1.88	4	8,000	20,000	10,000	-13%
015_03	McMullen Creek	4	520		73%	1.69	5	3,000	5,000	70%	1.88	5	3,000	6,000	1,000	-3%
015_03	McMullen Creek	5	650	hawthorn	32%	4.26	5	3,000	10,000	40%	3.76	5	3,000	10,000	0	0%
015_03	McMullen Creek	6	1100		32%	4.26	5	6,000	30,000	30%	4.39	5	6,000	30,000	0	-2%
015_03	McMullen Creek	7	1100		32%	4.26	5	6,000	30,000	50%	3.14	5	6,000	20,000	(10,000)	0%
015_03	McMullen Creek	8	680	water birch	65%	2.19	6	4,000	9,000	60%	2.51	6	4,000	10,000	1,000	-5%
015_03	McMullen Creek	9	1070		65%	2.19	6	6,000	10,000	50%	3.14	6	6,000	20,000	10,000	-15%
015_03	McMullen Creek	10	210		65%	2.19	6	1,000	2,000	60%	2.51	6	1,000	3,000	1,000	-5%
015_03	McMullen Creek	11	870		65%	2.19	6	5,000	10,000	50%	3.14	6	5,000	20,000	10,000	-15%
015_03	McMullen Creek	12	190		65%	2.19	6	1,000	2,000	40%	3.76	6	1,000	4,000	2,000	-25%
015_03	McMullen Creek	13	440		65%	2.19	6	3,000	7,000	60%	2.51	6	3,000	8,000	1,000	-5%
015_03	McMullen Creek	14	270		65%	2.19	6	2,000	4,000	50%	3.14	6	2,000	6,000	2,000	-15%
015_03	McMullen Creek	15	590		65%	2.19	6	4,000	9,000	30%	4.39	6	4,000	20,000	10,000	-35%
015_03	McMullen Creek	16	710		65%	2.19	6	4,000	9,000	20%	5.02	6	4,000	20,000	10,000	-45%
015_03	McMullen Creek	17	460		65%	2.19	6	3,000	7,000	60%	2.51	6	3,000	8,000	1,000	-5%
015_03	McMullen Creek	18	50		58%	2.63	7	400	1,000	90%	0.63	7	400	300	(700)	0%
015_03	McMullen Creek	19	1240		58%	2.63	7	9,000	20,000	30%	4.39	7	9,000	40,000	20,000	-28%
015_03	McMullen Creek	20	900		58%	2.63	7	6,000	20,000	50%	3.14	7	6,000	20,000	0	-8%
015_03	McMullen Creek	21	450		58%	2.63	7	3,000	8,000	30%	4.39	7	3,000	10,000	2,000	-28%
015_03	McMullen Creek	22	360		58%	2.63	7	3,000	8,000	20%	5.02	7	3,000	20,000	10,000	-38%
							Totals		250,000					340,000	81,000	

Table C-13. Existing and target solar loads for McMullen Creek tributaries.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
015_02	1st tributary	1	310	lodgepole	96%	0.25	1	300	80	90%	0.63	1	300	200	100	-6%
015_02	1st tributary	2	310	aspen	100%	0.00	1	300	0	80%	1.25	1	300	400	400	-20%
015_02	1st tributary	3	350	Geyers/sedge	82%	1.13	2	700	800	80%	1.25	2	700	900	100	-2%
015_02	1st tributary	4	650		82%	1.13	2	1,000	1,000	90%	0.63	2	1,000	600	(400)	0%
015_02	Donahue Creek	1	240	lodgepole	96%	0.25	1	200	50	90%	0.63	1	200	100	50	-6%
015_02	Donahue Creek	2	350		96%	0.25	1	400	100	70%	1.88	1	400	800	700	-26%
015_02	Donahue Creek	3	120		96%	0.25	1	100	30	80%	1.25	1	100	100	70	-16%
015_02	Donahue Creek	4	320	aspen	100%	0.00	1	300	0	90%	0.63	1	300	200	200	-10%
015_02	Donahue Creek	5	580	Geyers/sedge	82%	1.13	2	1,000	1,000	80%	1.25	2	1,000	1,000	0	-2%
015_02	Donahue Creek	6	270		82%	1.13	2	500	600	60%	2.51	2	500	1,000	400	-22%
015_02	Donahue Creek	7	1040	aspen	99%	0.06	2	2,000	100	80%	1.25	2	2,000	3,000	3,000	-19%
015_02	Donahue Creek	8	360	Geyers/sedge	64%	2.26	3	1,000	2,000	50%	3.14	3	1,000	3,000	1,000	-14%
015_02	Donahue Creek	9	640	aspen	99%	0.06	3	2,000	100	80%	1.25	3	2,000	3,000	3,000	-19%
015_02	Donahue Creek	10	830		99%	0.06	3	2,000	100	90%	0.63	3	2,000	1,000	900	-9%
015_02	2nd trib (left fork	1	160		100%	0.00	1	200	0	80%	1.25	1	200	300	300	-20%
015_02	2nd trib (left fork	2	220		99%	0.06	2	400	30	90%	0.63	2	400	300	300	-9%
015_02	2nd trib (rt fork)	1	80		100%	0.00	1	80	0	90%	0.63	1	80	50	50	-10%
015_02	2nd trib (rt fork)	2	420		100%	0.00	1	400	0	90%	0.63	1	400	300	300	-10%
015_02	2nd tributary	1	560	Geyers/sedge	82%	1.13	2	1,000	1,000	70%	1.88	2	1,000	2,000	1,000	-12%
015_02	N. Willow Spring	1	390		82%	1.13	2	800	900	50%	3.14	2	800	3,000	2,000	-32%
015_02	N. Willow Spring	2	370		82%	1.13	2	700	800	80%	1.25	2	700	900	100	-2%
015_02	N. Willow Spring	3	920		82%	1.13	2	2,000	2,000	70%	1.88	2	2,000	4,000	2,000	-12%
015_02	N. Willow Spring	4	300		64%	2.26	3	900	2,000	70%	1.88	3	900	2,000	0	0%
015_02	N. Willow Spring	5	470		64%	2.26	3	1,000	2,000	70%	1.88	3	1,000	2,000	0	0%
015_02	5th tributary	1	860		82%	1.13	2	2,000	2,000	70%	1.88	2	2,000	4,000	2,000	-12%
015_02	5th tributary	2	210		82%	1.13	2	400	500	70%	1.88	2	400	800	300	-12%
015_02	8th tributary	1	290	water birch	91%	0.56	2	600	300	70%	1.88	2	600	1,000	700	-21%
015_02	8th tributary	2	470		91%	0.56	2	900	500	40%	3.76	2	900	3,000	3,000	-51%
015_02	8th tributary	3	180		91%	0.56	2	400	200	70%	1.88	2	400	800	600	-21%
015_02	8th tributary	4	130		91%	0.56	2	300	200	40%	3.76	2	300	1,000	800	-51%
015_02	8th tributary	5	100		91%	0.56	2	200	100	70%	1.88	2	200	400	300	-21%
015_02	8th tributary	6	510		91%	0.56	2	1,000	600	40%	3.76	2	1,000	4,000	3,000	-51%
015_02	8th tributary	7	170		91%	0.56	2	300	200	50%	3.14	1	200	600	400	-41%

Table C-13 (cont.). Existing and target solar loads for McMullen Creek tributaries.

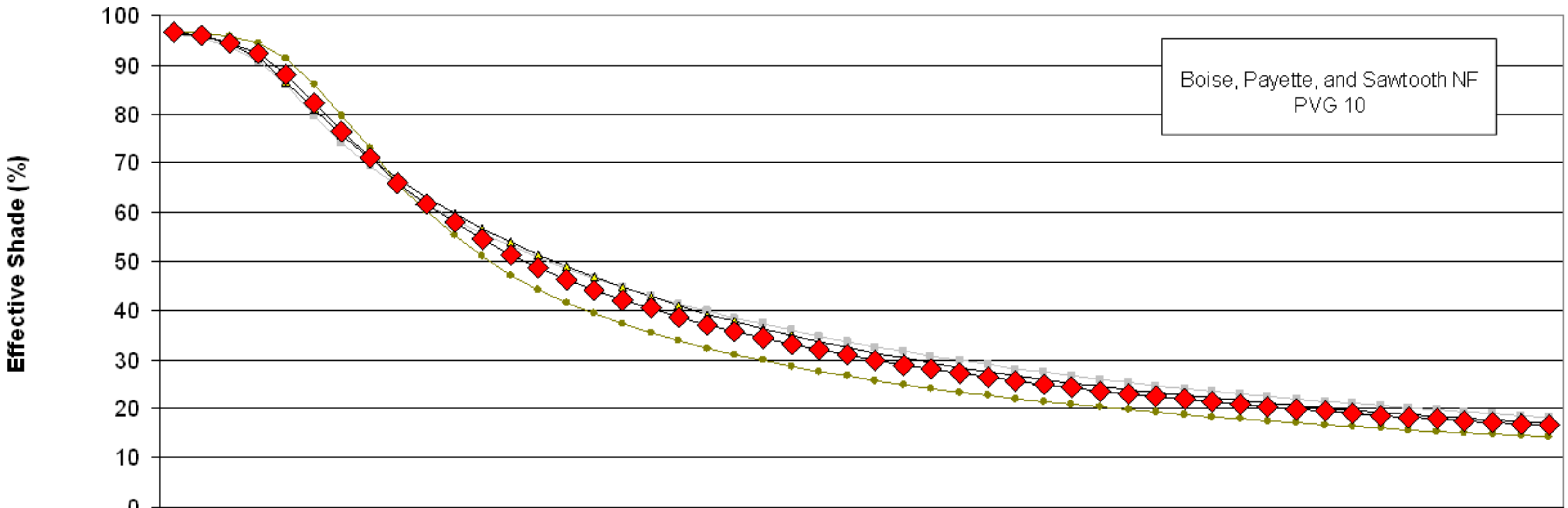
Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
015_02	Dry Gulch	1	250	Geyers/sedge	82%	1.13	2	500	600	60%	2.51	2	500	1,000	400	-22%
015_02	Dry Gulch	2	400		82%	1.13	2	800	900	80%	1.25	2	800	1,000	100	-2%
015_02	Dry Gulch	3	440		82%	1.13	2	900	1,000	60%	2.51	2	900	2,000	1,000	-22%
015_02	Dry Gulch	4	1000	hawthorn	45%	3.45	3	3,000	10,000	60%	2.51	3	3,000	8,000	(2,000)	0%
015_02	Dry Gulch	5	650		45%	3.45	3	2,000	7,000	70%	1.88	3	2,000	4,000	(3,000)	0%
015_02	Dry Gulch	6	230		45%	3.45	3	700	2,000	40%	3.76	3	700	3,000	1,000	-5%
015_02	Dry Gulch	7	300		45%	3.45	3	900	3,000	70%	1.88	3	900	2,000	(1,000)	0%
015_02	Dry Gulch	8	340		45%	3.45	3	1,000	3,000	50%	3.14	3	1,000	3,000	0	0%
015_02	Dry Gulch	9	190		37%	3.95	4	800	3,000	50%	3.14	4	800	3,000	0	0%
015_02	Dry Gulch	10	190		37%	3.95	4	800	3,000	40%	3.76	4	800	3,000	0	0%
015_02	Dry Gulch	11	140		37%	3.95	4	600	2,000	60%	2.51	4	600	2,000	0	0%
015_02	Dry Gulch	12	80		37%	3.95	4	300	1,000	30%	4.39	4	300	1,000	0	-7%
015_02	Dry Gulch	13	460		37%	3.95	4	2,000	8,000	50%	3.14	4	2,000	6,000	(2,000)	0%
015_02	Dry Gulch	14	260		37%	3.95	4	1,000	4,000	40%	3.76	4	1,000	4,000	0	0%
015_02	Dry Gulch	15	530		37%	3.95	4	2,000	8,000	60%	2.51	4	2,000	5,000	(3,000)	0%
015_02	Dry Gulch	16	350		37%	3.95	4	1,000	4,000	0%	6.27	4	1,000	6,000	2,000	-37%
015_02	Dry Gulch	17	330		37%	3.95	4	1,000	4,000	40%	3.76	4	1,000	4,000	0	0%
015_02	Dry Gulch	18	460		37%	3.95	4	2,000	8,000	0%	6.27	4	2,000	10,000	2,000	-37%
015_02	Dry Gulch	19	1100		37%	3.95	4	4,000	20,000	30%	4.39	4	4,000	20,000	0	-7%
								Totals	110,000					130,000	22,000	

Table C-14. Existing and target solar loads for Dry Creek.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/ day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/ day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
022_03	Dry Creek	1	220	hawthorn	32%	4.26	5	1,000	4,000	50%	3.14	5	1,000	3,000	(1,000)	0%
022_03	Dry Creek	2	520		32%	4.26	5	3,000	10,000	40%	3.76	5	3,000	10,000	0	0%
022_03	Dry Creek	3	670	water birch	73%	1.69	5	3,000	5,000	70%	1.88	5	3,000	6,000	1,000	-3%
022_03	Dry Creek	4	490		73%	1.69	5	2,000	3,000	60%	2.51	5	2,000	5,000	2,000	-13%
022_03	Dry Creek	5	1570		73%	1.69	5	8,000	10,000	70%	1.88	5	8,000	20,000	10,000	-3%
022_03	Dry Creek	6	300		73%	1.69	5	2,000	3,000	50%	3.14	5	2,000	6,000	3,000	-23%
022_03	Dry Creek	7	330		73%	1.69	5	2,000	3,000	60%	2.51	5	2,000	5,000	2,000	-13%
022_03	Dry Creek	8	270		73%	1.69	5	1,000	2,000	30%	4.39	5	1,000	4,000	2,000	-43%
022_03	Dry Creek	9	1260		73%	1.69	5	6,000	10,000	60%	2.51	5	6,000	20,000	10,000	-13%
022_03	Dry Creek	10	2060		65%	2.19	6	10,000	20,000	40%	3.76	6	10,000	40,000	20,000	-25%
022_03	Dry Creek	11	290		65%	2.19	6	2,000	4,000	20%	5.02	6	2,000	10,000	6,000	-45%
022_03	Dry Creek	12	140		65%	2.19	6	800	2,000	40%	3.76	6	800	3,000	1,000	-25%
022_03	Dry Creek	13	150		65%	2.19	6	900	2,000	20%	5.02	6	900	5,000	3,000	-45%
022_03	Dry Creek	14	500		65%	2.19	6	3,000	7,000	40%	3.76	6	3,000	10,000	3,000	-25%
022_03	Dry Creek	15	1160		65%	2.19	6	7,000	20,000	30%	4.39	6	7,000	30,000	10,000	-35%
022_03	Dry Creek	16	170		65%	2.19	6	1,000	2,000	60%	2.51	6	1,000	3,000	1,000	-5%
022_03	Dry Creek	17	3780		65%	2.19	6	20,000	40,000	10%	5.64	6	20,000	100,000	60,000	-55%
022_03	Dry Creek	18	140		65%	2.19	6	800	2,000	50%	3.14	6	800	3,000	1,000	-15%
022_03	Dry Creek	19	170		65%	2.19	6	1,000	2,000	10%	5.64	6	1,000	6,000	4,000	-55%
022_03	Dry Creek	20	250		65%	2.19	6	2,000	4,000	50%	3.14	6	2,000	6,000	2,000	-15%
022_03	Dry Creek	21	780		65%	2.19	6	5,000	10,000	20%	5.02	6	5,000	30,000	20,000	-45%
022_03	Dry Creek	22	300		65%	2.19	6	2,000	4,000	50%	3.14	6	2,000	6,000	2,000	-15%
022_03	Dry Cr bl Lake	1	260		65%	2.19	6	2,000	4,000	30%	4.39	6	2,000	9,000	5,000	-35%
022_03	Dry Cr bl Lake	2	340		65%	2.19	6	2,000	4,000	60%	2.51	6	2,000	5,000	1,000	-5%
022_03	Dry Cr bl Lake	3	480		65%	2.19	6	3,000	7,000	50%	3.14	6	3,000	9,000	2,000	-15%
022_03	Dry Cr bl Lake	4	740		65%	2.19	6	4,000	9,000	10%	5.64	6	4,000	20,000	10,000	-55%
022_03	Dry Cr bl Lake	5	440		65%	2.19	6	3,000	7,000	40%	3.76	6	3,000	10,000	3,000	-25%
022_03	Dry Cr bl Lake	6	300		65%	2.19	6	2,000	4,000	30%	4.39	6	2,000	9,000	5,000	-35%
022_03	Dry Cr bl Lake	7	360		65%	2.19	6	2,000	4,000	50%	3.14	6	2,000	6,000	2,000	-15%
022_03	Dry Cr bl Lake	8	460		65%	2.19	6	3,000	7,000	30%	4.39	6	3,000	10,000	3,000	-35%
022_03	Dry Cr bl Lake	9	530		65%	2.19	6	3,000	7,000	50%	3.14	6	3,000	9,000	2,000	-15%
022_03	Dry Cr bl Lake	10	740		65%	2.19	6	4,000	9,000	40%	3.76	6	4,000	20,000	10,000	-25%
							Totals		230,000					440,000	210,000	

Table C-15. Existing and target solar loads for Dry Creek tributaries.

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
024_02	EF Dry Creek	1	660	PVG10	96%	0.25	1	700	200	90%	0.63	1	700	400	200	-6%
024_02	EF Dry Creek	2	220		96%	0.25	1	200	50	80%	1.25	1	200	300	300	-16%
024_02	EF Dry Creek	3	210		96%	0.25	1	200	50	90%	0.63	1	200	100	50	-6%
024_02	EF Dry Creek	4	770		96%	0.25	1	800	200	80%	1.25	1	800	1,000	800	-16%
024_02	EF Dry Creek	5	580		96%	0.25	2	1,000	300	90%	0.63	2	1,000	600	300	-6%
024_02	EF Dry Creek	6	410	Geyer/sedge	82%	1.13	2	800	900	70%	1.88	2	800	2,000	1,000	-12%
024_02	EF Dry Creek	7	120	PVG10	96%	0.25	2	200	50	80%	1.25	2	200	300	300	-16%
024_02	EF Dry Creek	8	150	Geyer/sedge	82%	1.13	2	300	300	60%	2.51	2	300	800	500	-22%
024_02	EF Dry Creek	9	240	PVG10	96%	0.25	2	500	100	90%	0.63	2	500	300	200	-6%
024_02	EF Dry Creek	10	350		96%	0.25	2	700	200	80%	1.25	2	700	900	700	-16%
024_02	EF Dry Creek	11	220	Geyer/sedge	82%	1.13	2	400	500	60%	2.51	2	400	1,000	500	-22%
024_02	EF Dry Creek	12	170	PVG10	94%	0.38	3	500	200	80%	1.25	3	500	600	400	-14%
024_02	EF Dry Creek	13	1070	Geyer/sedge	64%	2.26	3	3,000	7,000	70%	1.88	3	3,000	6,000	(1,000)	0%
024_02	EF Dry Creek	14	400		64%	2.26	3	1,000	2,000	60%	2.51	3	1,000	3,000	1,000	-4%
024_02	EF Dry Creek	15	470	PVG10	94%	0.38	3	1,000	400	70%	1.88	3	1,000	2,000	2,000	-24%
024_02	EF Dry Creek	16	2280		92%	0.50	4	9,000	5,000	70%	1.88	4	9,000	20,000	20,000	-22%
024_02	EF Dry Creek	17	2580	water birch	83%	1.07	4	10,000	10,000	80%	1.25	4	10,000	10,000	0	-3%
024_02	EF Dry Creek	18	2980		73%	1.69	5	10,000	20,000	70%	1.88	5	10,000	20,000	0	-3%
024_02	EF Dry Creek	19	370		73%	1.69	5	2,000	3,000	60%	2.51	5	2,000	5,000	2,000	-13%
022_02	MF Dry Creek	1	230	Geyer/sedge	93%	0.44	1	200	90	70%	1.88	1	200	400	300	-23%
022_02	MF Dry Creek	2	190	aspen	100%	0.00	1	200	0	70%	1.88	1	200	400	400	-30%
022_02	MF Dry Creek	3	980		100%	0.00	1	1,000	0	80%	1.25	1	1,000	1,000	1,000	-20%
022_02	MF Dry Creek	4	220		100%	0.00	1	200	0	90%	0.63	1	200	100	100	-10%
022_02	MF Dry Creek	5	100	PVG10	96%	0.25	1	100	30	90%	0.63	1	100	60	30	-6%
022_02	MF Dry Creek	6	270		96%	0.25	2	500	100	70%	1.88	2	500	900	800	-26%
022_02	MF Dry Creek	7	750		96%	0.25	2	2,000	500	60%	2.51	2	2,000	5,000	5,000	-36%
022_02	MF Dry Creek	8	1530		96%	0.25	2	3,000	800	70%	1.88	2	3,000	6,000	5,000	-26%
022_02	MF Dry Creek	9	550	hawthorn	60%	2.51	2	1,000	3,000	60%	2.51	2	1,000	3,000	0	0%
022_02	MF Dry Creek	10	550		60%	2.51	2	1,000	3,000	70%	1.88	2	1,000	2,000	(1,000)	0%
022_02	MF Dry Creek	11	670		45%	3.45	3	2,000	7,000	60%	2.51	3	2,000	5,000	(2,000)	0%
022_02	MF Dry Creek	12	1110		45%	3.45	3	3,000	10,000	50%	3.14	3	3,000	9,000	(1,000)	0%
022_02	MF Dry Creek	13	410		45%	3.45	3	1,000	3,000	30%	4.39	3	1,000	4,000	1,000	-15%
022_02	MF Dry Creek	14	290		45%	3.45	3	900	3,000	50%	3.14	3	900	3,000	0	0%
023_02	WF Dry Creek	1	870	aspen	100%	0.00	1	900	0	90%	0.63	1	900	600	600	-10%
023_02	WF Dry Creek	2	230		100%	0.00	1	200	0	80%	1.25	1	200	300	300	-20%
023_02	WF Dry Creek	3	120	Geyer/sedge	93%	0.44	1	100	40	50%	3.14	1	100	300	300	-43%
023_02	WF Dry Creek	4	1210	aspen	100%	0.00	1	1,000	0	80%	1.25	1	1,000	1,000	1,000	-20%
023_02	WF Dry Creek	5	480		99%	0.06	2	1,000	60	70%	1.88	2	1,000	2,000	2,000	-29%
023_02	WF Dry Creek	6	230	hawthorn	60%	2.51	2	500	1,000	30%	4.39	2	500	2,000	1,000	-30%
023_02	WF Dry Creek	7	590		60%	2.51	2	1,000	3,000	60%	2.51	2	1,000	3,000	0	0%
023_02	WF Dry Creek	8	560	aspen	99%	0.06	2	1,000	60	80%	1.25	2	1,000	1,000	900	-19%
023_02	WF Dry Creek	9	320	hawthorn	60%	2.51	2	600	2,000	40%	3.76	2	600	2,000	0	-20%
023_02	WF Dry Creek	10	970	aspen	99%	0.06	3	3,000	200	70%	1.88	3	3,000	6,000	6,000	-29%
023_02	WF Dry Creek	11	4370	hawthorn	45%	3.45	3	10,000	30,000	40%	3.76	3	10,000	40,000	10,000	-5%
							Totals		120,000					170,000	61,000	

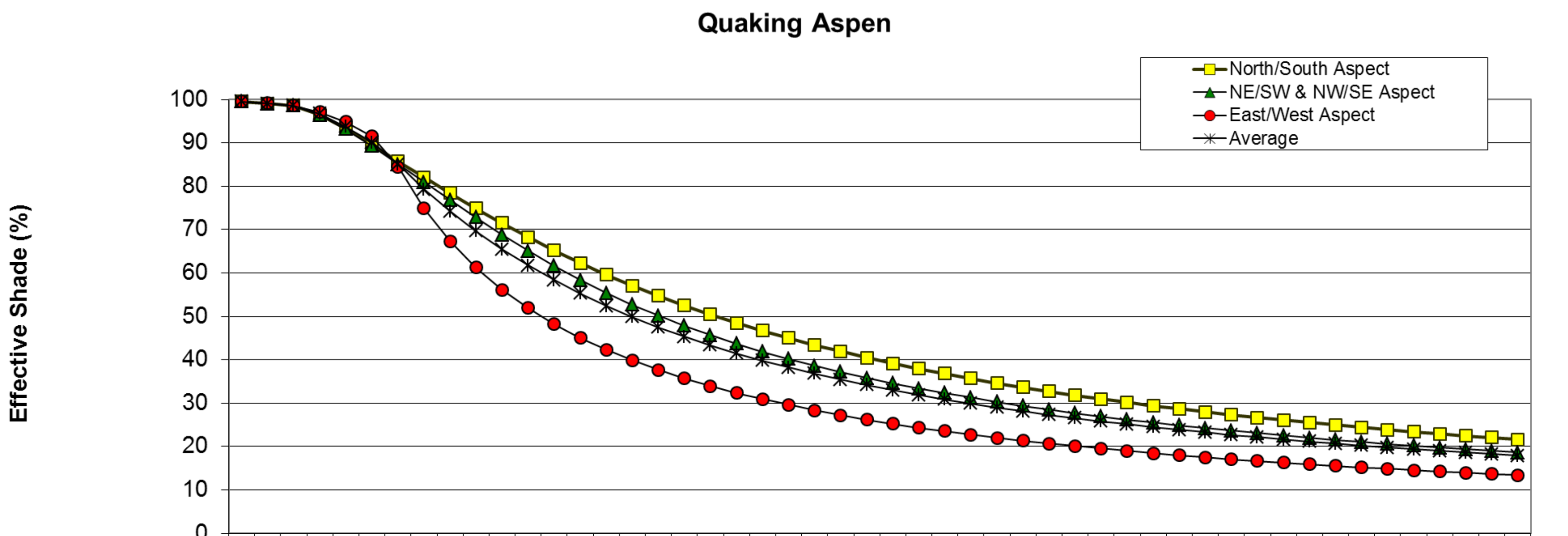


"Vegetation" Channel Width (meters)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North - South	96	96	94	91	86	80	74	69	65	62	59	56	53	51	49	47	45	43	41	40	38	37	36	35	34
Northeast/Southwest	96	96	94	92	87	81	76	71	67	63	60	57	54	51	49	47	45	43	41	39	38	36	35	34	32
East - West	97	97	96	94	91	86	80	73	66	60	55	51	47	44	42	39	37	35	34	32	31	30	29	28	27
Average	96	96	94	92	88	82	76	71	66	62	58	54	51	49	46	44	42	40	39	37	36	34	33	32	31

"Vegetation" Channel Width (meters)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North - South	33	32	31	30	29	28	27	27	26	25	25	24	24	23	23	22	22	21	21	20	20	19	19	19	18
Northeast/Southwest	31	30	29	28	28	27	26	25	25	24	23	23	22	22	21	21	20	20	19	19	18	18	18	17	17
East - West	26	25	24	23	23	22	21	21	20	20	19	19	18	18	17	17	17	16	16	16	15	15	15	15	14
Average	30	29	28	27	26	26	25	24	24	23	22	22	21	21	20	20	19	19	19	18	18	18	17	17	17

"Vegetation" Channel Width (meters) and Calculated Shade Conditions

Figure C-1. Target shade curve for the lodgepole pine (PVG 10) community.

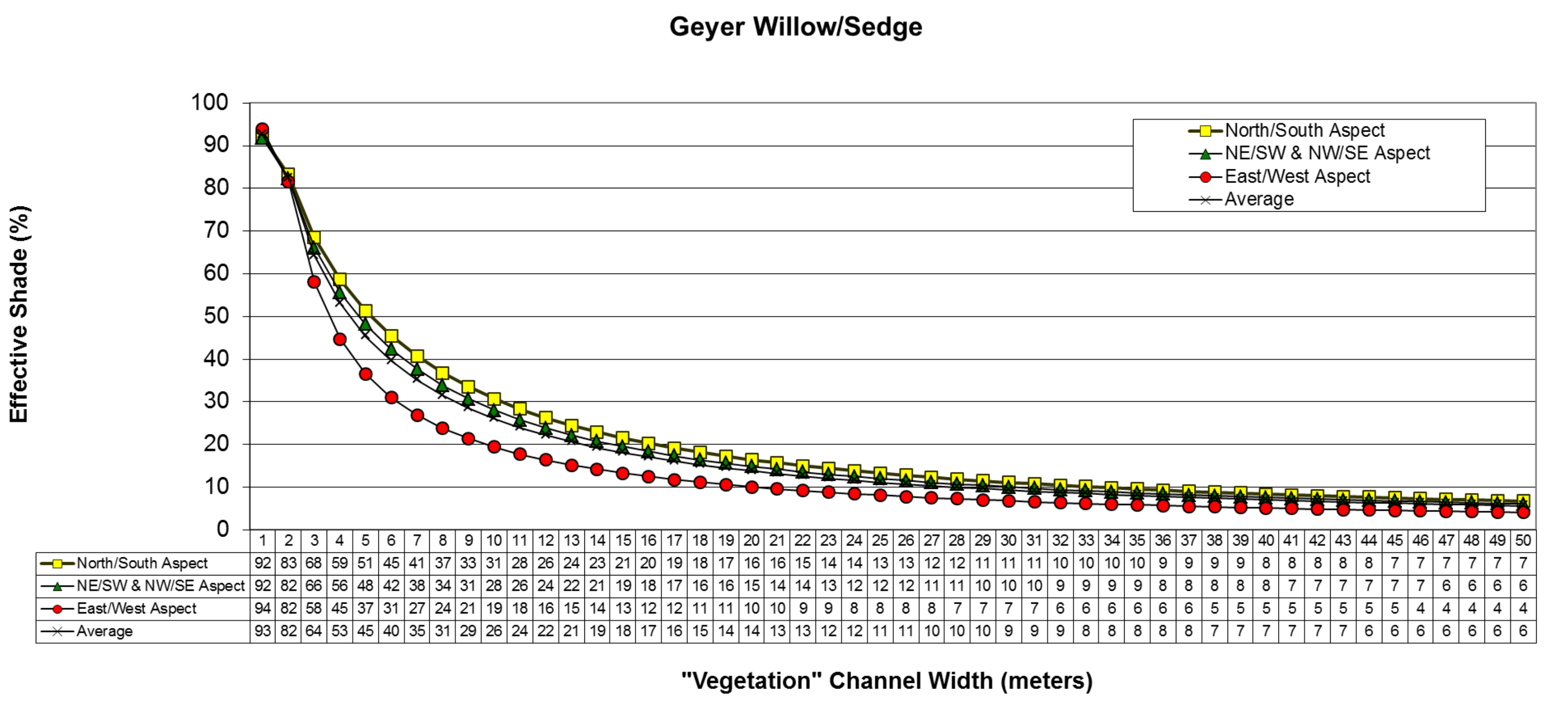


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North/South Aspect	99	99	99	96	93	90	86	82	78	75	71	68	65	62	60	57	55	52	50	48	47	45	43	42	41
NE/SW & NW/SE Aspect	100	99	99	96	93	89	85	81	77	73	69	65	62	58	55	53	50	48	46	44	42	40	39	37	36
East/West Aspect	100	99	99	97	95	91	84	75	67	61	56	52	48	45	42	40	38	36	34	32	31	30	28	27	26
Average	100	99	99	97	94	90	85	79	74	70	66	62	58	55	52	50	48	45	43	42	40	38	37	35	34

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	39	38	37	36	35	34	33	32	31	30	29	29	28	27	27	26	26	25	24	24	23	23	22	22	22
NE/SW & NW/SE Aspect	35	33	32	31	30	29	29	28	27	26	26	25	24	24	23	23	22	22	21	21	20	20	19	19	19
East/West Aspect	25	24	24	23	22	21	21	20	20	19	18	18	18	17	17	16	16	16	15	15	15	14	14	14	13
Average	33	32	31	30	29	28	27	27	26	25	24	24	23	23	22	22	21	21	20	20	19	19	19	18	18

"Vegetation" Channel Width (meters)

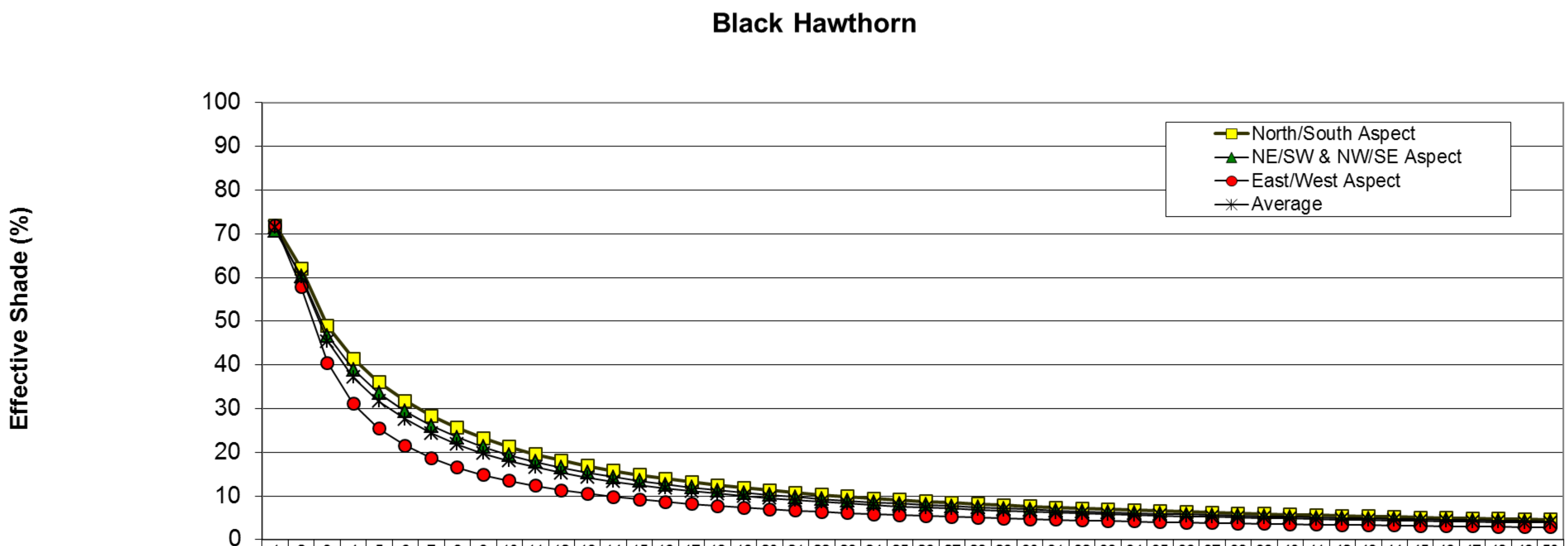
Figure C-2. Target shade curve for the aspen community.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North/South Aspect	92	83	68	59	51	45	41	37	33	31	28	26	24	23	21	20	19	18	17	16	16	15	14	14	13
NE/SW & NW/SE Aspect	92	82	66	56	48	42	38	34	31	28	26	24	22	21	19	18	17	16	16	15	14	14	13	12	12
East/West Aspect	94	82	58	45	37	31	27	24	21	19	18	16	15	14	13	12	12	11	11	10	10	9	9	8	8
Average	93	82	64	53	45	40	35	31	29	26	24	22	21	19	18	17	16	15	14	14	13	13	12	12	11

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

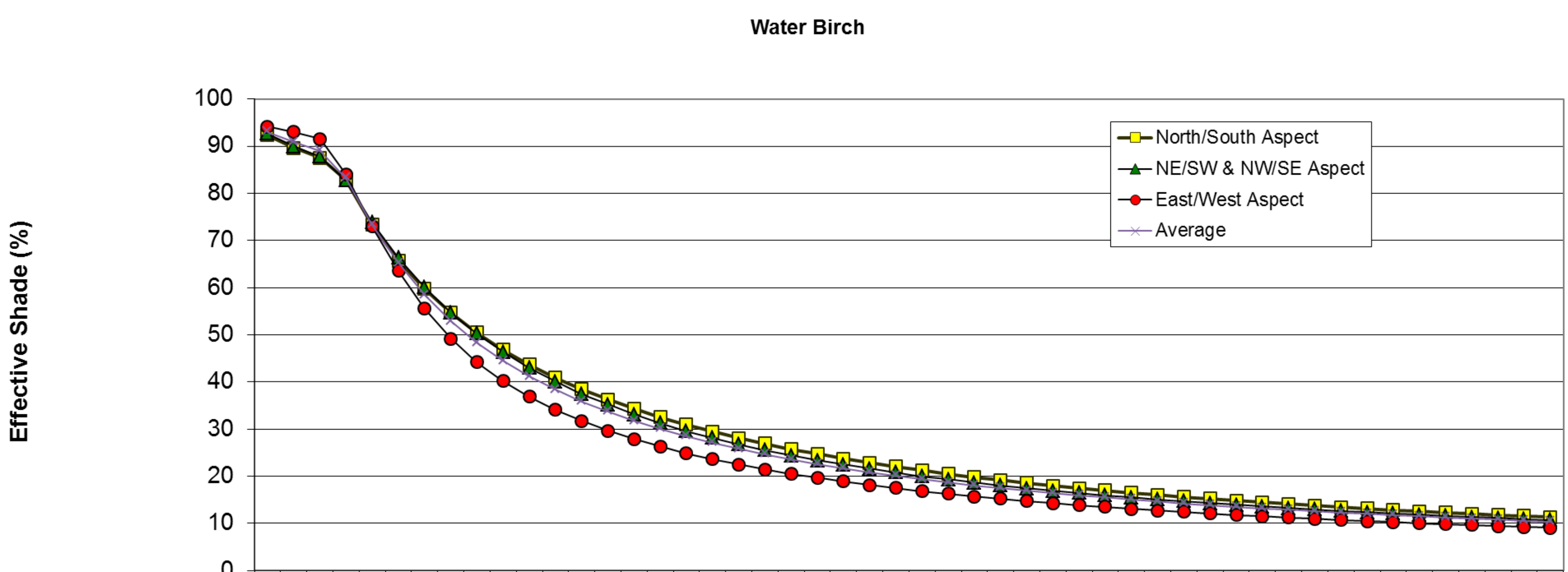
Figure C-3. Target shade curve for the Geyer willow/sedge community.



"Vegetation" Channel Width (meters)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North/South Aspect	72	62	49	41	36	32	28	26	23	21	20	18	17	16	15	14	13	12	12	11	11	10	10	9	9
NE/SW & NW/SE Aspect	71	60	47	39	34	29	26	23	21	19	18	16	15	14	13	13	12	11	11	10	10	9	9	9	8
East/West Aspect	72	58	40	31	25	21	19	17	15	13	12	11	11	10	9	9	8	8	7	7	7	6	6	6	6
Average	71	60	45	37	32	28	24	22	20	18	17	15	14	13	12	12	11	10	10	9	9	9	8	8	8

"Vegetation" Channel Width (meters)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	9	8	8	8	8	7	7	7	7	7	6	6	6	6	6	6	5	5	5	5	5	5	5	5	5
NE/SW & NW/SE Aspect	8	8	7	7	7	7	6	6	6	6	6	6	5	5	5	5	5	5	5	5	5	4	4	4	4
East/West Aspect	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	3	3	3	3	3	3	3	3	3	3
Average	7	7	7	7	6	6	6	6	6	5	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4

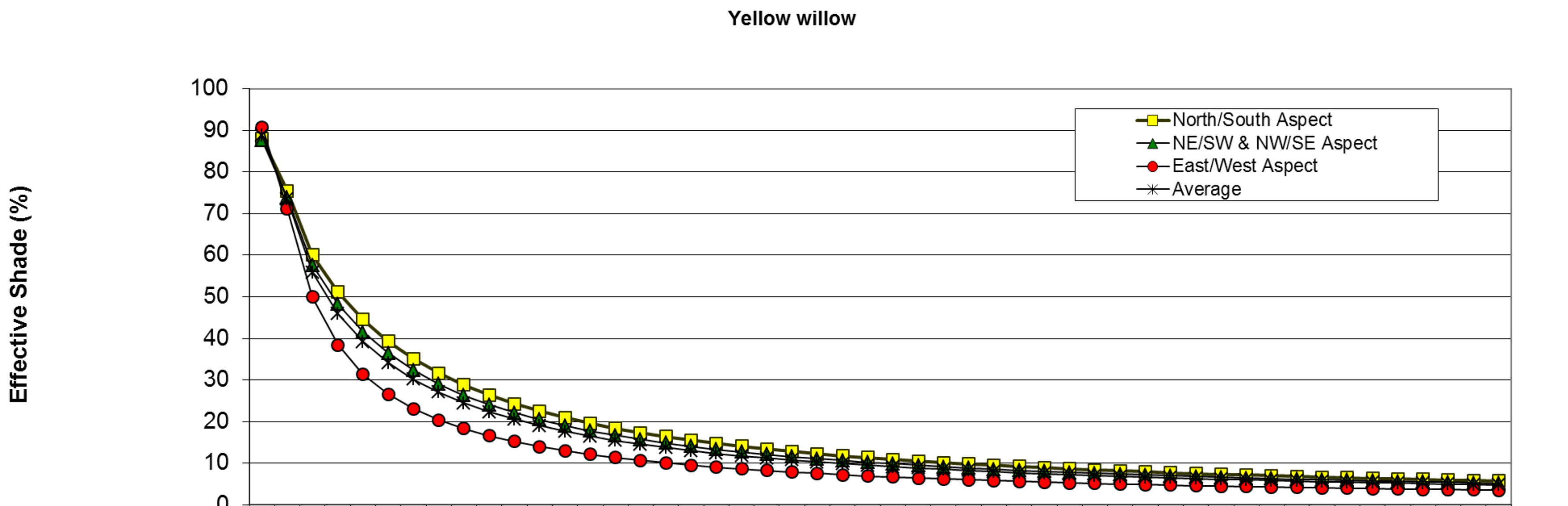
Figure C-4. Target shade curve for the hawthorn community.



"Vegetation" Channel Width (meters)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North/South Aspect	92	90	88	83	73	66	60	55	50	47	44	41	38	36	34	33	31	29	28	27	26	25	24	23	22
NE/SW & NW/SE Aspect	93	90	88	83	74	66	60	55	50	46	43	40	37	35	33	31	30	28	27	26	24	23	22	22	21
East/West Aspect	94	93	92	84	73	64	55	49	44	40	37	34	32	30	28	26	25	24	22	21	21	20	19	18	17
Average	93	91	89	83	73	65	58	53	48	44	41	38	36	34	32	30	28	27	26	25	24	23	22	21	20

"Vegetation" Channel Width (meters)	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	21	20	20	19	19	18	17	17	16	16	16	15	15	14	14	14	13	13	13	13	12	12	12	12	11
NE/SW & NW/SE Aspect	20	19	19	18	17	17	16	16	15	15	15	14	14	14	13	13	13	12	12	12	12	11	11	11	11
East/West Aspect	17	16	16	15	15	14	14	13	13	13	12	12	12	11	11	11	11	10	10	10	10	10	9	9	9
Average	19	19	18	17	17	16	16	15	15	15	14	14	14	13	13	13	12	12	12	11	11	11	11	11	10

Figure C-5. Target shade curve for the water birch community.

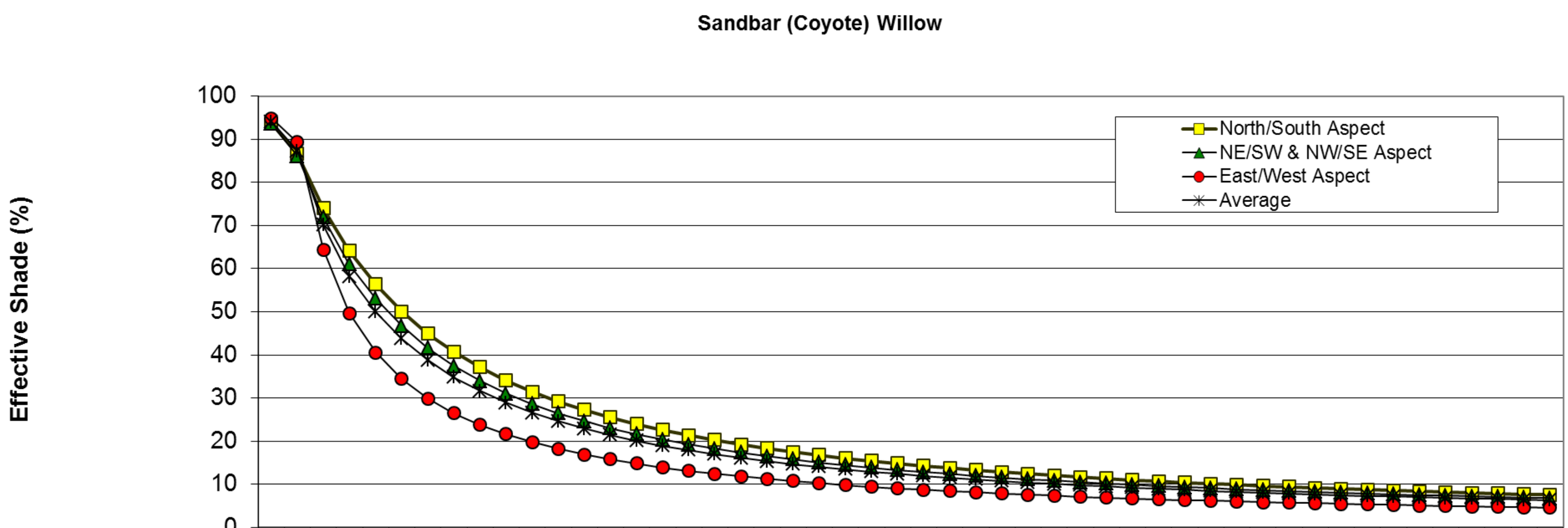


	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North/South Aspect	88	75	60	51	45	39	35	32	29	26	24	22	21	20	18	17	16	16	15	14	13	13	12	12	11
NE/SW & NW/SE Aspect	88	74	58	48	42	36	32	29	26	24	22	20	19	18	17	16	15	14	13	13	12	12	11	11	10
East/West Aspect	91	71	50	38	31	27	23	20	18	17	15	14	13	12	11	11	10	10	9	9	8	8	8	7	7
Average	89	73	56	46	39	34	30	27	24	22	21	19	18	16	15	15	14	13	12	12	11	11	10	10	9

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

"Vegetation" Channel Width (meters)

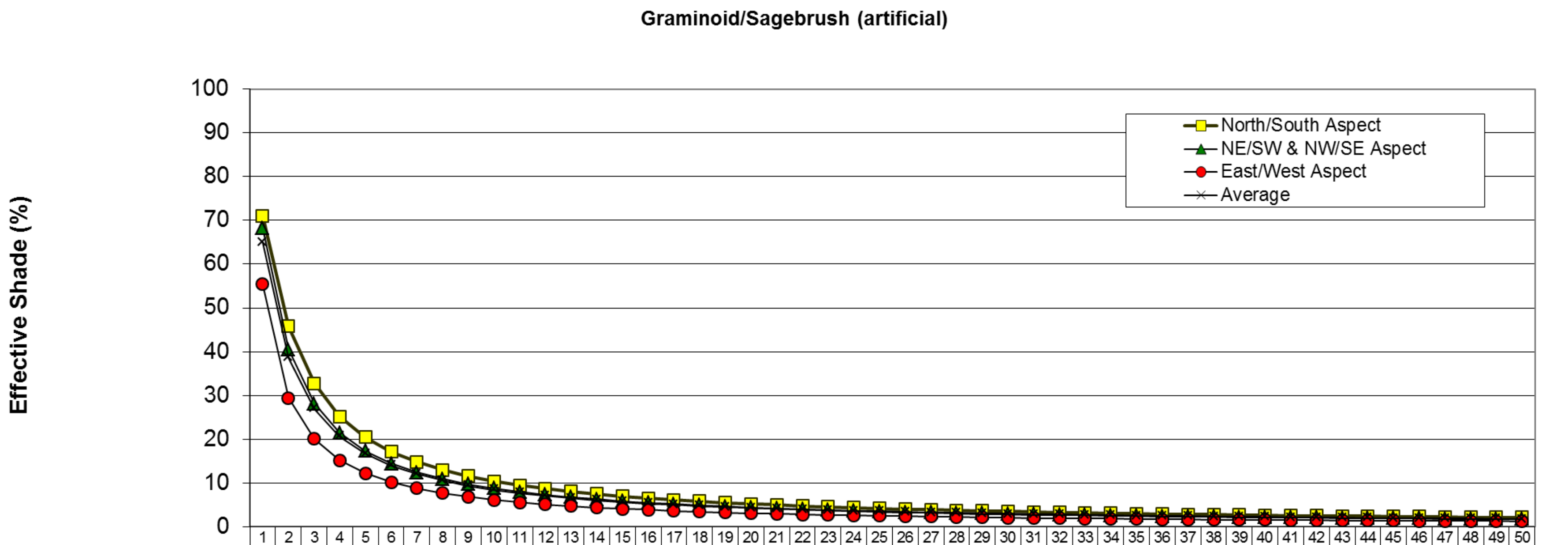
Figure C-6. Target shade curve for the yellow willow community.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North/South Aspect	94	87	74	64	56	50	45	41	37	34	31	29	27	25	24	23	21	20	19	18	18	17	16	15	15
NE/SW & NW/SE Aspect	94	86	72	61	53	47	42	37	34	31	29	26	25	23	22	20	19	18	17	17	16	15	14	14	13
East/West Aspect	95	89	64	50	41	34	30	27	24	22	20	18	17	16	15	14	13	12	12	11	11	10	10	9	9
Average	94	87	70	58	50	44	39	35	32	29	27	25	23	21	20	19	18	17	16	15	15	14	13	13	12

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

Figure C-7. Target shade curve for the sandbar (coyote) community.



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
North/South Aspect	71	46	33	25	20	17	15	13	12	10	9	9	8	7	7	7	6	6	6	5	5	5	5	4	4
NE/SW & NW/SE Aspect	68	41	28	21	17	14	12	11	10	9	8	7	7	6	6	5	5	5	5	4	4	4	4	4	4
East/West Aspect	55	29	20	15	12	10	9	8	7	6	6	5	5	4	4	4	4	3	3	3	3	3	3	3	2
Average	65	39	27	21	17	14	12	11	9	8	8	7	7	6	6	5	5	5	4	4	4	4	4	4	3

	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	4	4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2
NE/SW & NW/SE Aspect	3	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
East/West Aspect	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1
Average	3	3	3	3	3	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2

"Vegetation" Channel Width (meters)

Figure C-8. Target shade curve for the sagebrush/grass (graminoid) community.

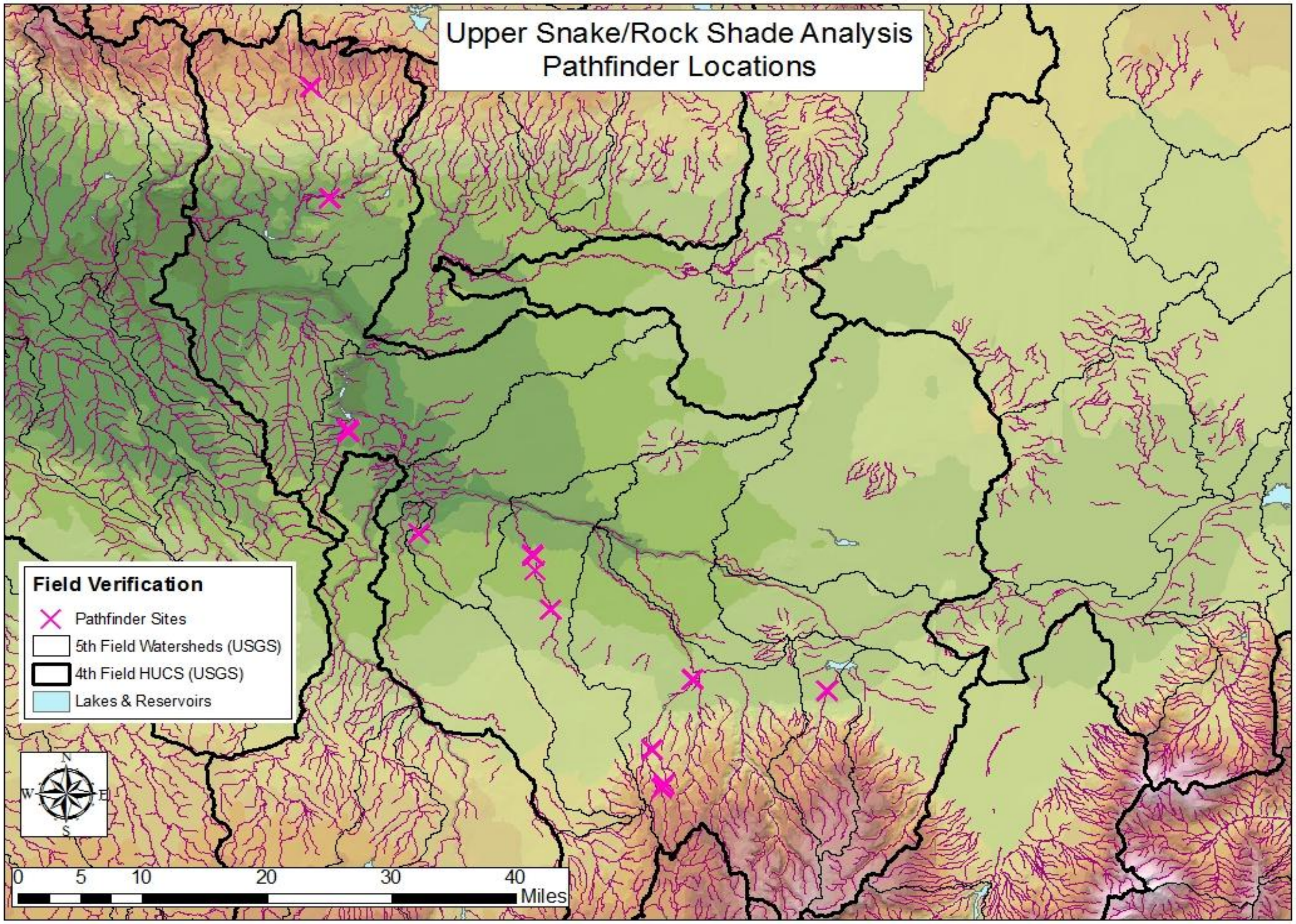


Figure C-9. Locations for field verification of existing shade using the Solar Pathfinder.

Figure C-10. Listing temperature data for Dry Creek (2011STWFTL0017).

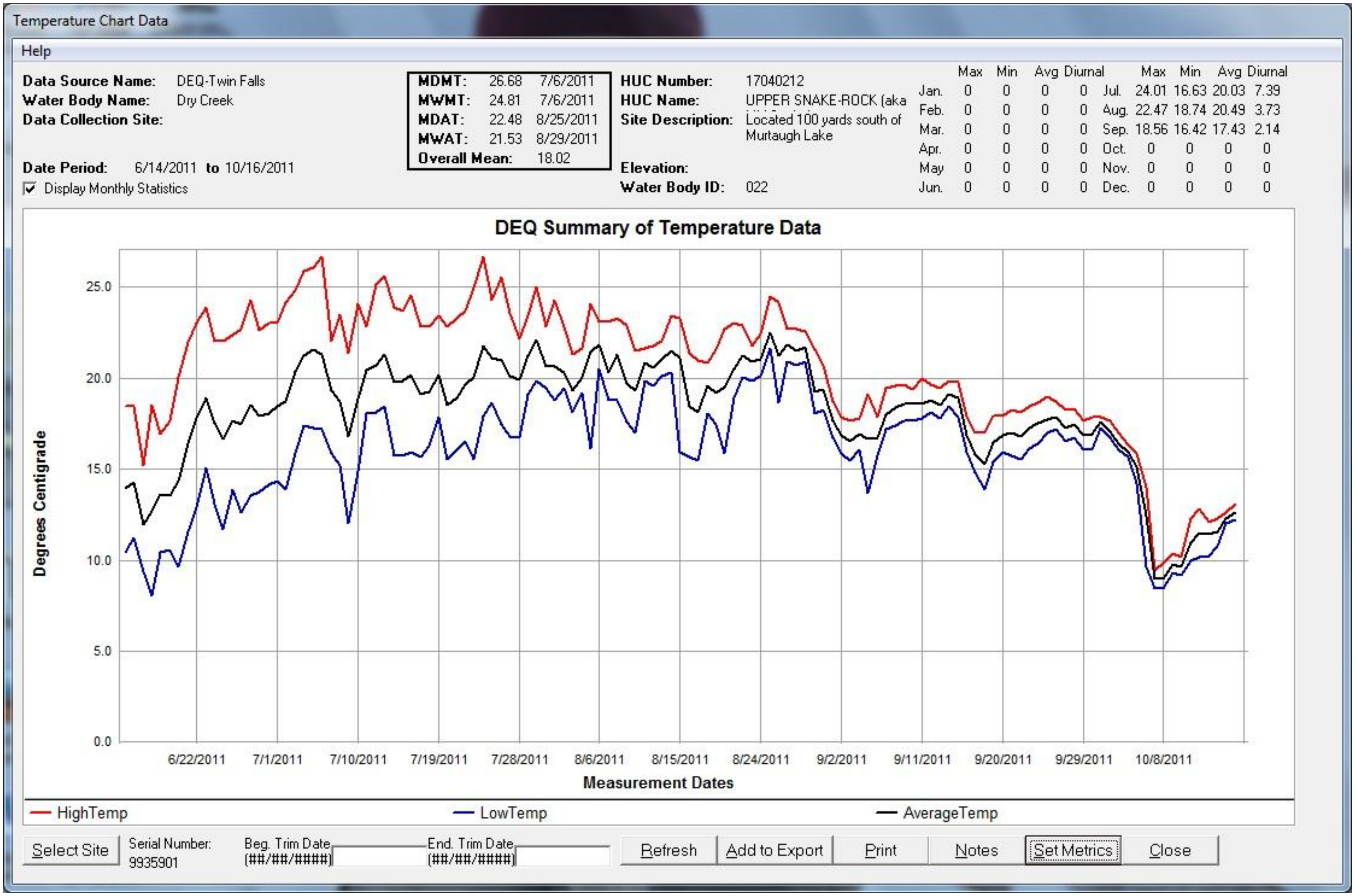


Figure C-11. Listing temperature data for Dry Creek (2011STWFTL0016).

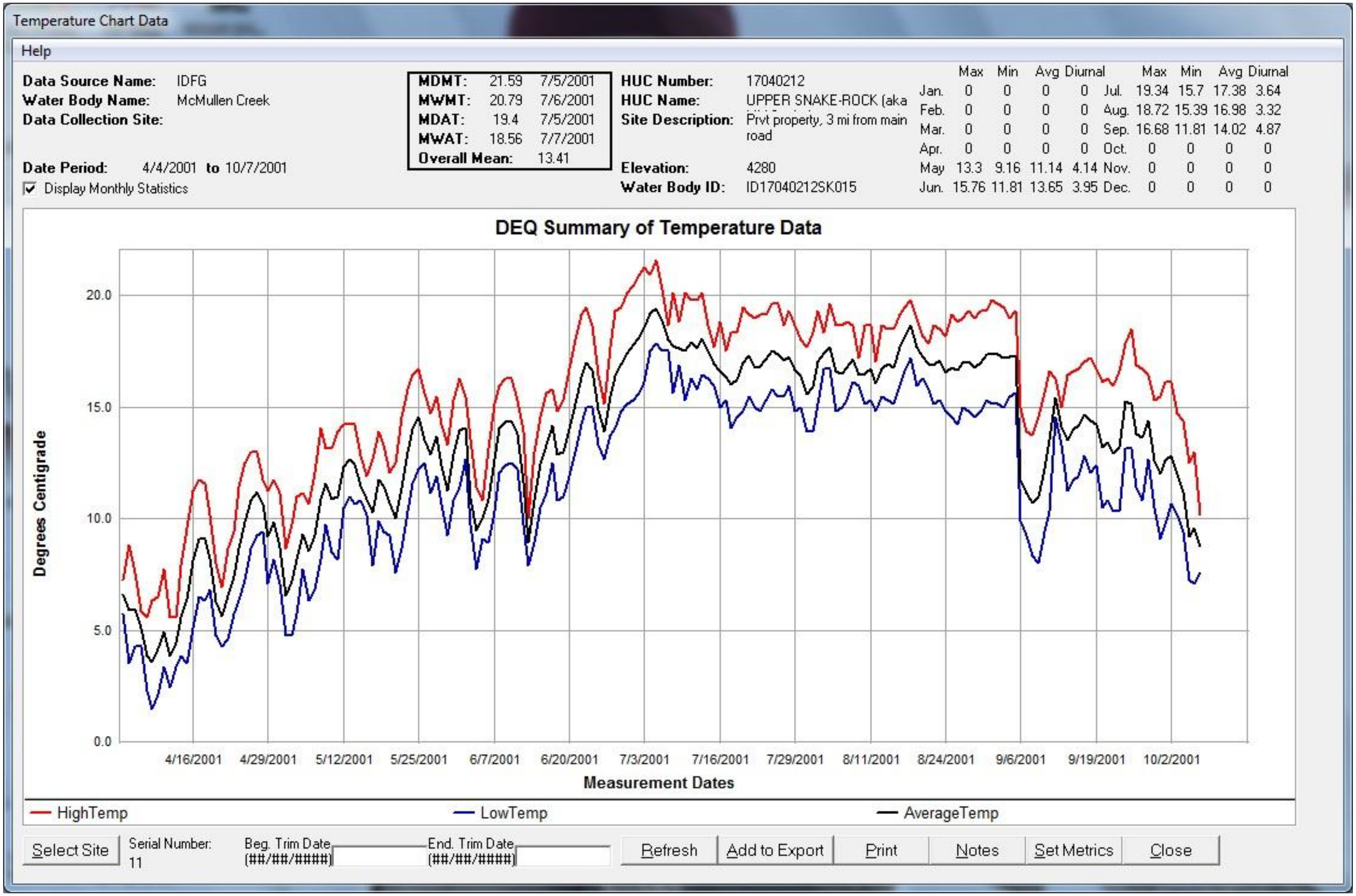


Figure C-12. Listing temperature data for McMullen Creek (2001IDFGTL026).

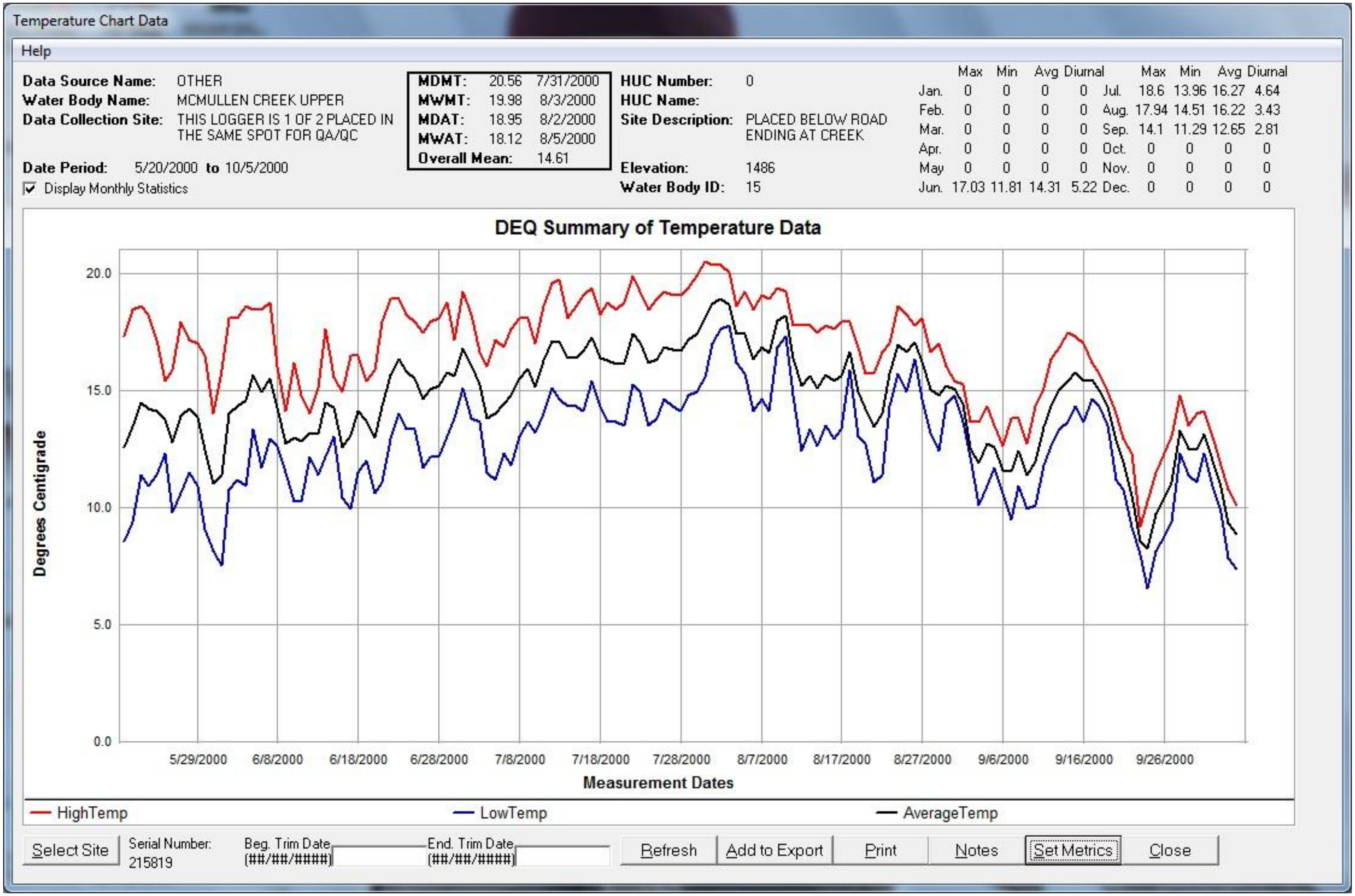


Figure C-13. Listing temperature data for McMullen Creek (2000TWFTL0001).

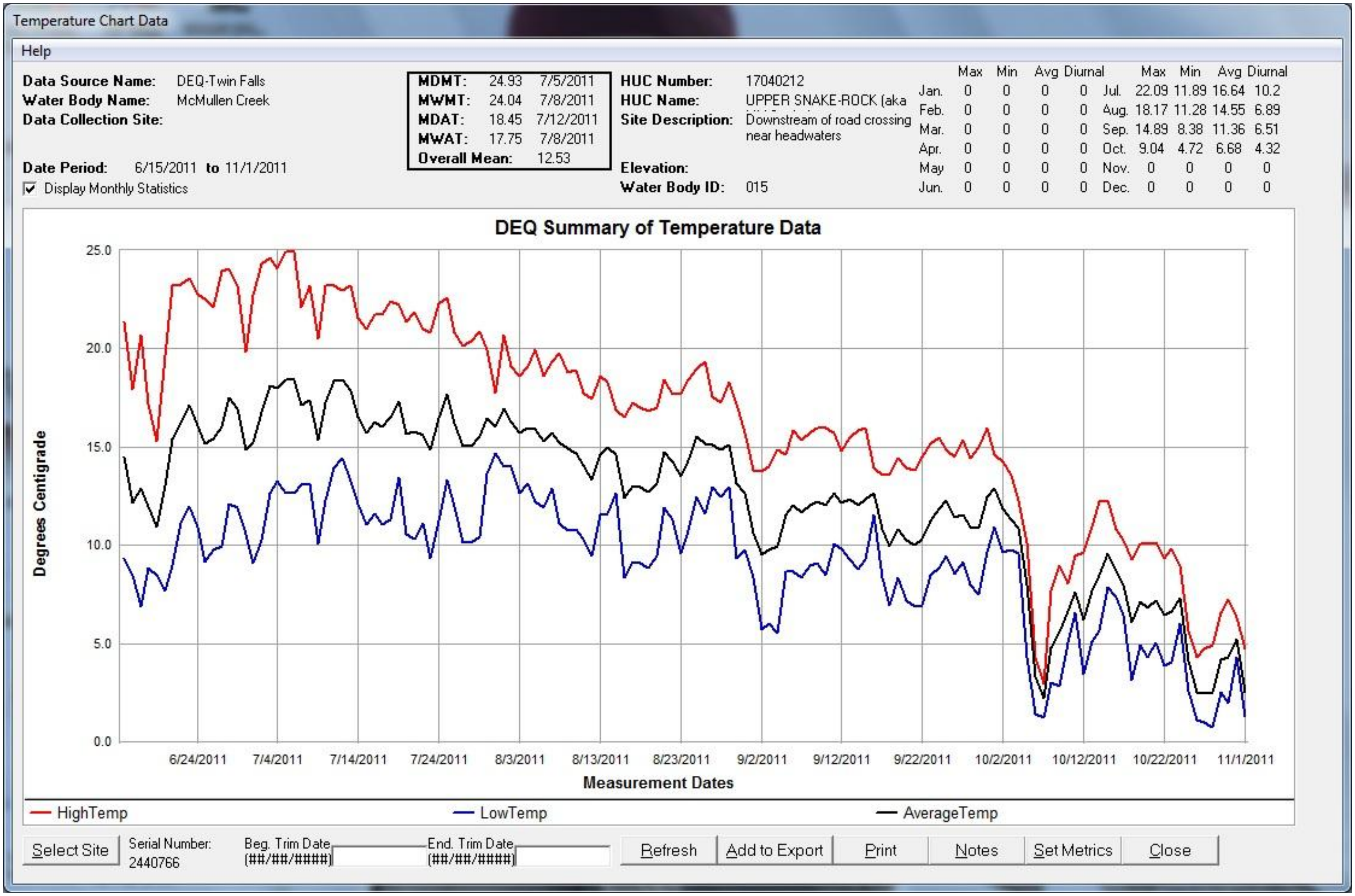


Figure C-14. Listing temperature data for McMullen Creek (2011STWFTL0020).

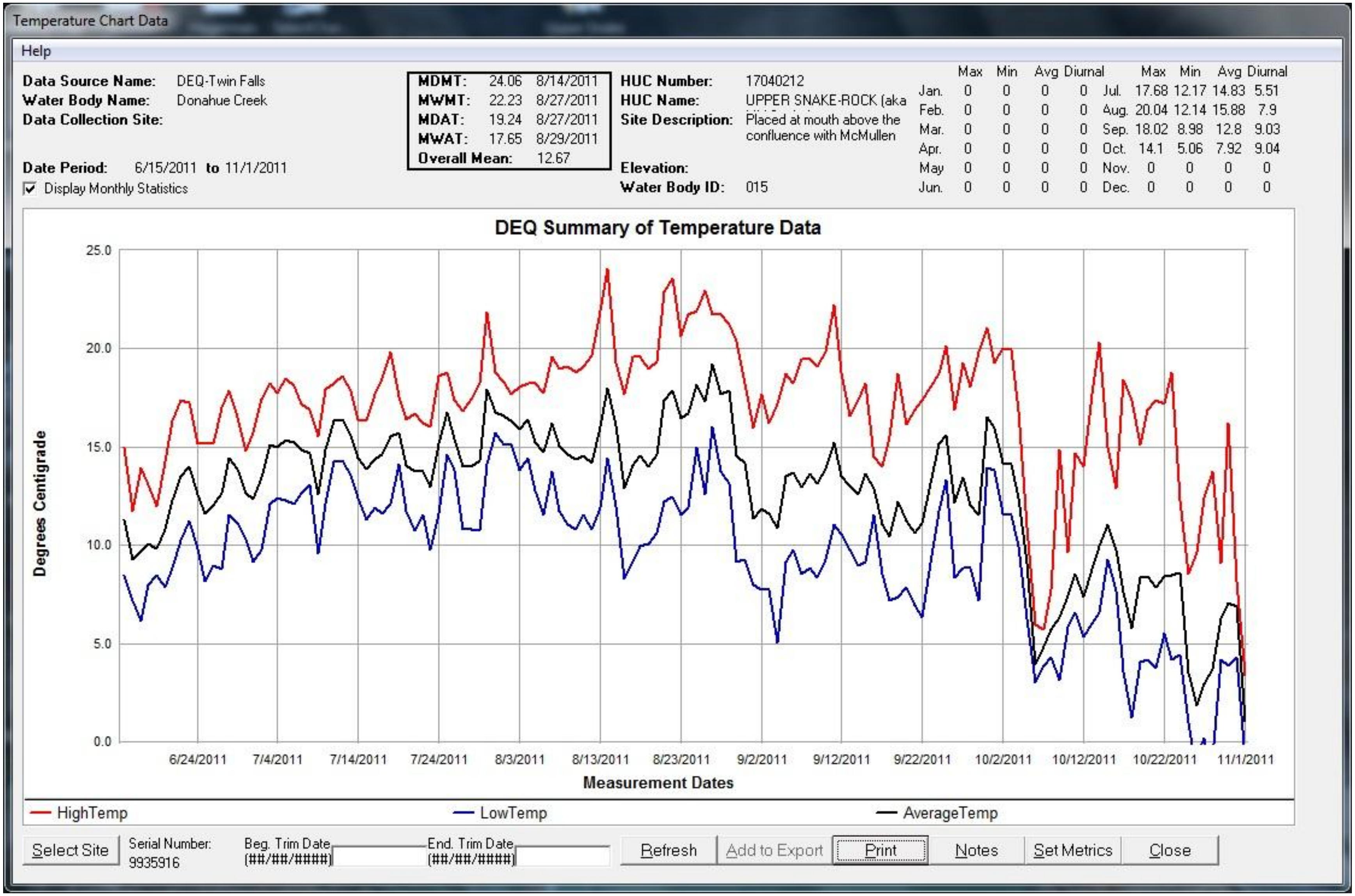


Figure C-15. Listing temperature data for Donahue Creek (2011STWFTL0019).

Figure C-16. Listing temperature data for North Cottonwood Creek (1999TWFTL0000).

Figure C-17. Listing temperature data for Cottonwood Creek (2011STWFTL0018).

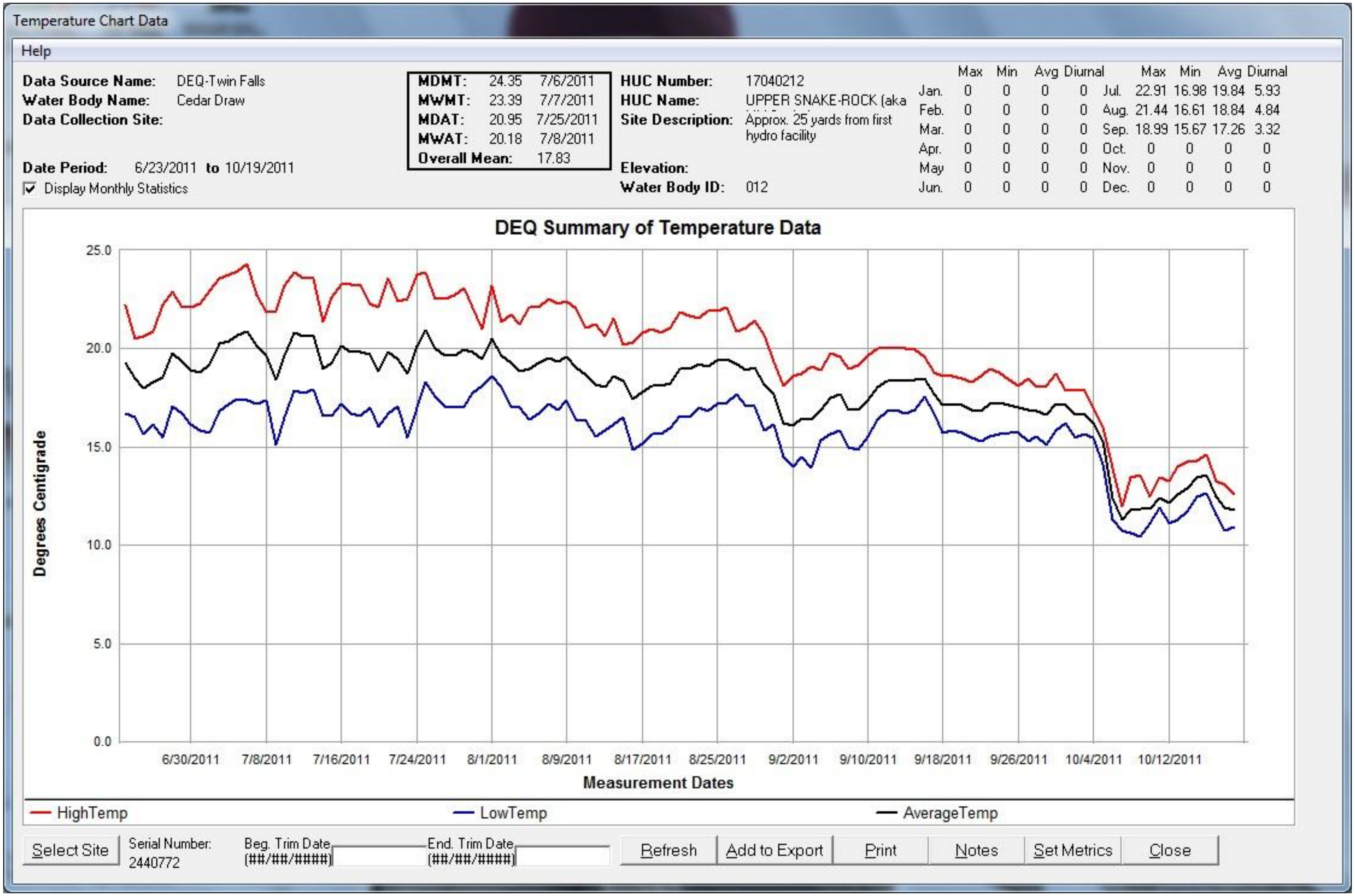


Figure C-18. Listing temperature data for Cedar Draw Creek (2011STWFTL0012).

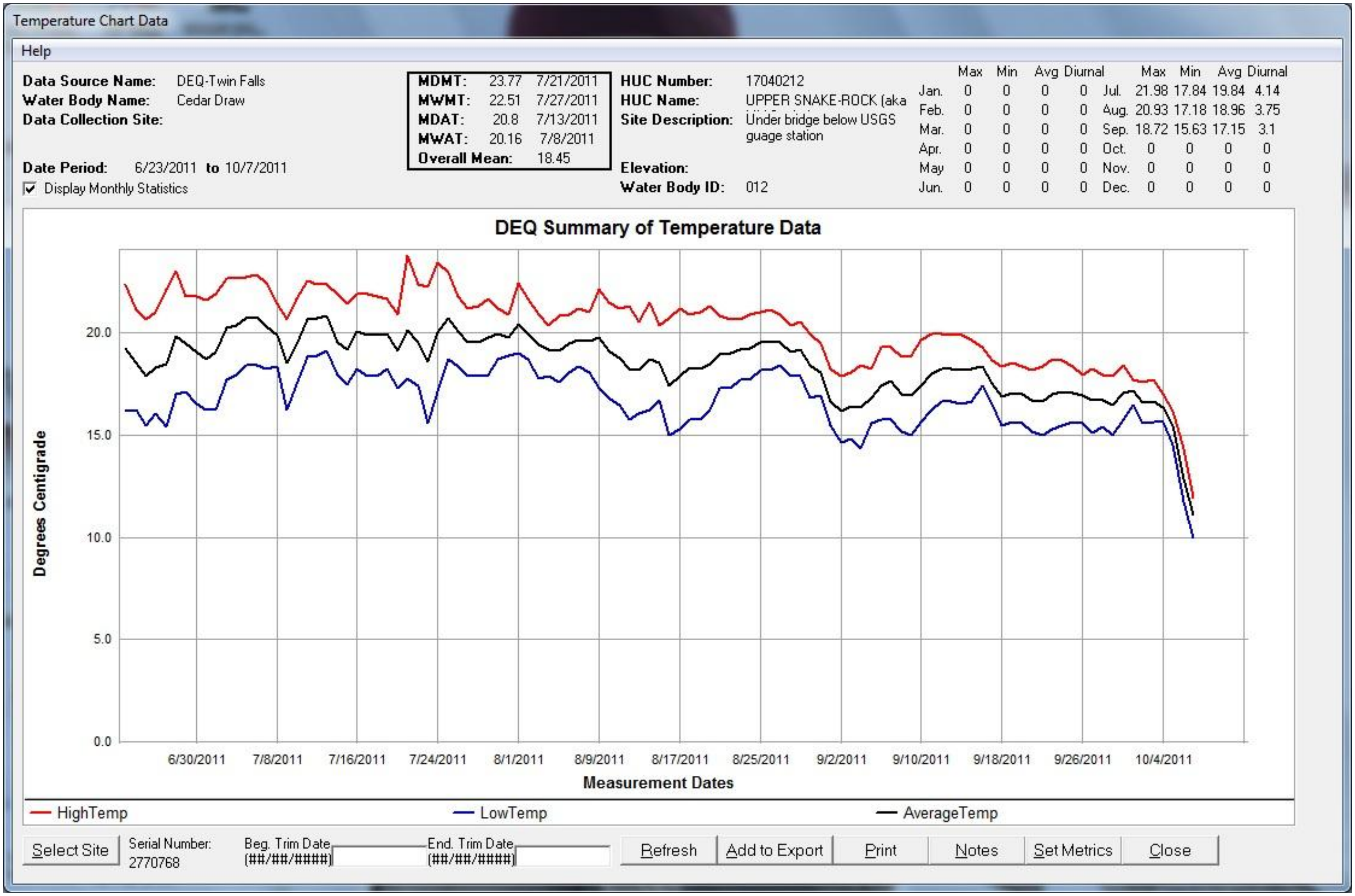


Figure C-19. Listing temperature data for Cedar Draw Creek (2011STWFTL0013).

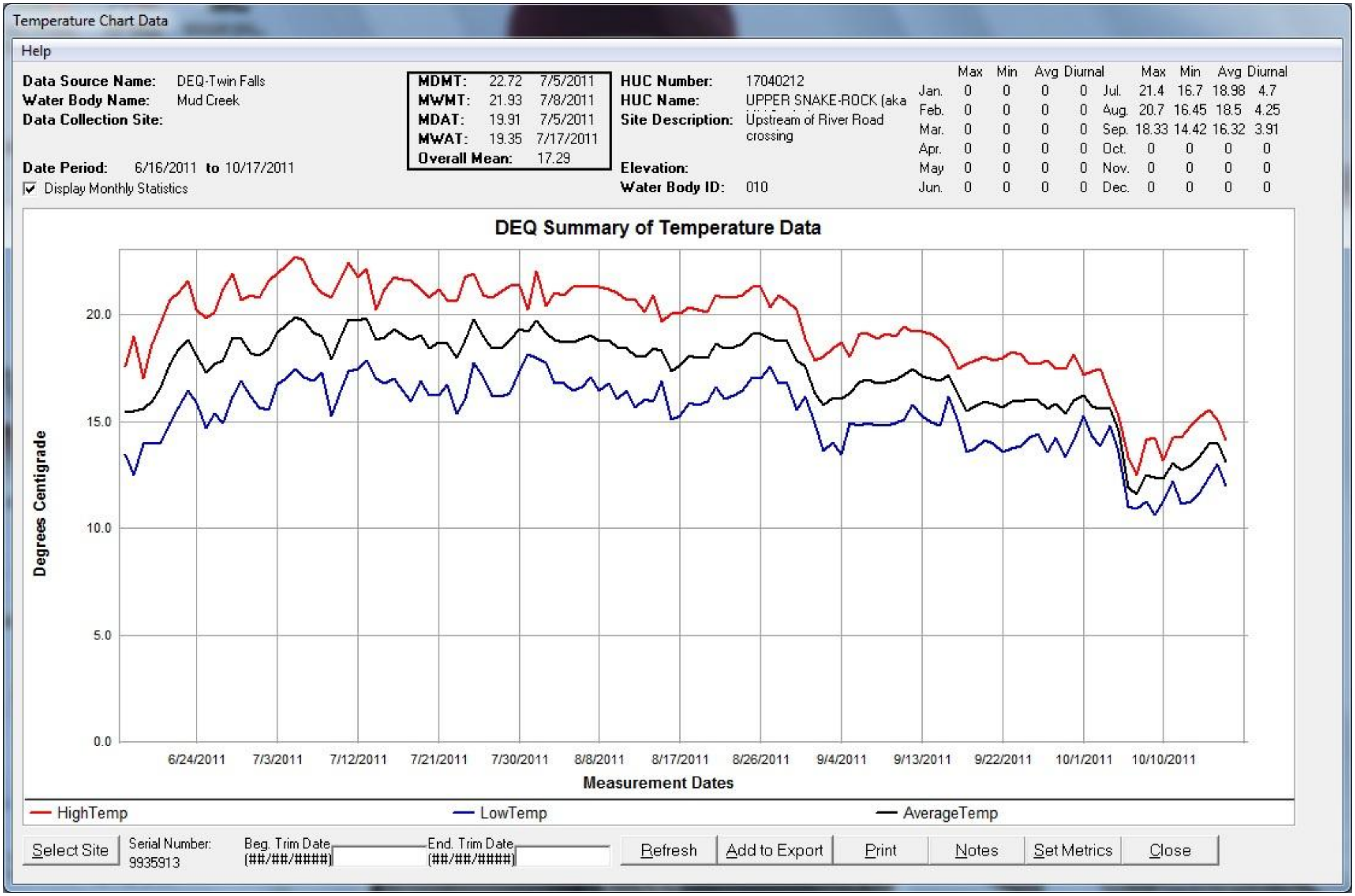


Figure C-20. Listing temperature data for Mud Creek (2011STWFTL0014).

Figure C-21. Listing temperature data for Mud Creek (2011STWFTL0015).

Figure C-22. Listing temperature data for Clover Creek (2011STWFTL0006).

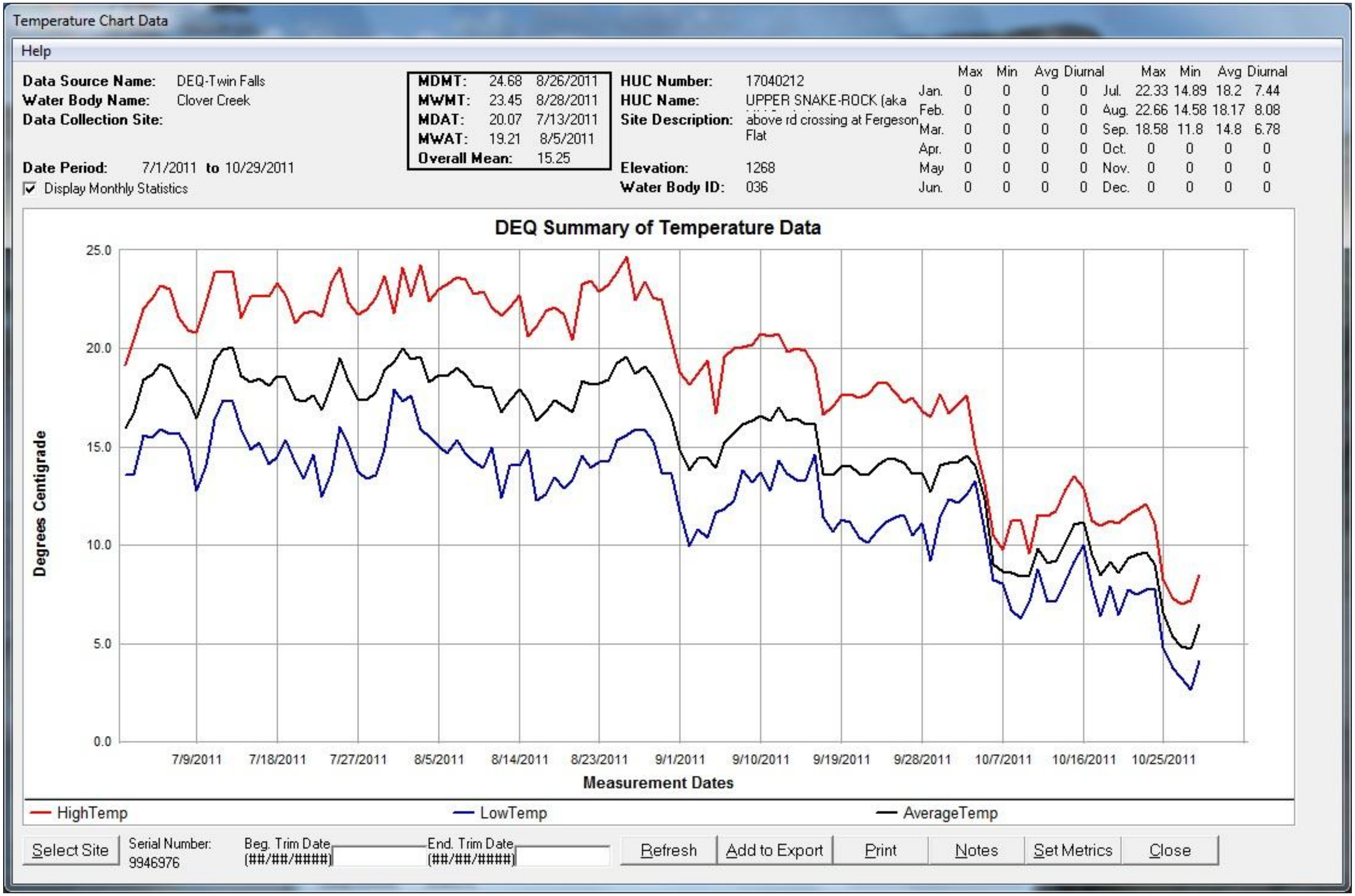


Figure C-23. Listing temperature data for Clover Creek (2011STWFTL0007).

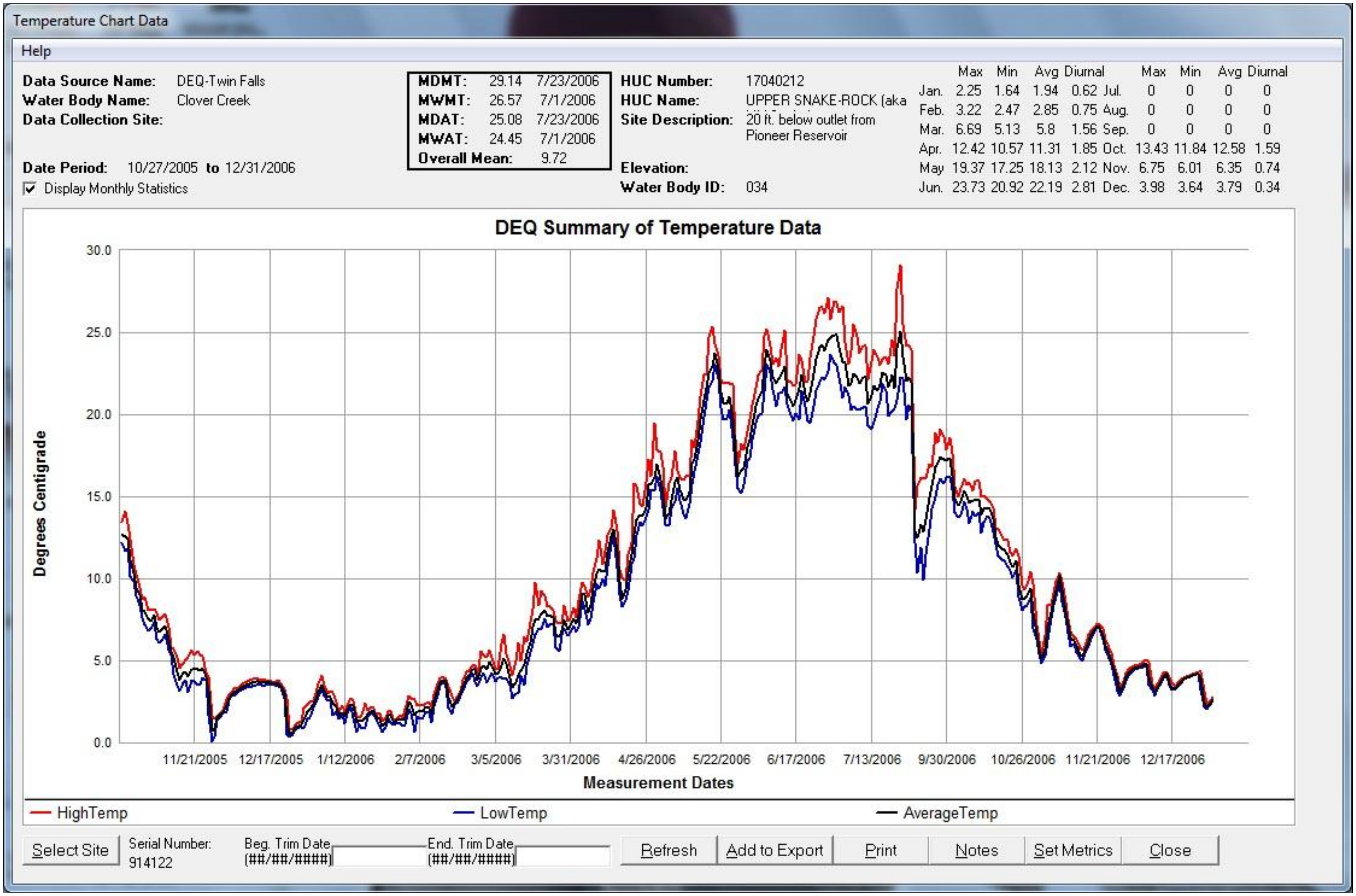


Figure C-24. Listing temperature data for Clover Creek (2005STWFTL0000).

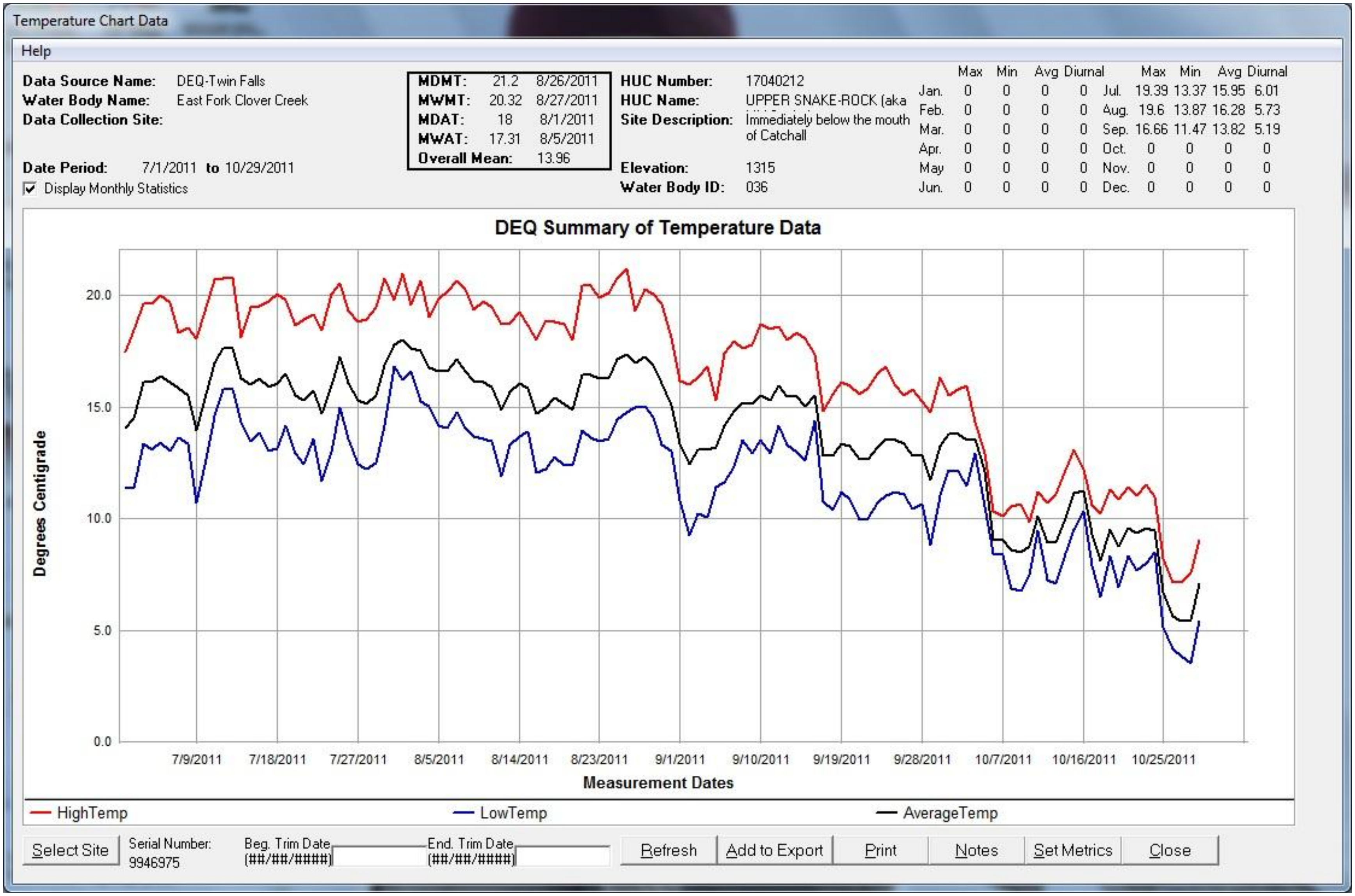


Figure C-25. Listing temperature data for East Fork Clover Creek (2011STWFTL0008).

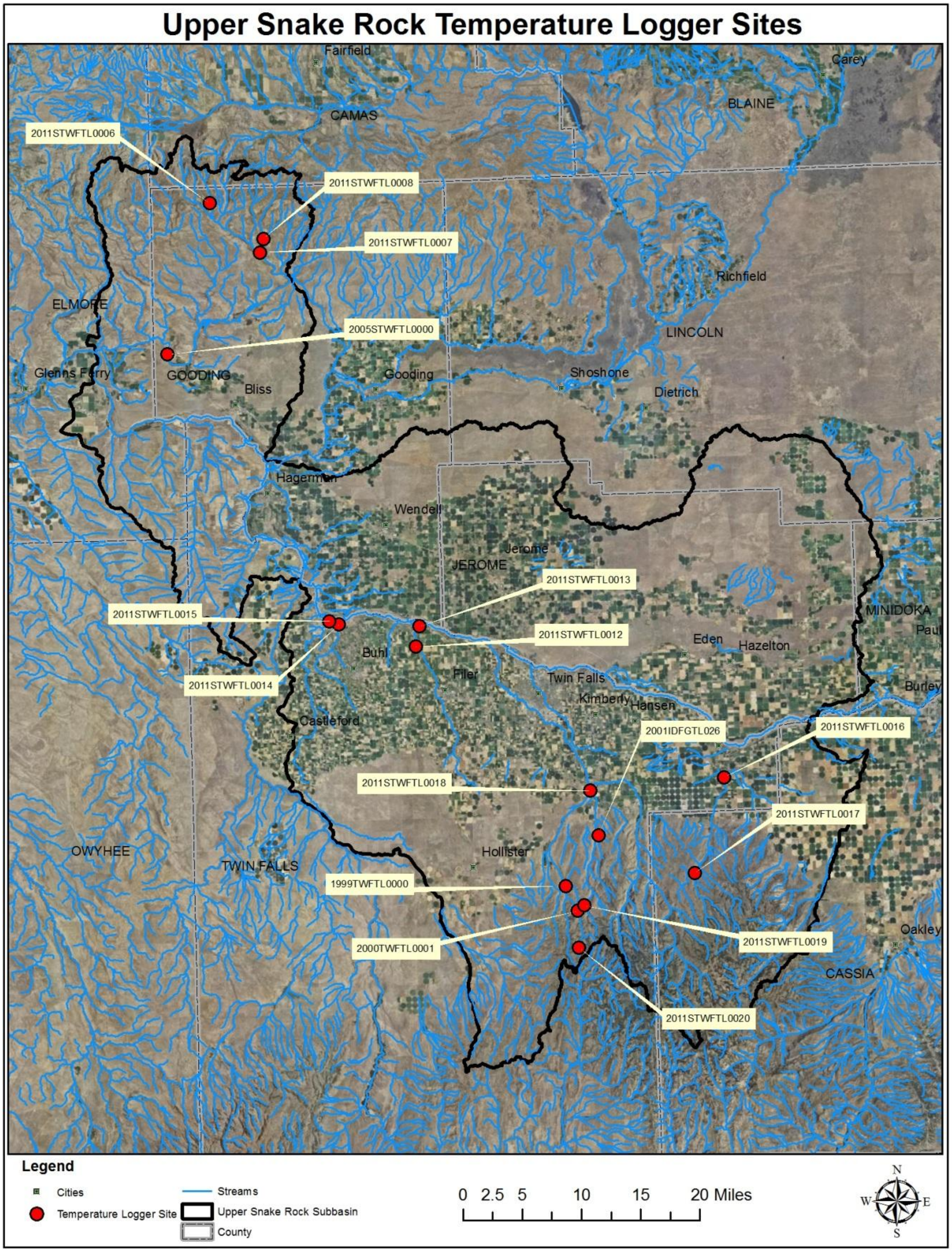


Figure C-26. Location of temperature logger sites.

Appendix D. Distribution List

[To be added following the public comment period.]

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Appendix E. Public Comments

[To be added following the public comment period.]

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