# Wildhorse River Subbasin Assessment and Total Maximum Daily Load

**Department of Environmental Quality**

**April 2007**

# Wildhorse River TMDL

2007

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# Abbreviations, Acronyms, and Symbols

| | |
|---|---|
| **§303(d)** | Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section |
| **µ** | micro, one-one thousandth |
| **§** | Section (usually a section of federal or state rules or statutes) |
| **ADB** | assessment database |
| **AU** | assessment unit |
| **AWS** | agricultural water supply |
| **BLM** | United States Bureau of Land Management |
| **BMP** | best management practice |
| **Btu** | British thermal unit |
| **BURP** | Beneficial Use Reconnaissance Program |
| **C** | Celsius |
| **CFR** | Code of Federal Regulations (refers to citations in the federal administrative rules) |
| **cfs** | cubic feet per second |
| **cm** | centimeters |
| **CWA** | Clean Water Act |
| **CWAL** | cold water aquatic life |
| **DEQ** | Department of Environmental Quality |
| **DO** | dissolved oxygen |
| **DOI** | U.S. Department of the Interior |
| **DWS** | domestic water supply |
| **EPA** | United States Environmental Protection Agency |
| **ESA** | Endangered Species Act |
| **F** | Fahrenheit |
| **FPA** | Idaho Forest Practices Act |
| **GIS** | Geographical Information Systems |
| **HUC** | Hydrologic Unit Code |
| **I.C.** | Idaho Code |
| **IDAPA** | Refers to citations of Idaho administrative rules |
| **IDFG** | Idaho Department of Fish and Game |
| **IDL** | Idaho Department of Lands |
| **IDWR** | Idaho Department of Water Resources |
| **INFISH** | the federal Inland Native Fish Strategy |
| **km** | kilometer |
| **$km^2$** | square kilometer |
| **LA** | load allocation |
| **LC** | load capacity |
| **m** | meter |

| | |
|---|---|
| **$m^3$** | cubic meter |
| **MBI** | Macroinvertebrate Biotic Index |
| **mg/L** | milligrams per liter |
| **mi** | mile |
| **$mi^2$** | square miles |
| **mm** | millimeter |
| **MOS** | margin of safety |
| **MWMT** | maximum weekly maximum temperature |
| **n.a.** | not applicable |
| **NA** | not assessed |
| **NB** | natural background |
| **nd** | no data (data not available) |
| **NFS** | not fully supporting |
| **NRCS** | Natural Resources Conservation Service |
| **ORV** | off-road vehicle |
| **PCR** | primary contact recreation |
| **PFC** | proper functioning condition |
| **RHCA** | riparian habitat conservation area |
| **SBA** | subbasin assessment |
| **SCR** | secondary contact recreation |
| **SFI** | DEQ's Stream Fish Index |
| **SHI** | DEQ's Stream Habitat Index |
| **SMI** | DEQ's Stream Macroinvertebrate Index |
| **SS** | salmonid spawning |
| **T&E** | threatened and/or endangered species |
| **TMDL** | total maximum daily load |
| **U.S.** | United States |
| **U.S.C.** | United States Code |
| **USDA** | United States Department of Agriculture |
| **USFS** | United States Forest Service |
| **USGS** | United States Geological Survey |
| **WAG** | Watershed Advisory Group |
| **WBAG** | *Water Body Assessment Guidance* |
| **WQLS** | water quality limited segment |
| **WQS** | water quality standard |

# Executive Summary

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

This document addresses the Wildhorse River in the Wildhorse River Subbasin which has been placed on Idaho's current §303(d) list.

This subbasin assessment (SBA) and TMDL analysis have been developed to comply with Idaho's TMDL schedule. The assessment describes the physical, biological, and cultural setting; water quality status; pollutant sources; and recent pollution control actions in the Wildhorse River Subbasin, located in west central Idaho.

The first part of this document, the SBA, is an important first step in leading to the TMDL. The starting point for this assessment was Idaho's current §303(d) list of water quality limited water bodies. The SBA examines the current status of §303(d) listed waters and defines the extent of impairment and causes of water quality limitation throughout the subbasin. The TMDL analysis quantifies pollutant sources and allocates responsibility for load reductions needed to return listed waters to a condition of meeting water quality standards.

## Subbasin at a Glance

The Wildhorse River watershed is part of the Brownlee Reservoir Subbasin (17050201), which is located in southwestern Idaho on the border between Idaho and Oregon (Figures A and B). In 2000, the Environmental Protection Agency (EPA) added streams to Idaho's 1998 §303d list of impaired waters that exceeded Idaho's temperature criteria. In the Brownlee Reservoir Subbasin, Wildhorse River was among those EPA additions.

The headwaters of the Wildhorse River originate in forested land at the southern end of the Seven Devils Mountains, which form the eastern border of Hells Canyon. The river flows southwesterly out of these mountains and enters the Snake River between Brownlee Dam and Oxbow Reservoir. This portion of the Snake River forms the border between the states of Idaho and Oregon. Although some of the southerly tributaries flow out of Washington County, the mainstem is located solely in the southern portion of Adams County. There are no towns and very few inhabitants located on the Wildhorse River. The unincorporated community of Bear is located in the Wildhorse Basin.

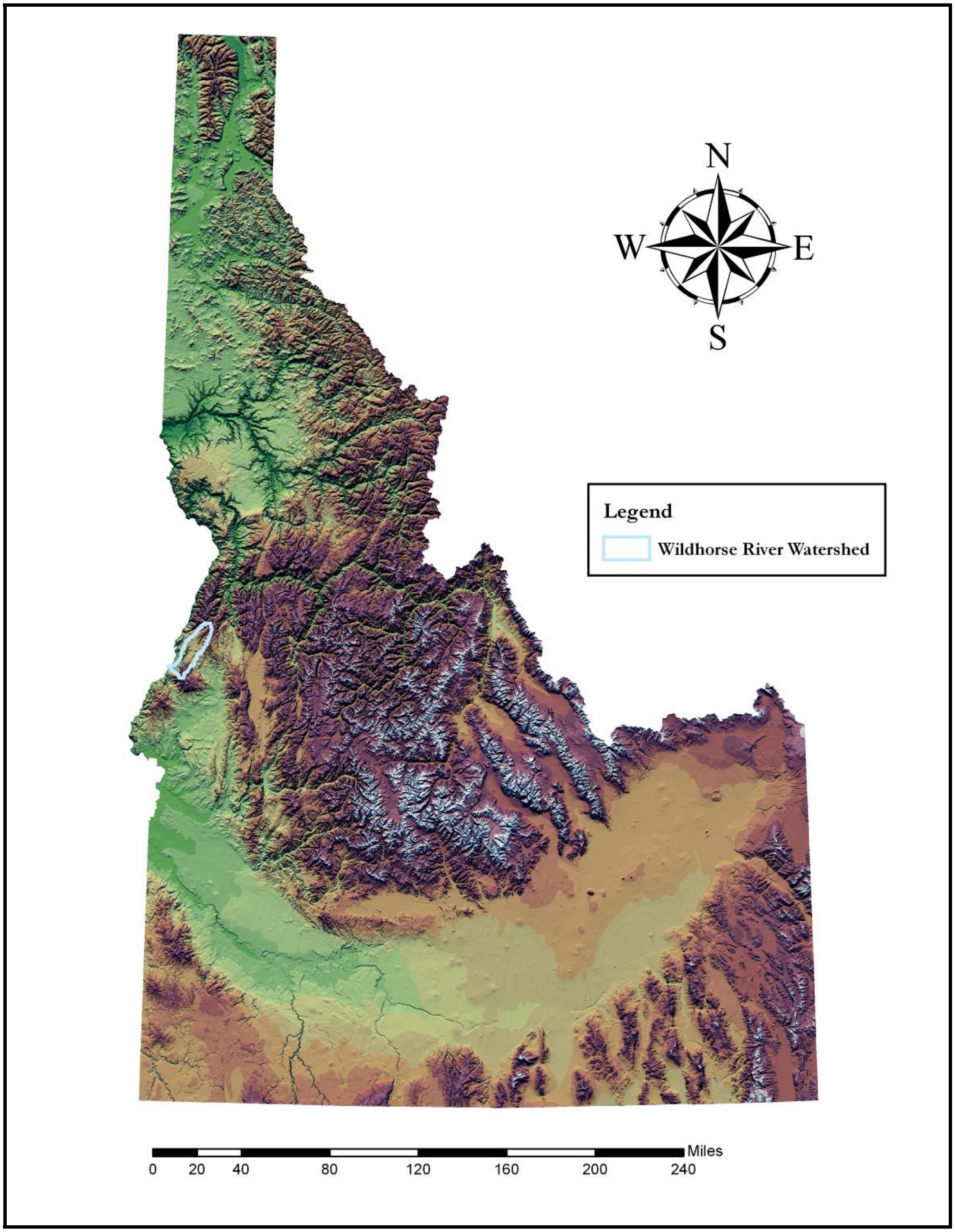



**Figure A. Location of Wildhorse River Watershed**

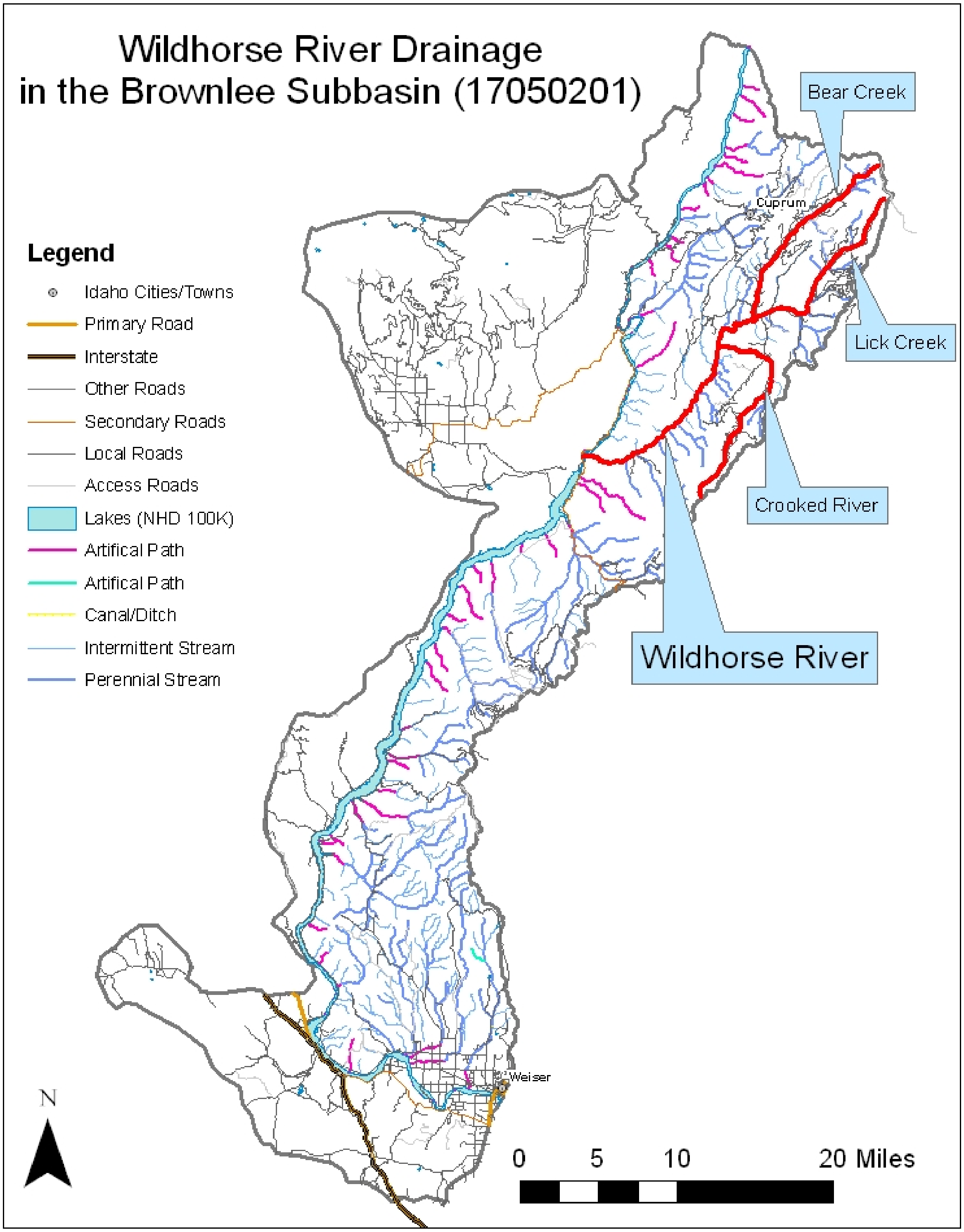



**Figure B. Wildhorse River Watershed in the Brownlee Reservoir Subbasin**

## Key Findings

The Wildhorse River was placed on the 1998 §303d list of impaired waters by EPA for reasons associated with temperature criteria violations (Tables A and B). This listing was carried over to the 2002 §303d list. In order to fully evaluate the heat loading to this river, its major tributaries (Bear Creek, Lick Creek, and the Crooked River) were also examined (Figure B).

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

| Stream | Pollutant(s) |
|---|---|
| Wildhorse River | Temperature |

**Table B. Summary of Assessment Outcomes**

| Water Body Segment/AU | Pollutant | TMDL(s) Completed | Recommended Changes to §303(d) List | Justification |
|---|---|---|---|---|
| Wildhorse River ID17050201SW015_04 | Temperature | Yes | n.a. | Existing Shade |

Effective shade targets were established for Wildhorse River and its three major tributaries based on the assumption that maximum shading under potential natural vegetation equals natural background temperature levels. Shade targets were actually derived from effective shade curves developed for similar vegetation types in the Northwest. Existing shade was determined from aerial photo interpretation field, which was verified with solar pathfinder data. Salmonid spawning temperature criteria including EPA bull trout temperature criteria were exceeded in Lick Creek, Bear Creek and Crooked River as well as the Wildhorse River. These tributaries will not be added to the 303(d) list (Integrated Report) because the TMDL allocation for the Wildhorse River addresses these tributaries. These tributaries will go in the next Integrated Report in the section covering waterbodies with an approved TMDL.

An analysis of shade reveals that the Wildhorse River is slightly below target shade levels and would require a 12% reduction in its own solar load to achieve background conditions. Additionally, the heat loading in the river is compounded by the excess solar loading to Lick Creek, Bear Creek, and Crooked River. Most streams appear to be in relatively good condition and should be considered of relatively lower priority for implementation, except for Lick Creek, which appears to have some excess heat loading that should be investigated further. However, improvements in riparian cover anywhere in the system would be beneficial to the watershed.

## Public Participation

The Wildhorse Watershed Advisory Group (WAG) first met August 21, 2006. Subsequent meetings were held September 28, 2006 and November 9, 2006. In the November meeting, the WAG voted unanimously to send the document out for public comment. The public comment period extended from November 29$^{th}$, 2006 through January 4, 2007.

# 1. Subbasin Assessment – Watershed Characterization

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

This document addresses the water bodies in the Wildhorse River Subbasin that have been placed on Idaho's current §303(d) list.

The overall purpose of the subbasin assessment (SBA) and TMDL is to characterize and document pollutant loads within the Wildhorse River Subbasin. The first portion of this document, the SBA, is partitioned into four major sections: watershed characterization, water quality concerns and status, pollutant source inventory, and a summary of past and present pollution control efforts (Sections 1–4). This information will then be used to develop a TMDL for each pollutant of concern for the Wildhorse River Subbasin (Section 5).

## 1.1 Introduction

In 1972, Congress passed the Federal Water Pollution Control Act, more commonly called the Clean Water Act. The goal of this act was to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters" (Water Environment Federation 1987, p. 9). The act and the programs it has generated have changed over the years, as experience and perceptions of water quality have changed.

The CWA has been amended 15 times, most significantly in 1977, 1981, and 1987. One of the goals of the 1977 amendment was protecting and managing waters to insure "swimmable and fishable" conditions. This goal, along with a 1972 goal to restore and maintain chemical, physical, and biological integrity, relates water quality with more than just chemistry.

### Background

The federal government, through the U.S. Environmental Protection Agency (EPA), assumed the dominant role in defining and directing water pollution control programs across the country. The Department of Environmental Quality (DEQ) implements the CWA in Idaho, while the EPA oversees Idaho and certifies the fulfillment of CWA requirements and responsibilities.

Section 303 of the CWA requires DEQ to adopt water quality standards and to review those standards every three years. (EPA must approve Idaho's water quality standards.) Additionally, DEQ must monitor waters to identify those not meeting water quality standards. For those waters not meeting standards, DEQ must establish a TMDL for each pollutant impairing the waters. Further, the agency must set appropriate controls to restore water quality and allow the water bodies to meet their designated uses.

These requirements result in a list of impaired waters, called the "§303(d) list." This list describes water bodies not meeting water quality standards. Waters identified on this list require further analysis. An SBA and TMDL provide a summary of the water quality status and allowable TMDL for water bodies on the §303(d) list. The Wildhorse River Subbasin TMDL provides this summary for the currently listed waters in the Wildhorse River Subbasin.

The SBA section of this document (Sections 1–4) includes an evaluation and summary of the current water quality status, pollutant sources, and control actions in the Wildhorse River Subbasin to date. While this assessment is not a requirement of the TMDL, DEQ performs the assessment to ensure impairment listings are up to date and accurate. The TMDL is a plan to improve water quality by limiting pollutant loads. Specifically, a TMDL is an estimation of the maximum pollutant amount that can be present in a water body and still allow that water body to meet water quality standards (Water quality planning and management, 40 CFR Part 130). Consequently, a TMDL is water body- and pollutant-specific. The TMDL also allocates allowable discharges of individual pollutants among the various sources discharging the pollutant.

Some conditions that impair water quality do not receive TMDLs. The EPA does consider certain unnatural conditions, such as flow alteration, human-caused lack of flow, or habitat alteration, that are not the result of the discharge of a specific pollutants as "pollution." However, TMDLs are not required for water bodies impaired by pollution but not by specific pollutants. A TMDL is only required when a pollutant can be identified and in some way quantified.

## Idaho's Role

Idaho adopts water quality standards to protect public health and welfare, enhance the quality of water, and protect biological integrity. A water quality standard defines the goals of a water body by designating the use or uses for the water, setting criteria necessary to protect those uses, and preventing degradation of water quality through antidegradation provisions.

The state may assign or designate beneficial uses for particular Idaho water bodies to support. These beneficial uses are identified in the Idaho water quality standards and include the following:

- Aquatic life support—cold water, seasonal cold water, warm water, salmonid spawning, modified
- Contact recreation—primary (swimming), secondary (boating)
- Water supply—domestic, agricultural, industrial
- Wildlife habitats
- Aesthetics

The Idaho legislature designates uses for water bodies. Industrial water supply, wildlife habitats, and aesthetics are designated beneficial uses for all water bodies in the state. If a water body is unclassified, then cold water and primary contact recreation are used as additional default designated uses when water bodies are assessed.

An SBA entails analyzing and integrating multiple types of water body data, such as biological, physical/chemical, and landscape data to address several objectives:

- Determine the degree of designated beneficial use support of the water body (i.e., attaining or not attaining water quality standards).
- Determine the degree of achievement of biological integrity.
- Compile descriptive information about the water body, particularly the identity and location of pollutant sources.
- Determine the causes and extent of the impairment when water bodies are not attaining water quality standards.

Idaho has been intensively investigating temperature criteria for the last decade. As part of this effort, Idaho has expanded the definition of natural background to take into account waters that will not naturally meet our state criteria even under pristine conditions. DEQ formally dissented with EPA's opinion on regional temperature criteria after researching temperatures in streams that run through relatively undisturbed areas. DEQ found that many of these streams did not meet the temperature criteria at certain times of the year.

In March 2006, DEQ held a temperature summit to discuss the issues and options before the state. These include keeping our current temperature criteria, developing site specific criteria, using potential natural vegetation as a surrogate for the temperature criteria, or adopting EPA Region 10 guidance. All of these avenues have definite pros and cons, and selection of a particular path is still under consideration.

## 1.2 Physical and Biological Characteristics

The Wildhorse River watershed lies within the Brownlee Reservoir Subbasin (Hydrologic Unit Code [HUC] 17050201). The headwaters of the Wildhorse River originate in forested land at the southern end of the Seven Devils Mountains, which form the eastern border of Hells Canyon. The river flows southwesterly out of these mountains and enters the Snake River between Brownlee Dam and Oxbow Reservoir. This portion of the Snake River forms the border between the states of Idaho and Oregon. Although some of the southerly tributaries flow out of Washington County, the mainstem is located solely in the southern portion of Adams County. There are no towns and very few inhabitants located on the Wildhorse River, though the unincorporated community of Bear is located in the Wildhorse Basin.

The Wildhorse River watershed contains four sixth-level hydrologic units, comprising almost 56,000 acres. Land ownership is approximately 86% federal (Payette National Forest and Bureau of Land Management) and 13% private, with less than 1% belonging to the State of Idaho (Southwest Basin Native Fish Technical Group, 1999). Wildhorse River is formed at the confluence of Crooked River and Bear Creek (Figure B). A narrow, linear, steeply graded river, the Wildhorse River flows into the Snake River just downstream of Brownlee Dam. A natural fish barrier, Bear Creek Falls, which is a 60 foot waterfall, is present in the lower Bear Creek watershed, forming a barrier between the Wildhorse River and the Bear Creek/Lick Creek subwatersheds.

## Climate

Climate data from the OX ranch in the Wildhorse River Subbasin is shown in Figures 1.1 and 1.2 below.

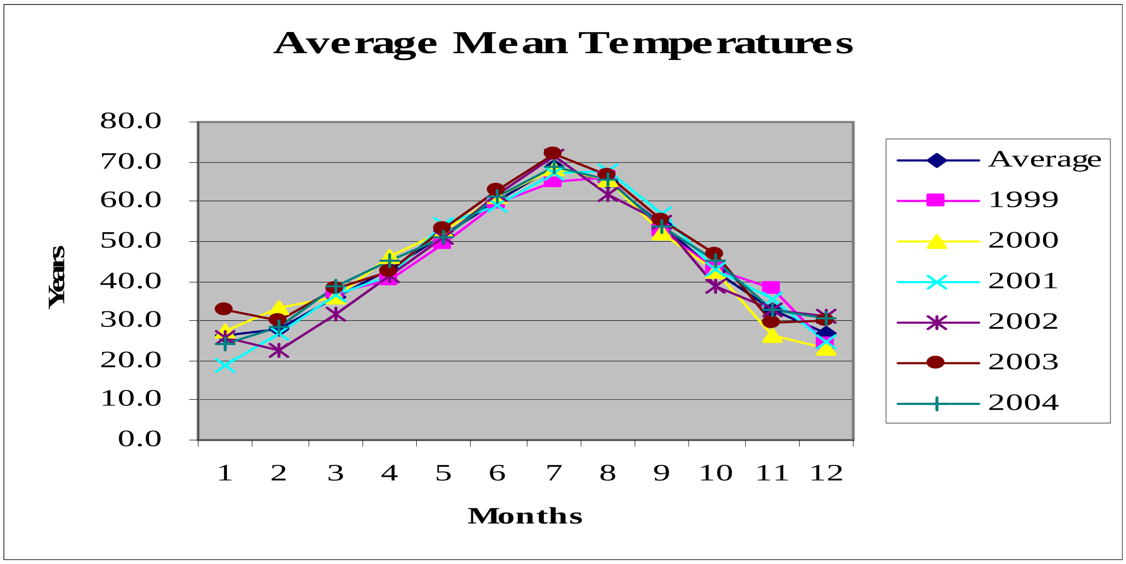



**Figure 1.1. Average Mean Temperature at OX Ranch**

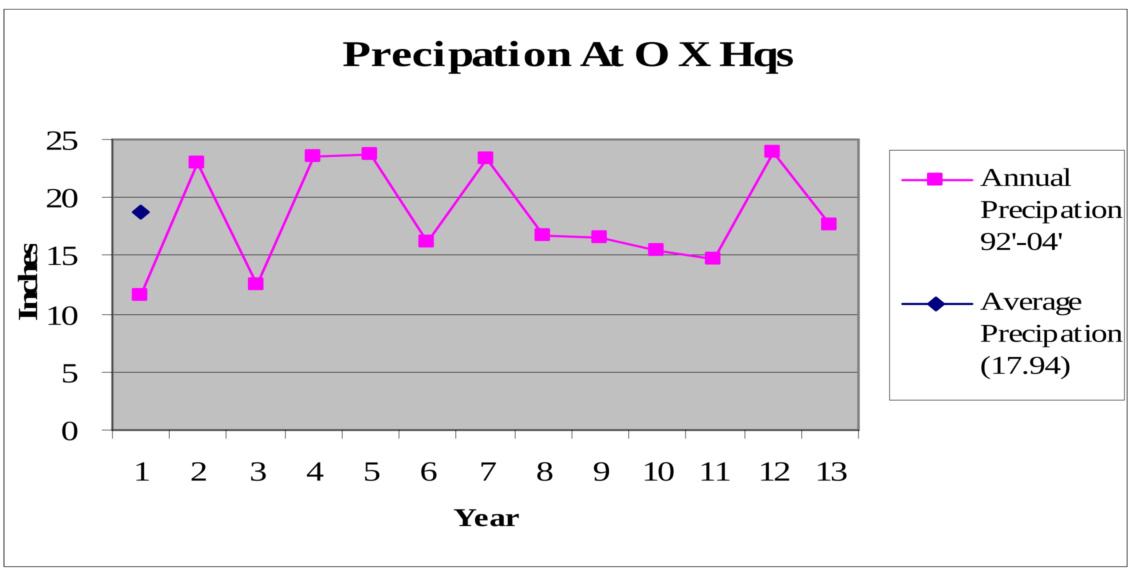



**Figure 1.2. Annual Average Precipitation at OX Ranch**

The climate of the area is influenced by both maritime and topographic factors. During winter and spring months, the Aleutian low pressure systems originating in the North Pacific bring moisture-laden air masses that account for the winter snow pack and spring rains. During the summer months, the Pacific high-pressure systems dominate the area, leading to prolonged dry periods interrupted by short duration and sometimes high-intensity thunderstorms. Precipitation ranges from 25-45 inches, increasing with elevation. Upper elevations can receive as much as 80-90% of precipitation in the form of snow from October to April. “Rain-on-snow” events can occur during the winter.

## Subbasin Characteristics

The following section describes general subbasin characteristics such as geology, vegetation, fisheries, and topography for the Wildhorse watershed.

### *Geology*

As shown in Figure 1.3, the majority of the geologic features in the Wildhorse watershed are of volcanic or meta-volcanic origin. The geology coverage is from John G. Bond, USGS, IDL, and Bureau of Mines, published in 1995.

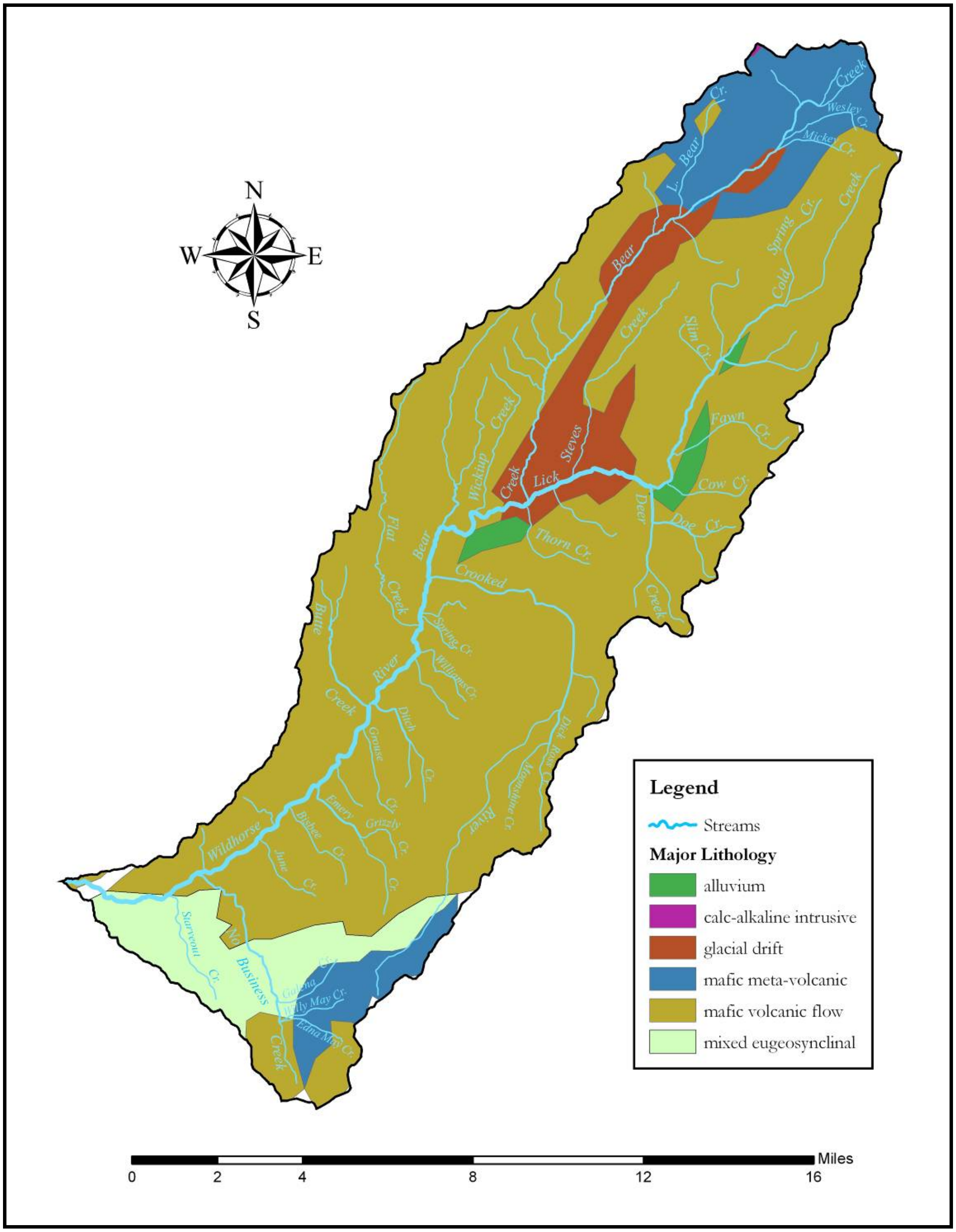



**Figure 1.3. Wildhorse River Geology (IDL 1995)**

## *Vegetation*

Vegetation at lower elevations consists principally of grass/shrublands, with ponderosa pine and Douglas fir only occurring on aspects where snowmelt is prolonged and evapotranspiration is limited by shading. Ponderosa and Douglas fir communities are typically found on south and east aspects under those conditions. Douglas fir and grand fir forests are found on north and east aspects.

Midslopes on southern aspects support ponderosa pine as well as the above-mentioned Douglas fir, grand fir, and subalpine fir. The vegetation is controlled by frost pockets with subalpine fir, lodgepole pine, and whitebark pine dominating those pocket landscapes. Aspens are found in seeps and other water holding areas. Larch is only found on the deep, soiled, moist benches.

Upper elevations support Douglas fir, grand fir, and subalpine fir with pockets of western larch, lodgepole pine, and aspen found in the above-mentioned conditions.

Riparian vegetation can be diverse and includes alders, red-osier dogwood, syringas, and occasionally, water birch, and cottonwoods.

### *Fisheries*

The Wildhorse River provides habitat for rainbow trout, brook trout, chiselmouth, flathead minnow, largescale sucker, longnose dace, mountain whitefish, northern pikeminnow, paiute sculpin, pumpkinseed, redside shiner, shorthead sculpin, smallmouth bass, speckled dace, torrent sculpin, warmouth, white crappie, bull trout, and redband trout. Rainbow and/or redband trout have been found in Bear Creek, Lick Creek, Crooked River, and the Wildhorse River. Bull trout have been documented in Bear Creek and the Crooked River but appear to have very limited distribution. Bull trout-brook trout hybrids have been observed in the Wildhorse drainage. Bear Creek falls, occurring below the confluence with Lick Creek, is a significant natural barrier to fish distribution.

The bull trout in the Wildhorse drainage are believed to be resident fish, although there is some uncertainty whether the bull trout found in the Bear Creek watershed above Bear Creek Falls are native to the area or were introduced. Habitat fragmentation due to the construction of dams in the Hells Canyon Complex of the Snake River has contributed to isolation of this bull trout population. Barriers to bull trout movement exist in the drainage at the Forest Road 130 crossing in Upper Bear Creek. This barrier may also restrict the distribution of brook trout, which may actually help the bull trout population by reducing the risk of introgression. Eleven bull trout were collected in 1999 at sites above 1600 meters in Bear Creek. Twenty-seven bull trout were collected in Crooked River in 2000.

Brook trout are found throughout the upper Bear Creek area and are a limiting factor for the bull trout population. Near Huckleberry Campground and farther upstream, Bear Creek is cool, with temperatures more favorable for bull trout than at many lower elevation sites. One significant feature is Bear Creek Falls, a natural fish migration barrier located in T19N, R3W, Sec.16 downstream of the confluence with Lick Creek.

The Crooked River also has bull trout and does not have a significant fish barrier. At least one bull trout of 9.5 inches (242 mm) was collected from Crooked River in 1999. Bull trout have been found as far downstream as Lafferty Campground, although there may be thermal barriers to their distribution in this area. However, bull trout have yet to be firmly identified in the Oxbow reach of the Snake River, and downstream migrants have not been collected in the Idaho Power weir at the mouth of the Wildhorse River.

Nelson and Burns (1998) determined that bull trout were unlikely to occur in Lick Creek because of the limited amount of contiguous stream above 5,249 feet, and previous investigations had not documented their presence. From 1999 through 2003, approximately 175 sites (100 meters per site) were surveyed to determine fish distribution in the analysis area. Redband trout and brook trout were the only species collected.

Fourteen known and three potential fish passage barrier culverts have created patches of unconnected stream habitat in the Lick Creek subwatershed. Approximately 12 miles of fishbearing stream exist upstream of the known barriers, and 18 miles of fishbearing habitat exist upstream of the potential barriers.

The most obvious limiting factor in the watershed as a whole is the lack of habitat for supporting bull trout populations. Fragmentation in the Snake River has reduced potential connectivity among headwaters populations, which has reduced reproductive potential. Bull trout are now mainly restricted to small headwaters populations, and the amount of habitat available to them is small.

Another probable limiting factor in the watershed is stream temperature, particularly near the mouths of the major streams and in some middle elevation valley bottom settings. For example, the Wildhorse River just upstream from the National Forest boundary has recorded July temperatures as high as 79.2°F (26.2°C). Bull trout need substantially cooler water for spawning and rearing success.

### *Topography*

The Wildhorse River watershed is characterized by long narrow canyons in the upper and lower reaches. The middle portions of the Bear Creek and the Crooked River subwatersheds open up into broad meadows. The lowermost portion of the Wildhorse River flows through north and south facing slopes dissected by small tributaries.

### *Tornado*

On June 4, 2006, an F-2 category tornado touched down near the community of Bear, Idaho, affecting private lands and National Forest lands within both the Bear Creek Watershed and, to a lesser extent, the Lick Creek watershed. The tornado also affected the Rapid River watershed, which is outside the Wildhorse drainage. The tornado changed the forest and fuels condition within the watershed, and the USFS is pursuing management actions to reduce the risk of fire and insect disease as a result of these changes. Within Bear Creek, 3.8% of the total riparian area experienced low levels of blowdown, 4.0% experienced moderate levels, and 1.8% high levels. An estimated 13 miles of stream channels experienced varying levels of blowdown in the Bear Creek subwatershed (USFS August 2006).

The affected area is approximately 12 miles long, ¼ to 1½ miles wide, and covers approximately 5,000 acres, encompassing both the Wildhorse Drainage and the upper Rapid River drainage. Table 1.1 shows the acres that were affected just in the Wildhorse River drainage (4,982 acres). The storm path extended in a southwest to northeast track from 2 miles west of Bear to 10 miles northeast of Bear.

**Table 1.1. Acres Affected by Watershed and Subwatershed**

| Watershed | Subwatershed | Acres Affected | % of Subwatershed |
|---|---|---|---|
| Wildhorse River | Bear Creek | 4,453 | 15.2% |
| | Lick Creek | 76 | 0.3% |
| Rapid River | Upper Rapid River | 453 | 1.7% |
| Total | | | 4,982 |

An F2 tornado has winds in the range of 113 to 157 MPH. Based on the size of the trees snapped and the extent of the damage, the National Weather Service estimated the tornado likely had winds in the upper range of an F2 (around 150 MPH). This ranking and the length of the damage makes the tornado among the strongest to hit Idaho in the last 50 years (USFS August 2006).

The storm was concentrated within the Bear Creek Subwatershed, where 15% of the drainage was affected. Small portions of the Lick Creek Subwatershed were also affected, as shown in Table 1.1 (USFS August 2006).

Lightning strikes in the blowdown areas may be more successful in initiating wildland fires than in past conditions. This is due to an increase in surface fuels in the 0-3 inch loading and a significant decrease in shading from the forest canopy. This “lost” shading effect increases the amount of solar radiation that also increases the average temperatures and decreases the average relative humidities. This will increase the average fuel bed temperatures and reduce fuel moistures. Wind reduction factors are also decreased, allowing more wind-induced drying. All of these factors combined will increase the number of days per fire season that these fuels are receptive to initiating wildland fires.

Tornado-damaged forest stands exhibit varying levels of down and standing damaged trees that provide ideal habitat for a variety of bark beetles. Assessments by Forest entomologists have indicated that the Douglas-fir bark beetle is the most likely insect to increase in populations and in overall activity due to the tornado followed by potential increases in western pine bark beetles. Both increased fire and insect disease potential may eventually result in decreased shade in the riparian area, in addition to what shade has already been lost due to blowdown.

Given the presence of wetter soils, increased proportion of shallow-rooted tree species (i.e., spruce) and wind “funneling” effect of draws, some areas of blowdown were concentrated in riparian areas.

Impacts on riparian areas include varying increases in levels of large woody debris (LWD) and conversely, reduced shading potential from conifers. An estimated 9.5 miles of intermittent and 5.7 miles of perennial channels occur within the tornado-affected area, the majority in the Bear Creek subwatershed (Table 1.2). Within Bear Creek, this equates to 12% of the total intermittent channel network and 7% of the perennial channel network. Within Lick Creek, less than 1% of the intermittent channel network was affected (Table 1.2) (USFS August 2006).

**Table 1.2. Miles of Stream Affected within the Tornado Area and Percent of Total Stream Miles by Subwatershed**

| Subwatershed | Miles of Intermittent Streams / % of Total | Miles of Perennial Streams / % of Total |
|---|---|---|
| Bear Creek | 8.4 / 12.0% | 4.5 / 7.0% |
| Lick Creek | 0.05 / <0.1% | 0.0 / 0.0% |

The impact of the tornado on riparian overstory vegetation varied greatly. In some Riparian Conservation Areas (RCAs), 100% of the overstory trees were blown over or broken while other RCAs within the tornado path had little or no blowdown. In general, RCAs appeared to have a higher incidence of blowdown than surrounding areas. This may be due to shallower root systems for spruce and other riparian trees, wet ground, and the physics of wind direction and velocity through the drainage. The riparian understory vegetation was generally not affected and continues to provide bank stability and act as a sediment buffer (USFS August 2006).

#### ***Tornado Impact on Fisheries***

The primary effect of the blowdown on fish habitat was a reduction in overstory canopy in riparian areas and an increase in large woody debris in stream channels. The majority of stream channels within the tornado path were intermittent or perennial but non-fish bearing due to small size and steep gradient. One exception occurred where the tornado path crossed Bear Creek on private land in Section 24, which is a perennial fish-bearing stream. The tornado path did not intersect stream reaches on Bear Creek with documented bull trout occurrence, but it did intersect several tributaries that flow into occupied bull trout habitat (USFS August 2006).

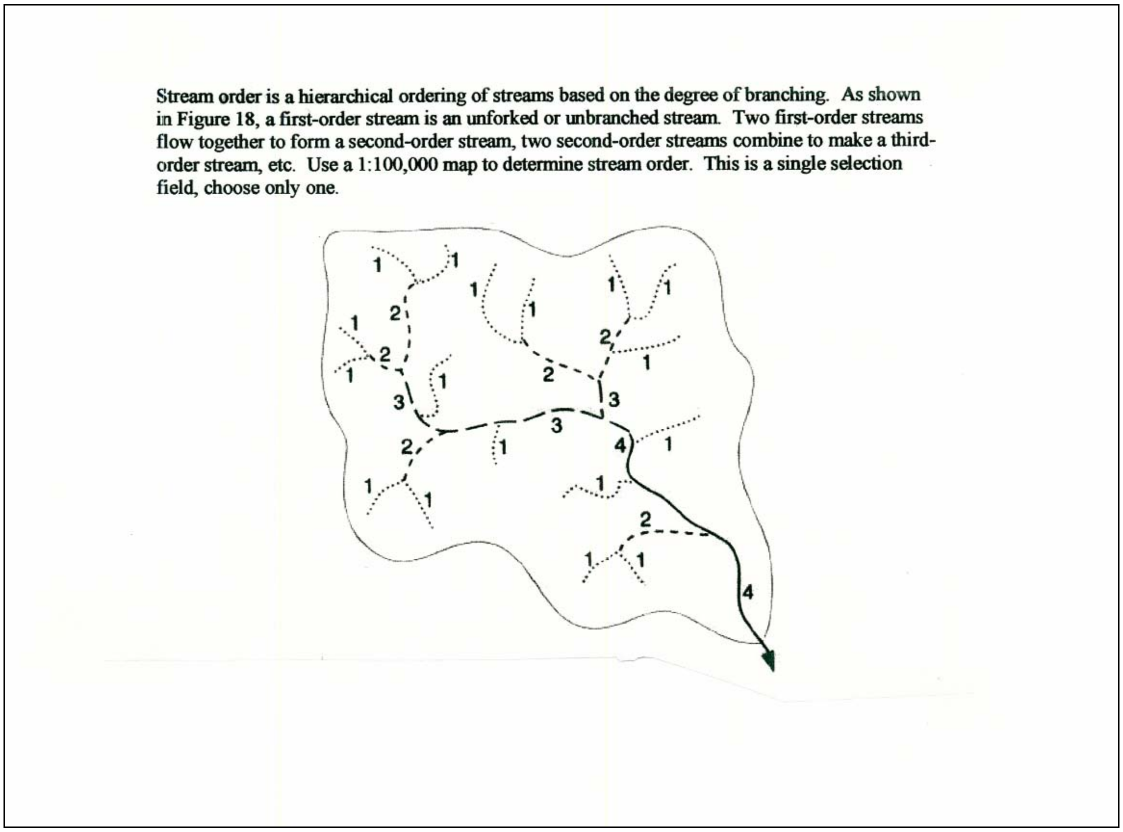
When viewed in context of the total riparian acreage, the tornado affected a relatively small portion of the riparian areas. Within Bear Creek, 9.6% of the riparian areas were affected by blowdown, with 5.8% experiencing medium to high levels. Lick Creek had very minor impacts to riparian areas. Riparian areas with moderate to high levels of blowdown have the greatest potential for culvert blockages and may present a future elevated risk to long duration, high severity burning, given the increased levels of large woody debris. Areas with low levels of blowdown likely present little risk to blockages and will likely benefit from the added large woody debris (USFS August 2006).

In most cases there will be a negligible increase in sediment delivery to the stream channel due to exposed root wads. Blowdown may be blocking the inlets of some culverts and could present drainage or erosion problems if streams overtop and erode the surface of roads (USFS August 2006).

## Stream Characteristics

### *Stream Order*

*Stream order* is a hierarchical ordering of streams based on the degree of branching (Figure 1.4). A first-order stream is an unforked or unbranched stream. Higher order streams result from the joining of two streams of the same order. The Wildhorse River is a fourth-order stream.



Stream order is a hierarchical ordering of streams based on the degree of branching. As shown in Figure 18, a first-order stream is an unforked or unbranched stream. Two first-order streams flow together to form a second-order stream, two second-order streams combine to make a third-order stream, etc. Use a 1:100,000 map to determine stream order. This is a single selection field, choose only one.

**Figure 1.4. Stream Order**

### *Rosgen Stream Types*

The Rosgen Stream Classification System is useful in describing general stream characteristics like channel shape, channel patterns (i.e., braided), and valley types that a stream may be found in. In section 2 and Appendix D of this report on the information available for each particular stream, Rosgen classifications are used to describe streams. Based on the geomorphological characteristics of streams, the Rosgen classification scheme delineates expected ranges for width/depth ratios, entrenchment, substrate materials, sinuosity, and gradient. When dealing with streams impaired by sediment, the Rosgen Stream Classification System is an important tool in determining whether a stream is stable or not and whether that instability is leading to contribution of excess sediment to the stream.

General stream classes are broken out by an A-G lettering scheme (Figure 1.5), which can be further subdivided in each letter grouping by numbers (i.e., C1, C2,...C6). The following section is an overview of the geomorphic stream categories found throughout the watershed.

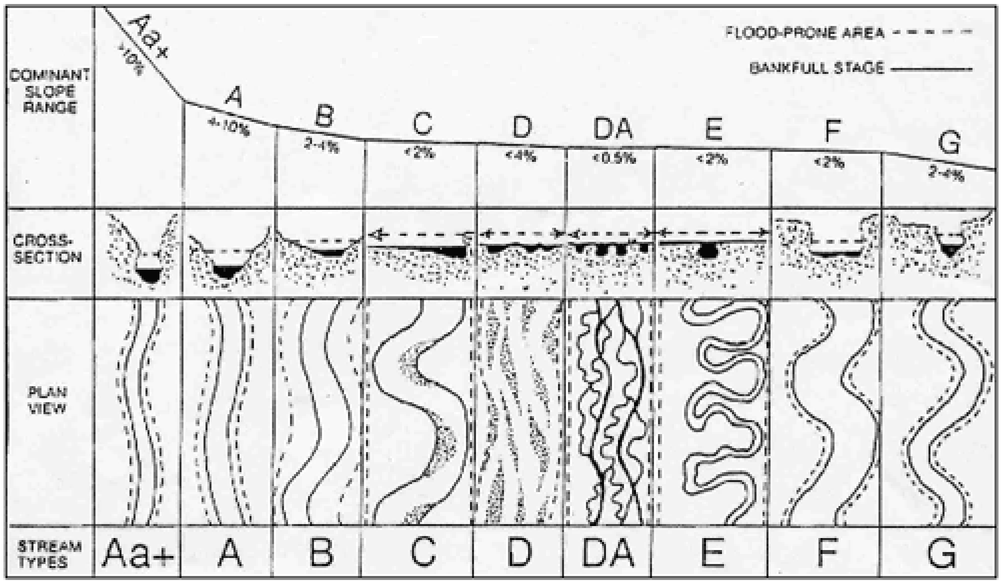



**Figure 1.5. Rosgen Stream Characteristics (Rosgen, 1996)**

The majority of the first- and second-order tributaries are high-gradient, confined A-channels dominated by gravel substrates. As drainage area increases and valley bottoms widen, B- and C-type channels are common. In general, A-channels are more sensitive to disturbances and changes in flows given their high gradient/energy and inability to diffuse high flows (i.e., no floodplains).

Type B streams generally occupy stable channels with moderately stable banks. These streams tend to occur in narrow, gently sloping valleys in areas of moderate relief. They may be moderately entrenched in low-gradient channels. Channel gradients typically range from 2-4% but may be lower or higher. Width-to-depth ratios are moderate, and bed forms are predominantly riffle with infrequently spaced pools. Moderate gradient and moderately to well-confined type B channels are predominantly associated with mainstem and tributary reaches within moderate relief landforms. B- and C-type channels (i.e., the lower parts of Bear and Lick Creeks and Crooked River) are considered fairly resilient, given their moderate gradients and presence of an active floodplain that helps dissipate the energy of high flows. However, their resiliency is strongly dependent upon healthy streamside and floodplain vegetation.

### *Hydrology*

Figures 1.6 and 1.7 show average stream flows for the Wildhorse River. From 1979 to 1996, the United States Geological Survey ran a gage site at the mouth. In September 1996, Idaho Power Company took over gage management. Thus, there is a gap in the period of record for this gage. A water year runs from October of the previous year through September of the current year (i.e., water year 2004 would run from October 1, 2003 through September 30, 2004). Typically, the Wildhorse River peaks in May. The drainage may show sharp increases in flow in response to rain-on-snow events at other times during the year (i.e., winter and early spring).

Other factors affecting the hydrology of the stream include active beaver colonies in Bear Creek, Lick Creek, and Crooked River. Their dam building activity can affect channel width and stream flows, as well as the riparian area.

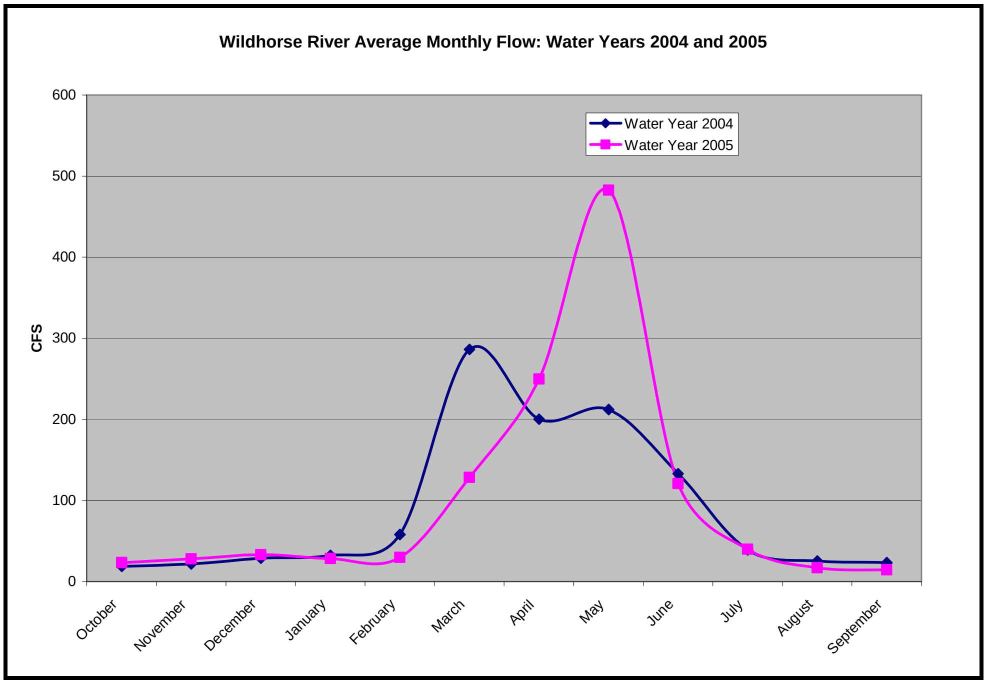



**Figure 1.6. Wildhorse River Average Stream Flow, 2004-2005**

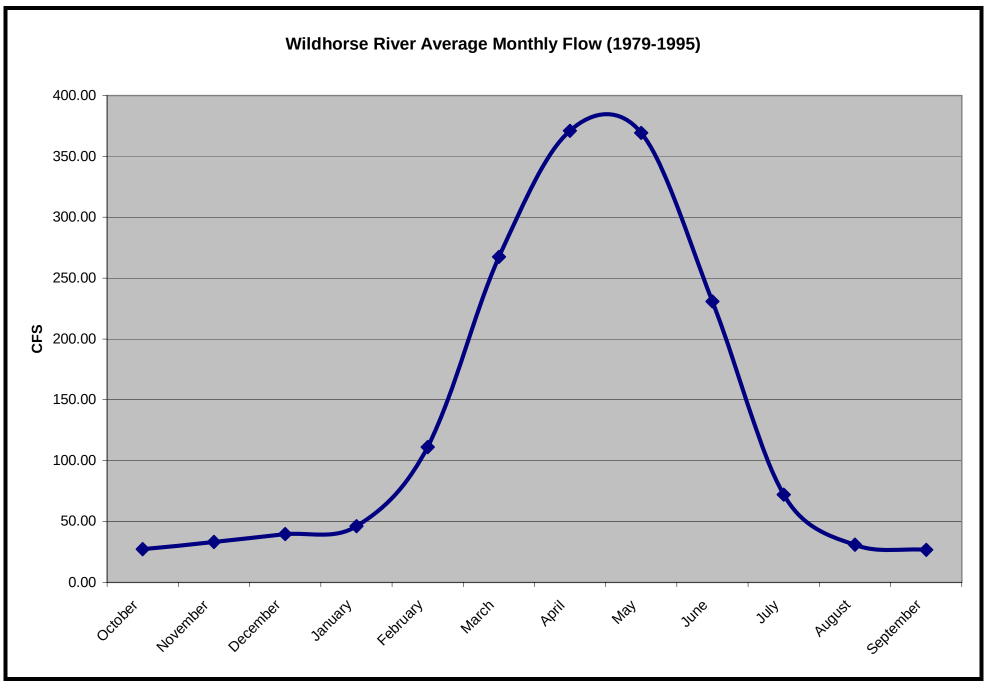



**Figure 1.7. Wildhorse River Average Stream Flow, 1979-1996**

## 1.3 Cultural Characteristics

The Wildhorse River watershed remains predominantly undeveloped. Historic and current land uses, all of which can affect water quality, include grazing, timber harvest, and recreation. Historic land use can play a significant role in determining what the current water quality is.

Thus, it is important to describe historical land use in the watershed and any potential effects it might have had on the current water quality status.

## Land Use

Current land use is mainly livestock grazing, recreation, and forestry (Figure 1.8). The majority of timber harvest has occurred in the Bear Creek, Lick Creek, and Crooked River subwatersheds. The road density in the lower Bear Creek and Lick Creek subwatersheds is 3.1 linear kilometers of road per square kilometer.

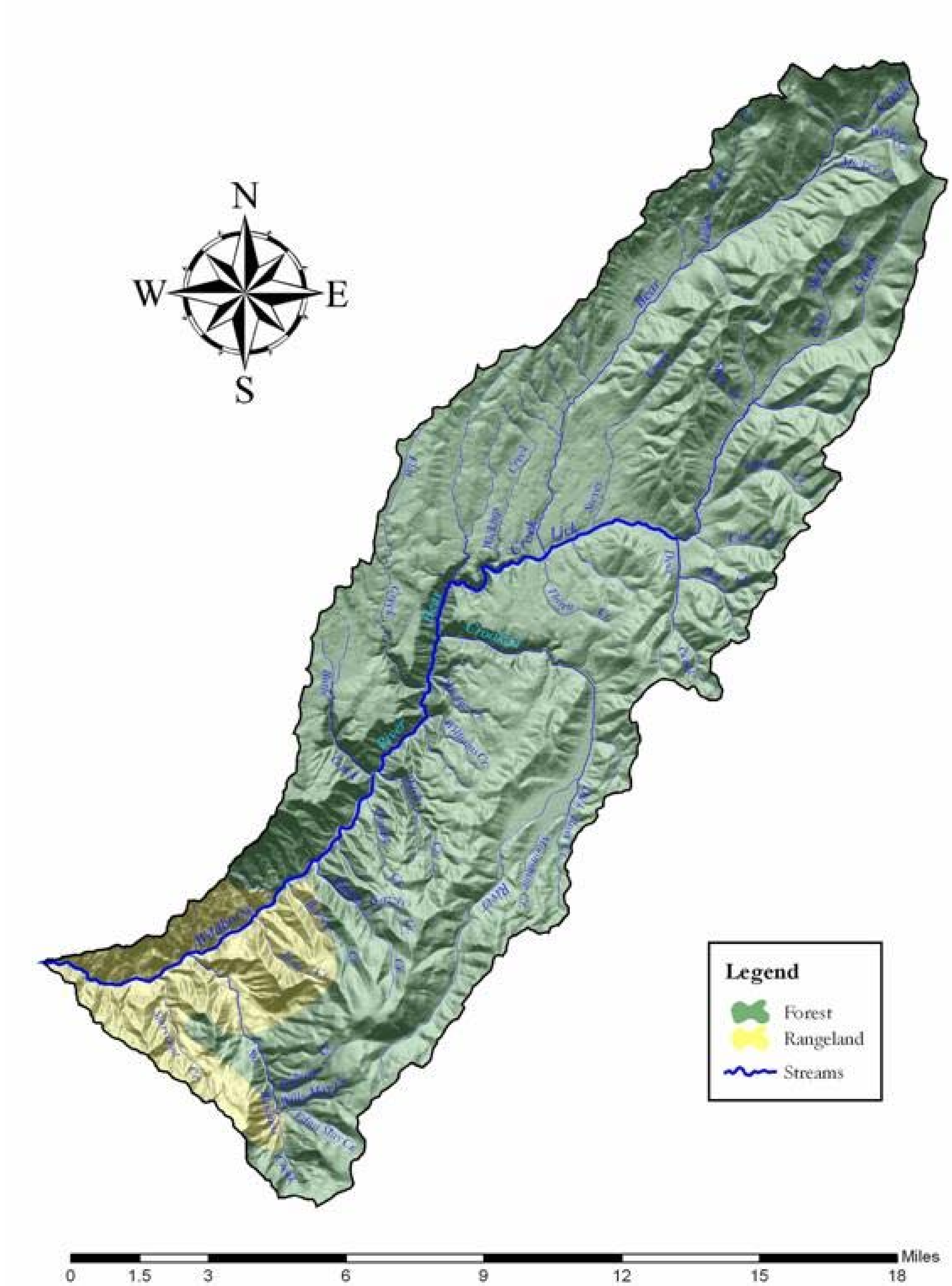



**Figure 1.8. Land Use in the Wildhorse River Subbasin**

## Land Ownership, Cultural Features, and Population

The Wildhorse River watershed is primarily public land administered by either the Payette National Forest or the USBLM. However, the Wildhorse River corridor is primarily privately owned. There is also private land in the upper part of the Crooked and Bear Creek subwatersheds (Figure 1.9).

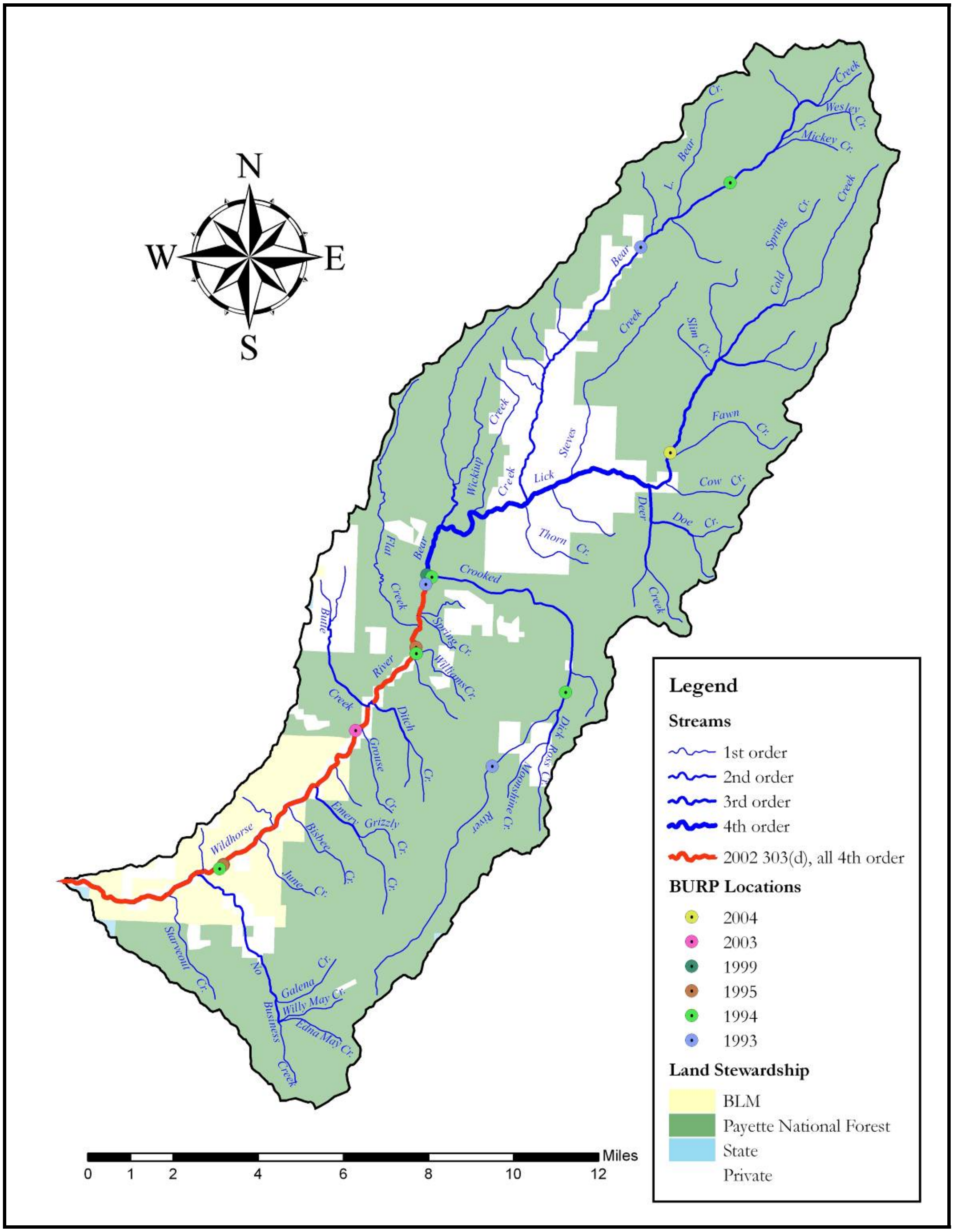



**Figure 1.9. Wildhorse River Land Ownership**

## Demographics

Adams County has a total area of 1,365 square miles or 873,408 acres. The population of the county as of the 2000 U.S Census was 3,476, with the population density at 2.5 people per square mile. A 2005 estimate of population in Adams County was 3,591. Between 2000 and

2005, the population increase in Adams County was 3.3 % (Idaho Association of Counties 2006). Council and New Meadows are the largest towns. In 2000, the ethnic makeup of the county was 97.1% white (1.6% of those being of Hispanic or Latino origin), with the second largest racial group being Native American, at 1.41% of the population. The median age of the populace was 44. The per capita income for a household in the county in 2003 was $23,061 (Idaho Association of Counties). Of the population, 15.1% was below the poverty line (U.S. Census Bureau, 2000), which varies according to household size and age.

## History

Early access into Adams County was along the Weiser River rather than along the torturous terrain of Snake River in Hells Canyon. The area was inhabited by small bands of Shoshoni Indians who taught the early settlers how to catch and preserve salmon. By 1868, non-native families were living along the Weiser River as far north as Indian Valley. The arrival of the railroad in 1882 at the town of Weiser, near the mouth of the Weiser River, spurred growth farther north. By 1896, Council Valley, now known as Council, was beginning to develop (Adams County Past and Present, 2006).

The unincorporated community of Bear, at 4,365 feet, is located about 28 miles northwest of Council. It boasted a post office from 1892 until 1966. Bear came into being with the Seven Devils mining boom. It was inhabited with many mine workers. Its first businesses included hotels and a general merchandise store.

Although Bear has had at least three different school buildings, the last Bear School also served as a public meeting place, church, theater, and dance hall. When the school closed and the Bear students were bussed down to Council, the old school was still used occasionally for dances and social gatherings.

There were many sawmills present along Crooked River, and extensive private forestry activities took place in that area.

The Bear Creek irrigation ditch was established in 1896 to irrigate lands used by early miners to maintain livestock and gardens for mining activities in the region.

In more recent years, several land exchanges have occurred between the USFS and what is now Western Pacific Timber.

## Economics

Council is the nearest town to the headwaters of Wildhorse River. The town is located along U.S. Highway 95, a major north-south route through Idaho. Council is the county seat of Adams County and had a population of 816 as of the 2000 U.S. census. Currently, the principal employers are Adams County, the Community Hospital, the school district, and Payette National Forest.

Historically, the mining industry played an important economic role in the mountainous area near Wildhorse River. The copper and gold mining that took place in the Seven Devils Areas benefited from the railroad that extended to Council. The Thunder Mountain mining boom came in 1902, with Council being the nearest rail town to the gold rush area. The area continued to boom throughout the first decade of the twentieth century. Cattle, sheep, farming, and mining formed the core of the economy. In the early 20$^{th}$ century, the fruit industry began to develop, with the main crop being apples. This industry was hard hit in 1949 when the area experienced 63 straight days of temperatures of zero or below. There are no active mines in the Wildhorse drainage (Adams County Past and Present), nor does it appear that historic mining affected present day stream morphology.

Forestry has also played an important role in the community. In 1939, the Boise-Payette Lumber Company built a sawmill in Council and started logging operations in the surrounding mountains. Logging and ranching became the core industries until the 1980s, when timber-related jobs began to decline. The Council sawmill closed on March 31, 1995, due in part to declining timber sales on the Payette National Forest. A small sawmill remains at Tamarack near the town of New Meadows.

# 2. Subbasin Assessment – Water Quality Concerns and Status

The following section summarizes the stream data available for the Wildhorse River watershed. This section also discusses beneficial uses, Idaho water quality standards, and assessment units.

## 2.1 Water Quality Limited Assessment Units Occurring in the Subbasin

Section 303(d) of the CWA states that waters that are unable to support their beneficial uses and that do not meet water quality standards must be listed as water quality limited waters. Subsequently, these waters are required to have TMDLs developed to bring them into compliance with water quality standards. This section more specifically discusses the Wildhorse River and its tributaries.

### About Assessment Units

Assessment Units (AUs) now define all the waters of the state of Idaho. AUs are groups of similar streams, usually classified by stream order, that have similar land use practices, ownership, or land management. Using assessment units allows all the waters of the state to be defined consistently.

### Listed Waters

Table 2.1 shows the pollutants listed and the basis for listing for each §303(d) listed AU in the subbasin.

**Table 2.1. §303(d) Segments in the Wildhorse River Subbasin**

| Water Body Name | Assessment Unit ID Number | 2002 §303(d) Boundaries | Pollutants | Listing Basis |
|---|---|---|---|---|
| Wildhorse River | 17050201SW015_04 | Confluence of Crooked River and Bear Creek to mouth | Temperature | EPA |

## 2.2 Applicable Water Quality Standards

The following section discusses the relationship between beneficial uses and Idaho's water quality standards in reference to the Wildhorse River watershed.

### Beneficial Uses

Idaho water quality standards require that surface waters of the state be protected for beneficial uses, wherever attainable (IDAPA 58.01.02.050.02). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses as briefly described in the following paragraphs. Beneficial uses are described for individual assessment units.

### *Existing Uses*

Existing uses under the CWA are "those uses actually attained in the water body on or after November 28, 1975, whether or not they are included in the water quality standards." The existing in-stream water uses and the level of water quality necessary to protect the uses shall be maintained and protected (IDAPA 58.01.02.050.02, .02.051.01, and .02.053). Existing uses include uses actually occurring, whether or not the level of quality to fully support the uses exists.

### *Designated Uses*

Designated uses under the CWA are "those uses specified in water quality standards for each water body or segment, whether or not they are being attained." Designated uses are simply uses officially recognized by the state, and these uses are listed in the Idaho water quality standards (IDAPA 58.01.02.003.27 and .02.109–.02.160). In Idaho, these include uses such as aquatic life support, recreation in and on the water, domestic water supply, and agricultural uses. Water quality must be sufficiently maintained to meet the most sensitive use. Designated uses may be added or removed using specific procedures provided for in state law, but the effect must not be to preclude protection of an existing higher quality use such as cold water aquatic life or salmonid spawning.

### *Presumed Uses*

In Idaho, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific use designations. In the interim, and absent information on existing uses, DEQ presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.101.01). To protect these "presumed uses," DEQ applies the numeric cold water criteria and primary or secondary contact recreation criteria to undesignated waters. If in addition to these presumed uses, an additional existing use (e.g., salmonid spawning) exists, because of the requirement to protect levels of water quality for existing uses, then the additional numeric criteria for salmonid spawning would also apply.

The Wildhorse River is designated for salmonid spawning, cold water aquatic life, and primary contact recreation. The uses designated in the Wildhorse River and Crooked River are shown in Table 2.2. Designated uses for Bear Creek are shown in Table 2.3. Bull trout critical habitat is designated on the streams listed below, but only for non-federal lands that have greater than 1/2 mile of river frontage.

**Table 2.2. Wildhorse River Subbasin Beneficial Uses of §303(d) Listed Streams**

| Water Body | Uses[a] | Type of Use |
|---|---|---|
| Wildhorse River (Fourth order assessment unit downstream of confluence of Bear Creek and Crooked River) | Cold, SS (including bull trout), PCR | Designated |

[a] CW – cold water, SS – salmonid spawning, PCR – primary contact recreation

**Table 2.3. Wildhorse River Subbasin Beneficial Uses of Assessed, Non-§303(d) Listed Streams**

| Water Body | Uses[a] | Type of Use |
|---|---|---|
| Bear Creek (includes Lick Creek) | Cold, SS (including bull trout) , PCR | Designated |
| Wildhorse River (Headwaters of Crooked River to confluence with Bear Creek) | Cold, SS (including bull trout) ,PCR | Designated |

[a] CW – cold water, SS – salmonid spawning, PCR – primary contact recreation

## Criteria to Support Beneficial Uses

Beneficial uses are protected by a set of criteria, which include *narrative* criteria for pollutants such as sediment and nutrients and *numeric* criteria for pollutants such as bacteria, pH, dissolved oxygen, and temperature (IDAPA 58.01.02.250) (Table 2.4).

DEQ’s procedure to determine whether a water body fully supports designated and existing beneficial uses is outlined in IDAPA 58.01.02.053. The procedure relies heavily upon biological parameters and is presented in detail in the Water Body Assessment Guidance (Grafe et al. 2002). This guidance requires the use of the most complete data available to make beneficial use support status determinations.

**Table 2.4. Selected Numeric Criteria Supportive of Designated Beneficial Uses in Idaho Water Quality Standards**

| Designated and Existing Beneficial Uses | | | | |
|---|---|---|---|---|
| **Water Quality Parameter** | **Primary Contact Recreation** | **Secondary Contact Recreation** | **Cold Water Aquatic Life** | **Salmonid Spawning (During Spawning and Incubation Periods for Inhabiting Species)** |
| **Water Quality Standards: IDAPA 58.01.02.250** | | | | |
| **Bacteria, ph, and Dissolved Oxygen** | Less than 126 *E. coli*/100 ml[a] as a geometric mean of five samples over 30 days; no sample greater than 406 *E. coli* organisms/100 ml. | Less than 126 *E. coli*/100 ml as a geometric mean of five samples over 30 days; no sample greater than 576 *E. coli*/100 ml. | pH between 6.5 and 9.0.<br>DO[b] exceeds 6.0 mg/L[c]. | pH between 6.5 and 9.5.<br>Water Column DO: DO exceeds 6.0 mg/L in water column or 90% saturation, whichever is greater.<br>Intergravel DO: DO exceeds 5.0 mg/L for a one day minimum and exceeds 6.0 mg/L for a seven day average. |
| **Temperature[d]** | | | 22 °C or less daily maximum; 19 °C or less daily average. | 13 °C or less daily maximum; 9 °C or less daily average.<br>Bull trout: not to exceed 13 °C maximum weekly maximum temperature over warmest 7-day period, June–August; not to exceed 9 °C daily average in September and October. |
| **EPA Bull Trout Temperature Criteria: Water Quality Standards for Idaho, 40 CFR Part 131** | | | | |
| **Temperature** | | | | Seven day moving average of 10 °C or less maximum daily temperature for June–September. |

[a] *Escherichia coli* per 100 milliliters, [b] dissolved oxygen, [c] milligrams per liter, [d] Temperature Exemption - Exceeding the temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the ninetieth percentile of the seven-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.

## 2.3 Pollutant/Beneficial Use Support Status Relationships

Most of the pollutants that impair beneficial uses in streams are naturally occurring in streams but have reached unnatural levels due to human activity. That is, streams naturally have sediment, nutrients, and the like, but when human activities cause these to reach unnatural levels and adversely impact beneficial uses like fisheries, they are considered “pollutants.”

### Temperature

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

Human influenced factors include heated discharges (such as those from point sources), riparian alteration, channel alteration, and flow alteration.

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

## 2.4 Summary and Analysis of Existing Water Quality Data

This section includes habitat and temperature data for the Wildhorse River watershed as well as its tributaries. Much of this information was gathered by the USFS on USFS-managed land. Information on the effect of the tornado on the watershed is found in Section 1.

### Wildhorse River

Much of the general information for the Wildhorse River was covered in Section 1. The following is more specific information related to temperature and habitat. The Wildhorse River was added to the §303(d) list for temperature in 2000 by the EPA. Tributary streams to the Wildhorse River below the confluence of Bear Creek and the Crooked River are generally steep first- and second-order streams. Most are densely vegetated and small volume tributaries.

General information on major tributaries and available instream temperature measurements follow this section. Temperature logger locations are shown in Figure 2.1.More detailed information on the tributaries has been included in Appendix D.

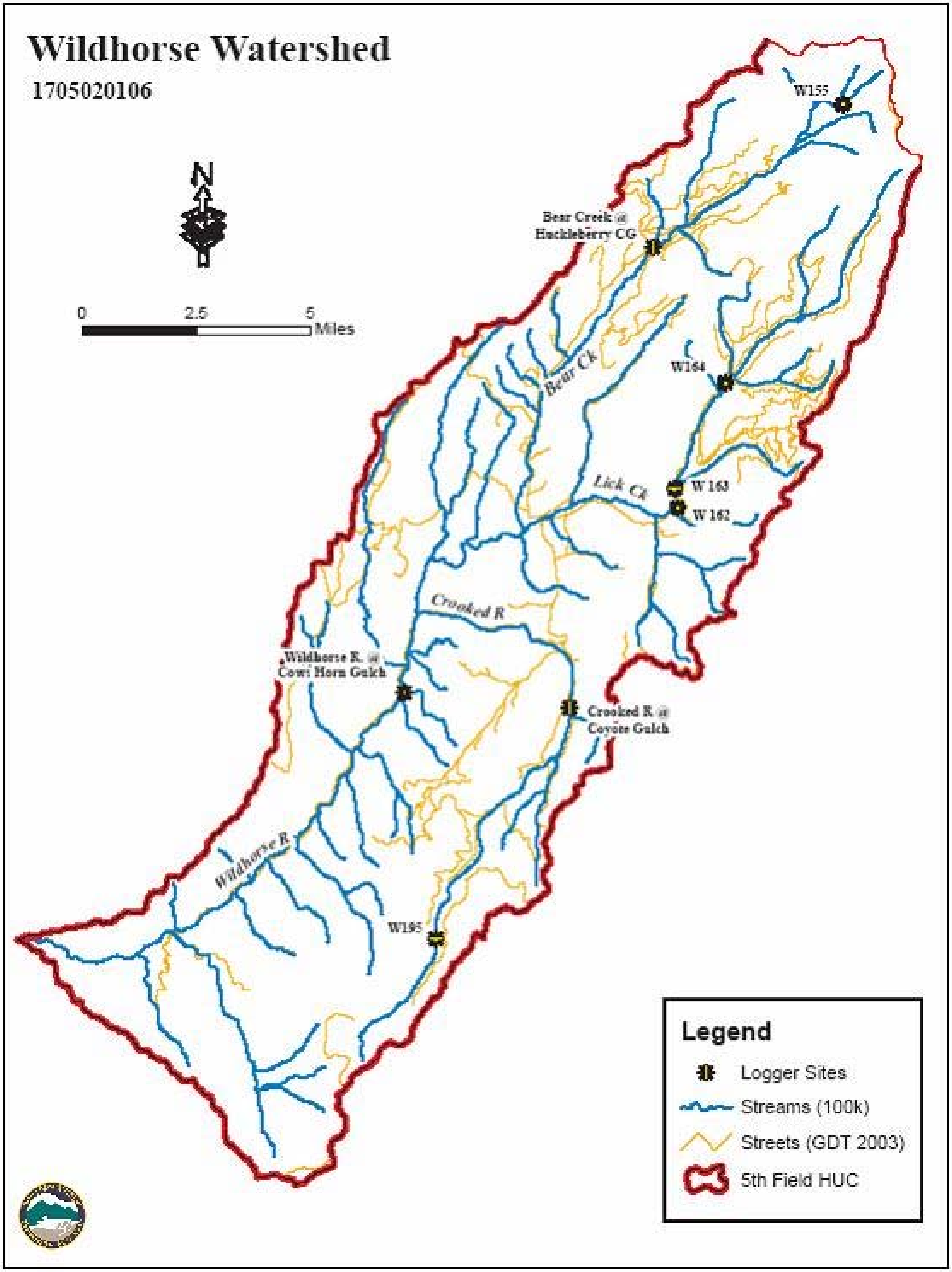



**Figure 2.1. Wildhorse Drainage Temperature Logger Locations**

### *Water Temperature Data*

Temperature data was available for the Wildhorse River at Cows Horn Gulch near the most downstream portion of Forest Service managed land (USFS 2006), as shown in Tables 2.5 and 2.6. As shown in these tables, the temperature criteria are exceeded throughout the summer months. Temperature data for Wildhorse River at the mouth has been collected by Idaho Power and 2006 results are shown in Appendix D. Exceedances of the cold water aquatic life standard were seen, particularly in July and August. In the Wildhorse River upstream and downstream of No Business Creek, there are hot or warm springs that influence stream temperature. Measurements taken by DEQ in February 2007 verified that there is a thermal influence in this area.

**Table 2.5. Wildhorse River Temperatures at Cows Horn Gulch, 2005**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Days Max> 13C | Days Avg> 9C | Days Max> 22C | Days Avg >19C |
|---|---|---|---|---|---|---|---|---|
| June | Second Half | 15 | 20.9 | 15.2 | 14 | 15 | 0 | 0 |
| July | First Half | 15 | 24 | 17.6 | 15 | 15 | 6 | 2 |
| July | Second Half | 16 | 25.4 | 19 | 16 | 16 | 16 | 9 |
| August | First Half | 15 | 25.6 | 18.9 | 15 | 15 | 14 | 8 |
| August | Second Half | 16 | 23 | 16.4 | 16 | 16 | 3 | 0 |
| September | First Half | 15 | 19.9 | 13.7 | 15 | 15 | 0 | 0 |
| September | Second Half | 15 | 15.9 | 10.9 | 11 | 15 | 0 | 0 |

**Table 2.6. Wildhorse River Temperatures at Cows Horn Gulch, 2000**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Days Max> 13C | Days Avg> 9C | Days Max> 22C | Days Avg> 19C |
|---|---|---|---|---|---|---|---|---|
| July | First Half | 15 | 23.2 | 16.5 | 15 | 15 | 3 | 0 |
| July | Second Half | 16 | 24.8 | 18.8 | 16 | 16 | 13 | 8 |
| August | First Half | 15 | 25.2 | 19.0 | 15 | 15 | 13 | 6 |

### *Biological Data*

Much of the available biologic data for the Wildhorse River is greater than five years old. However, human activities in the watershed have remained fairly constant since then. The January 1997 rain-on-snow event did result in scouring of the Wildhorse River channel due to very high flows. Idaho Power was unable to measure the flow during the rain-on-snow event but estimated it to have peaked at 4,200 cfs. This falls midway between a 50 year flow event (3,950 cfs) and the 100 year flood event (4,680 cfs) (Idaho Power Personal Communication 2006).

Table 2.7 shows water body assessment scores from DEQ’s Beneficial Use Reconnaissance Program (BURP) stream inventory.

**Table 2.7. DEQ Water Body Assessment Scores: Wildhorse River**

| Stream Site ID | SMI | SFI | SHI | Support Status |
|---|---|---|---|---|
| 1993SBOIA012 (confluence of Bear Creek and Crooked River) | 3 | Not measured | 1 | 2 (Full Support) |
| 1994SBOIA03(upstream of No Business Creek) | 3 | 1 | 2 | 2 (Full Support) |
| 1994SBOIA034 (1.5 miles downstream from confluence with Crooked River) | 3 | < min | 1 | 1.33 (Not Full Support) |
| 1995SBOIB030 (Above Williams Creek) | 3 | Not measured | 2 | 2.5 (Full Support) |
| 2003SBOIF003 (Downstream of Grouse Creek) | Not measured | 2 | Not measured | Cannot determine with only SFI score |

DEQ's BURP program sends crews into the field to collect water temperature data, biological samples (e.g., fish, bacteria), chemical measures (e.g., specific conductivity, the ability of water to pass an electrical current), and habitat data from Idaho's surface water. Aquatic insects and fish are very sensitive to changes in water quality, so their presence, abundance, and health serve as indicators of the overall quality of a water body. Generally, unpolluted waters support a greater variety of aquatic insects and fish than polluted waters.

The data collected are used to determine whether beneficial uses are being supported in Idaho's streams, rivers, and lakes. This determination is done by analyzing the habitat data, aquatic insect (macroinvertebrate) data, and fisheries data and assigning a score to each of those categories based on how it compares to a reference community.

The Stream Habitat Index (SHI) is calculated from a range of habitat inventory parameters, including bank stability, riparian cover, percent surface fines, pool quality, large organic debris, etc. Scores range from 1 to 3, with 3 being the highest score. The Stream Macroinvertebrate Index (SMI) is calculated from nine macroinvertebrate metrics having to do with pollutant tolerance, species diversity, number of individuals, species distribution, etc. Scores range from the lowest score, which is below the less than (<) minimum threshold, to the highest score of three. The < minimum threshold score indicates an impaired aquatic environment and lack of beneficial use support.

The Stream Fish Index (SFI) is also calculated from a range of fish metrics, and like the SMI, the scores also range from < minimum to a high score of three. Not assessed (NA) means that the stream was not electrofished. Not all streams are electrofished, depending upon the safety conditions and whether or not a DEQ staff person with an electrofishing permit is available to electrofish the stream with the stream inventory crew.

Figure 1.9 in Section 1 shows the location of BURP sites, with the exception of 2003SBOIF003, which was located on the Wildhorse River just below Grouse Creek.

### *Conclusion*

Although the Wildhorse River appeared to support beneficial uses, it does not meet the state temperature criteria. When a stream does not meet the state criteria, a more detailed investigation of temperature is required. As shown in the biological metric scores, the fish metrics (SFI) score indicates that fish populations are not always robust in the summer months, and conditions are present that may impair the aquatic environment. Likely, the fish move up into cooler tributaries or into deep pools where available. The 1994–1995 fisheries measurements were taken in July and August, whereas the higher 2003 score was measured in September, when water temperatures were cooler.

Shading was investigated throughout the watershed to see if the water could be cooler. Shading in the Wildhorse River itself is close to its potential. Thus, tributaries to the Wildhorse were evaluated for shading.

## Bear Creek

Bear Creek is a third-order stream that combines with the Crooked River to form the Wildhorse River. The creek lies entirely within Adams County and drains over 29,000 acres, about 20% of which are privately owned. Elevations in the Bear Creek subwatershed range from 3,348 feet at the confluence with the Wildhorse River to 8,005 feet at the top of Smith Mountain. Surface geology is dominated by metamorphic rocks of the Seven Devils Group and Columbia River basalts to the south of the analysis area.

The landscape is dissected by a moderate to strongly confined drainage system that is characterized by narrow V-shaped valleys in most tributary drainages and U-shaped troughs in the main valley floors. Tributary streams to Bear Creek are generally high gradient (greater than 4%) channels with large cobble to gravel substrates. Bear Creek flows through a deeply incised canyon in the area above its confluence with the Crooked River. This canyon is also where Bear Creek Falls, a 60 foot high natural fish barrier, is located. Most tributaries have healthy riparian areas and are in stable condition currently. See Figure 2.2 for a photograph of typical stream conditions in Bear Creek.

**Figure 2.2. Bear Creek at Forest Trail 228 Trailhead**

The Bear Creek irrigation ditch currently serves 20 users and about 750 acres. Improvement projects have occurred recently that have benefited fisheries. These projects include fish screening and fish passage enhancements.

There are currently range allotments in the Bear Creek area. Stream protection measures identified for these allotments include herding sheep away from bull trout habitat in the Bear

Creek area. Cattle are removed from upper Bear Creek by August 15 each year. Private pastureland is also only used seasonally in the watershed, which reduces impacts to the riparian area. Additional habitat information can be found in Appendix D.

### *Water Temperature Data*

As shown in Tables 2.8 through 2.11, temperatures in Bear Creek are generally cool as the creek leaves the USFS managed land upstream of the community of Bear.

**Table 2.8. Bear Creek Water Temperatures at Huckleberry Campground, 1999**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Min C | Days Max>22 C | Days Avg>19 C |
|---|---|---|---|---|---|---|---|
| August | First Half | 15 | 12.5 | 8.9 | 5 | 0 | 0 |
| August | Second Half | 16 | 12.9 | 9.5 | 4.9 | 0 | 0 |
| September | First Half | 15 | 10 | 6.6 | 3.9 | 0 | 0 |
| September | Second Half | 15 | 10.3 | 6.2 | 0.6 | 0 | 0 |

**Table 2.9. Bear Creek Water Temperatures at Huckleberry Campground, 2001**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Min C | Days Max>22 C | Days Avg>19 C |
|---|---|---|---|---|---|---|---|
| June | First Half | 15 | 11 | 6.1 | 3.4 | 0 | 0 |
| June | Second Half | 15 | 13.8 | 8.7 | 4 | 0 | 0 |
| July | First Half | 15 | 15.1 | 11.3 | 8.5 | 0 | 0 |
| July | Second Half | 16 | 14.7 | 9.7 | 6.7 | 0 | 0 |
| August | First Half | 15 | 16.5 | 11.2 | 6.4 | 0 | 0 |

**Table 2.10. Bear Creek Water Temperatures at Upper Site (W155), 2001**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Min C | Days Max>22 C | Days Avg>19 C |
|---|---|---|---|---|---|---|---|
| June | Second Half | 15 | 11.5 | 6.8 | 3.1 | 0 | 0 |
| July | First Half | 15 | 12.1 | 8.4 | 6.1 | 0 | 0 |
| July | Second Half | 16 | 10.9 | 7.2 | 5.0 | 0 | 0 |
| August | First Half | 15 | 11.5 | 8.4 | 4.8 | 0 | 0 |
| August | Second Half | 16 | 11.0 | 7.8 | 5.3 | 0 | 0 |
| September | First Half | 15 | 9.8 | 6.7 | 3.4 | 0 | 0 |
| September | Second Half | 15 | 8.6 | 6.3 | 4.1 | 0 | 0 |

**Table 2.11. Bear Creek Water Temperatures at Upper Site (W155), 2002**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Min C | Days Max>22 C | Days Avg>19 C |
|---|---|---|---|---|---|---|---|
| July | First Half | 15 | 11.5 | 7.2 | 4.4 | 0 | 0 |
| July | Second Half | 16 | 10.9 | 7.3 | 5.2 | 0 | 0 |
| August | First Half | 15 | 9 | 6.1 | 4.1 | 0 | 0 |
| August | Second Half | 16 | 8.6 | 6.1 | 4.4 | 0 | 0 |
| September | First Half | 15 | 8.3 | 6 | 3.4 | 0 | 0 |
| September | Second Half | 15 | 7 | 4.8 | 2.2 | 0 | 0 |
| October | First Half | 15 | 5.6 | 3 | 0.6 | 0 | 0 |

The temperatures shown in Tables 2.8 through 2.11 meet the Idaho cold water aquatic life criteria. The columns that show the number of days with a maximum temperature greater than 22 degrees Celsius and the number of days with an average temperature greater than 19 degrees Celsius tie directly into Idaho water quality criteria. The criteria are violated if temperatures are greater than those numbers, unless it can be shown that natural background temperatures are naturally elevated.

At the mouth of Bear Creek, again on National Forest lands, temperatures are elevated, as shown in Table 2.12. Temperatures in Bear Creek exceed the EPA bull trout criteria at Bear Creek at Huckleberry Campground. Additional information shown in Appendix D shows that the salmonid spawning criteria are not met at the Huckleberry Campground Site or at a site about ½ mile upstream at Little Bear Creek.

**Table 2.12. Bear Creek Water Temperatures above Confluence with Crooked River**

| Date Temperature Logger Placed | Days Recorded | Days Max > 22 C | Days Avg > 19 C |
|---|---|---|---|
| Summer 2002 | 110 | 16 | 14 |
| 7/14/2004 | 106 | 12 | 18 |
| 6/20/2005 | 127 | 20 | 8 |

In addition to temperature monitoring, shading was investigated to determine whether increased shading could occur, which would further cool off Bear Creek. This information is discussed in section 5.

## Lick Creek

The Lick Creek drainage is dominated by grassland and conifer forest. Lick Creek (Figure 2.3) originates from springs at over 7,000 feet in elevation and flows into Bear Creek at about 4,200 feet in elevation. Lick Creek drains approximately 28,000 acres, of which about 30% is privately owned land. Both livestock grazing and timber harvest have historically been important activities. Primary named tributaries include Hoo Hoo and Butterfield Gulches, and Slim, Fawn, Cold Spring, and Cow Creeks.

**Figure 2.3. Lick Creek**

Three miles of the Lick Creek riparian area are fenced off and in a Conservation Reserve Program (CRP). Grazing on both the private and public land is seasonal in nature. There have been fish passage and fish screening projects in the drainage, as well as improvements to the Lick Creek ditch resulting in piping of the water instead of an open ditch.

### *Water Temperature Data*

Recent monitoring of stream temperatures in Lick Creek at the forest boundary (USFS 2006) indicate that stream temperatures meet the Idaho State cold water aquatic life criteria (i.e., average daily temperatures of < = 19 degrees Celsius, and daily maximum temperatures of < = 22 degrees Celsius), as shown in Tables 2.13 through 2.18. Temperature logger locations are shown in Figure 2.1. Data shown in Appendix D indicate that salmonid spawning criteria are typically not met in late June and early July. Also, the EPA bull trout temperature criteria are not met in July and August.

**Table 2.13. Lick Creek at Lower Exclosure Upstream of Fawn Creek, 2000 (W162)**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Min C | Days Max>22 C | Days Avg>19 C |
|---|---|---|---|---|---|---|---|
| August | Second Half | 16 | 18.6 | 12.9 | 8.0 | 0 | 0 |
| September | First Half | 15 | 16.5 | 9.8 | 5.3 | 0 | 0 |
| September | Second Half | 15 | 17.0 | 8.9 | 2.0 | 0 | 0 |

**Table 2.14. Lick Creek at Upper Exclosure Upstream of Fawn Creek, 2000 (W163)**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Min C | Days Max>22 C | Days Avg>19 C |
|---|---|---|---|---|---|---|---|
| June | Second Half | 11 | 17.7 | 11.9 | 6.0 | 0 | 0 |
| July | First Half | 15 | 19.4 | 12.5 | 6.4 | 0 | 0 |
| July | Second Half | 16 | 20.7 | 14.8 | 9.1 | 0 | 0 |
| August | First Half | 15 | 21.2 | 15.0 | 9.1 | 0 | 0 |
| August | Second Half | 16 | 18.0 | 12.1 | 7.2 | 0 | 0 |
| September | First Half | 15 | 15.9 | 9.4 | 5.0 | 0 | 0 |
| September | Second Half | 15 | 15.9 | 8.5 | 1.7 | 0 | 0 |

**Table 2.15. Lick Creek Upstream of Butterfield Gulch, 2001 (W164)**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Min C | Days Max>22 C | Days Avg>19 C |
|---|---|---|---|---|---|---|---|
| May | Second Half | 9 | 13.9 | 9.8 | 4.3 | 0 | 0 |
| June | First Half | 15 | 13.9 | 8.6 | 4.8 | 0 | 0 |
| June | Second Half | 15 | 17.2 | 11.5 | 5.5 | 0 | 0 |

**Table 2.16. Lick Creek Upstream of Butterfield Gulch, 2002 (W164)**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Min C | Days Max>22 C | Days Avg>19 C |
|---|---|---|---|---|---|---|---|
| July | First Half | 15 | 19.5 | 12.8 | 7.4 | 0 | 0 |
| July | Second Half | 16 | 18.3 | 13.8 | 9.1 | 0 | 0 |
| August | First Half | 15 | 15.9 | 11.3 | 6.3 | 0 | 0 |
| August | Second Half | 16 | 15.3 | 11.0 | 7.1 | 0 | 0 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| September | First Half | 15 | 14.8 | 10.2 | 5.2 | 0 | 0 |
| September | Second Half | 15 | 12.2 | 7.8 | 4.0 | 0 | 0 |

**Table 2.17. Lick Creek Upstream of Butterfield Gulch, 2003 (W164)**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Min C | Days Max>22 C | Days Avg>19 C |
|---|---|---|---|---|---|---|---|
| June | First Half | 11 | 12.7 | 8.1 | 4.9 | 0 | 0 |
| June | Second Half | 15 | 14.8 | 9.6 | 4.8 | 0 | 0 |
| July | First Half | 15 | 16.7 | 11.8 | 7.7 | 0 | 0 |
| July | Second Half | 16 | 18.5 | 14.0 | 9.9 | 0 | 0 |
| August | First Half | 15 | 17.1 | 12.9 | 9.3 | 0 | 0 |
| August | Second Half | 16 | 16.1 | 12.4 | 8.3 | 0 | 0 |
| September | First Half | 15 | 15.6 | 10.4 | 4.8 | 0 | 0 |
| September | Second Half | 13 | 12.4 | 7.9 | 3.7 | 0 | 0 |

**Table 2.18. Lick Creek Upstream of Butterfield Gulch, 2004 (W164)**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Min C | Days Max>22 C | Days Avg>19 C |
|---|---|---|---|---|---|---|---|
| May | Second Half | 14 | 9.2 | 6.0 | 3.6 | 0 | 0 |
| June | First Half | 15 | 12.6 | 8.0 | 5.0 | 0 | 0 |
| June | Second Half | 15 | 16.4 | 10.8 | 5.5 | 0 | 0 |
| July | First Half | 15 | 17.7 | 12.0 | 7.0 | 0 | 0 |
| July | Second Half | 16 | 18.5 | 13.9 | 9.5 | 0 | 0 |
| August | First Half | 15 | 18.0 | 13.4 | 8.3 | 0 | 0 |
| August | Second Half | 16 | 17.8 | 11.8 | 6.9 | 0 | 0 |

A determination of current versus potential vegetation was also made for Lick Creek. This information appears in Section 5.

## Crooked River

The Crooked River watershed contains 27 miles of intermittent streams and 22 miles of perennial streams. Crooked River (Figure 2.4) arises on the northern flank of Cuddy Mountain at about 6,890 feet and flows generally northeastward until it joins Bear Creek to form the Wildhorse River.

**Figure 2.4. Crooked River**

The Crooked River area has been intensively managed for both timber harvest and livestock grazing, and it contains portions of the USFS Crooked River/Wildhorse allotments and Crooked River On/Off allotment. Streamside conditions in the upper reaches of Crooked River have retained their natural character. Pasture use in the Crooked River watershed is seasonal in nature. There is a water diversion on private land near the crossing of FDR 061 that essentially dewaters the stream in late summer and prevents fish movement; bull trout that have been found below this crossing are probably incidental.

### *Water Temperature Data*

Temperatures in the upper reaches of the Crooked River remain low (Tables 2.18 through 2.23) (USFS 2006). Temperature logger locations are shown in Figure 2.1. Farther downstream, instream temperatures in the meadows area of the Crooked River exceeded the Idaho cold water aquatic life standard in the second half of June, July, and sometimes in August. The Crooked River was further investigated to determine if shading was at its full potential. This information can be found in Section 5, and additional habitat information can be found in Appendix D. Additional temperature information showing that Crooked River at Coyote Gulch does not meet salmonid spawning temperature criteria can be found in Appendix D.  Given the high temperatures in July and the first half of August, it is clear that EPA bull trout temperature criteria are not met.

**Table 2.18. Crooked River Water Temperature at Coyote Gulch, 2001**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Min C | Days Max>22 C | Days Avg>19 C |
|---|---|---|---|---|---|---|---|
| May | Second Half | 9 | 19.7 | 12.9 | 5.9 | 0 | 0 |
| June | First Half | 15 | 19.7 | 11.4 | 6.4 | 0 | 0 |
| June | Second Half | 15 | 24.1 | 14.5 | 6.9 | 4 | 0 |
| July | First Half | 15 | 25.1 | 18.0 | 11.4 | 11 | 2 |
| July | Second Half | 16 | 23.2 | 15.4 | 9.3 | 5 | 0 |
| August | First Half | 15 | 24.6 | 17.1 | 8.6 | 12 | 0 |
| August | Second Half | 16 | 23.9 | 15.2 | 8.4 | 5 | 0 |
| September | First Half | 15 | 21.2 | 13.3 | 5.5 | 0 | 0 |
| September | Second Half | 15 | 18.9 | 11.6 | 5.5 | 0 | 0 |
| October | First Half | 15 | 15.6 | 7.2 | 1.4 | 0 | 0 |
| October | Second Half | 16 | 10.3 | 5.4 | 0.9 | 0 | 0 |
| November | First Half | 15 | 7.6 | 3.5 | -0.1 | 0 | 0 |

**Table 2.19. Crooked River Water Temperature at Coyote Gulch, 2002**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Min C | Days Max>22C | Days Avg>19 C |
|---|---|---|---|---|---|---|---|
| May | Second Half | 9 | 18.9 | 12.2 | 4.1 | 0 | 0 |
| June | First Half | 15 | 20.4 | 11.9 | 5.9 | 0 | 0 |
| June | Second Half | 15 | 23.2 | 15.5 | 7.8 | 3 | 0 |
| July | First Half | 15 | 26.1 | 17.4 | 10.4 | 8 | 4 |
| July | Second Half | 16 | 26.1 | 17.8 | 11.0 | 12 | 3 |
| August | First Half | 15 | 21.9 | 14.7 | 7.8 | 0 | 0 |
| August | Second Half | 16 | 20.5 | 13.9 | 8.6 | 0 | 0 |
| September | First Half | 15 | 20.1 | 12.9 | 6.1 | 0 | 0 |
| September | Second Half | 15 | 15.9 | 10.0 | 4.8 | 0 | 0 |
| October | First Half | 6 | 12.3 | 7.4 | 1.8 | 0 | 0 |

**Table 2.20. Crooked River Water Temperature at Coyote Gulch, 2003**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Min C | Days Max>22C | Days Avg>19C |
|---|---|---|---|---|---|---|---|
| June | First Half | 12 | 18.4 | 12.3 | 7.3 | 0 | 0 |
| June | Second Half | 15 | 24.0 | 13.8 | 6.8 | 3 | 0 |
| July | First Half | 6 | 25.2 | 15.5 | 11.2 | 3 | 0 |
| July | Second Half | 10 | 26.6 | 19.3 | 13.3 | 9 | 7 |
| August | First Half | 15 | 24.2 | 17.0 | 11.2 | 12 | 0 |
| August | Second Half | 16 | 23.0 | 15.9 | 9.5 | 4 | 0 |
| September | First Half | 15 | 20.6 | 13.0 | 5.4 | 0 | 0 |
| September | Second Half | 13 | 16.1 | 10.0 | 4.3 | 0 | 0 |

**Table 2.21. Crooked River Water Temperature at Coyote Gulch, 2005**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Min C | Days Max>22C | Days Avg>19C |
|---|---|---|---|---|---|---|---|
| June | First Half | 15 | 17.3 | 10.3 | 5.2 | 0 | 0 |
| June | Second Half | 15 | 20.5 | 14.2 | 7.3 | 0 | 0 |
| July | First Half | 15 | 23.4 | 16.1 | 10.3 | 6 | 0 |
| July | Second Half | 16 | 24.4 | 17.2 | 9.3 | 12 | 1 |
| August | First Half | 15 | 23.7 | 16.7 | 9.8 | 8 | 0 |
| August | Second Half | 16 | 21.4 | 14.2 | 7.5 | 0 | 0 |
| September | First Half | 15 | 18.6 | 11.3 | 5.2 | 0 | 0 |
| September | Second Half | 15 | 14.9 | 9.2 | 4.2 | 0 | 0 |

**Table 2.22. Crooked River Water Temperature at the Headwaters, 2002**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Min C | Days Max>22C | Days Avg>19C |
|---|---|---|---|---|---|---|---|
| July | First Half | 14 | 13.4 | 9.2 | 5.8 | 0 | 0 |
| July | Second Half | 16 | 13.1 | 10.0 | 7.3 | 0 | 0 |
| August | First Half | 15 | 11.3 | 8.3 | 5.1 | 0 | 0 |
| August | Second Half | 16 | 11.0 | 8.1 | 5.5 | 0 | 0 |
| September | First Half | 15 | 10.9 | 7.6 | 4.1 | 0 | 0 |
| September | Second Half | 15 | 9.3 | 5.7 | 2.6 | 0 | 0 |

**Table 2.23. Crooked River Water Temperature at Headwaters, 2005**

| Month | Period | Days | Max Degrees Celsius (C) | Avg C | Min C | Days Max>22C | Days Avg>19C |
|---|---|---|---|---|---|---|---|
| June | First Half | 15 | 7.6 | 4.7 | 3.1 | 0 | 0 |
| June | Second Half | 15 | 10.4 | 7.3 | 4.0 | 0 | 0 |
| July | First Half | 15 | 11.8 | 8.6 | 5.7 | 0 | 0 |
| July | Second Half | 16 | 13.2 | 9.7 | 6.5 | 0 | 0 |
| August | First Half | 15 | 13.0 | 10.0 | 6.8 | 0 | 0 |
| August | Second Half | 16 | 11.3 | 8.5 | 5.3 | 0 | 0 |
| September | First Half | 15 | 10.2 | 6.8 | 3.7 | 0 | 0 |
| September | Second Half | 15 | 7.6 | 4.9 | 2.6 | 0 | 0 |

# 3. Subbasin Assessment – Pollutant Source Inventory

## 3.1 Sources of Pollutants of Concern

The pollutant of concern is temperature. Human activities resulting in warmer water than would naturally occur tend to be related to activities that cause an increase in stream channel width, a decrease in riparian vegetation, and a decrease in flow. TMDLs do not address flow alteration.

### Point Sources

There are no point sources in the watershed.

### Nonpoint Sources

#### *Temperature*

Increases and decreases in water temperature are due to changes in the amount of heat reaching the water. Several factors contribute to the amount of heat reaching the water in the Wildhorse River watershed. The anthropogenic factors include irrigation management, dispersed recreation (camping), and loss of riparian vegetation (shading). Natural factors include seasonal air temperature changes and loss of vegetation to natural causes (i.e., tornado, rain-on-snow events that caused scouring flows). Only those anthropogenic sources that are directly controllable are addressed in this TMDL.

## 3.2 Data Gaps

TMDLs are written based on the data available at the time of writing. Thus, there are likely instances where more information would be useful.

### Nonpoint Sources

More ground truthed shading estimates would help further refine the temperature analysis. Fortunately, if more shading estimates are collected, these can be easily integrated into the dataset, and loading allocations can be changed if necessary.

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

Numerous water quality improvement projects are already underway or have been completed in the Wildhorse River watershed (Table 4.1).

**Table 4.1. Water Quality Improvement Projects in the Wildhorse River Subbasin**

| Watershed | Project Type | Party | Benefits |
|---|---|---|---|
| Lick Creek | Conservation Reserve Program (CRP) | OX Ranch | Creek protection, riparian planting, offsite watering. Fish screening. Fish passage. |
| | Lick Creek Ditch Improvement project | | 3.1 miles of pipe instead of open ditch. |
| Bear Creek | Irrigation Ditch Improvements | Bear Creek Community Ditch | Fish screening. Fish passage. |
| Crooked River | Large Woody Debris structures added to lower Crooked River (1999) | USFS | Fish habitat |
| | Riparian fencing of 2 miles of Crooked River upstream of Lafferty Campground (2002) | | Improved riparian habitat |

# 5. Total Maximum Daily Loads

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

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

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

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

## 5.1 Instream Water Quality Targets

For the Wildhorse River temperature TMDL, a potential natural vegetation (PNV) approach was utilized. The Idaho water quality standards include a provision (IDAPA 58.01.02.200.09) which establishes that if natural conditions exceed numeric water quality criteria, exceedance of the criteria is not considered to be a violation of water quality standards. In these situations, natural conditions essentially become the water quality standard, and the natural level of shade and channel width become the target of the TMDL. The instream temperature which results from attainment of these conditions is consistent with the water quality standards, even though it may exceed numeric temperature criteria. (See Appendix B for further discussion of water quality standards and background provisions.)

The PNV approach is described below. Additionally, the procedures and methodologies to develop PNV target shade levels and to estimate existing shade levels are described in this section. For a more complete discussion of shade and its effects on stream water temperature, the reader is referred to the South Fork Clearwater Subbasin Assessment and TMDL (IDEQ, 2004).

## Potential Natural Vegetation for Temperature TMDLs

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

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

Potential natural vegetation (PNV) along a stream is that intact riparian plant community that has grown to its fullest extent and has not been disturbed or reduced in anyway. The PNV can be removed by disturbance either naturally (wildfire, disease/old age, wind-blown, wildlife grazing) or anthropogenically (domestic livestock grazing, vegetation removal, erosion). The idea behind PNV as targets for temperature TMDLs is that PNV provides a natural "mature state" level of solar loading to the stream. Anything less than PNV results in the stream heating up from either naturally created or anthropogenically created additional solar inputs. We can estimate PNV from models of plant community structure (shade curves for specific riparian plant communities), and we can measure existing vegetative cover or shade. Comparing the two will tell us how much excess solar load the stream is receiving and what potential there is to decrease solar gain. Streams disturbed by wildfire require their own time to recover. Streams that have been disturbed by human activity may require additional restoration above and beyond natural recovery.

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

### *Pathfinder Methodology*

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

At each sampling location, the solar pathfinder should be placed in the middle of the stream about the bankfull water level. Follow the manufacturer’s instructions (orient to true south and level) for taking traces. Systematic sampling is easiest to accomplish and still not bias the location of sampling. Start at a unique location such as 100 m from a bridge or fence line and then proceed upstream or downstream, stopping to take additional traces at fixed intervals (e.g., every 100m, every 100 paces, every degree change on a GPS, every 0.1 mile change on an odometer, etc.). One can also randomly locate points of measurement by generating random numbers to be used as interval distances.

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

### *Aerial Photo Interpretation*

Canopy coverage estimates or expectations of shade based on plant type and density are provided for natural breaks in vegetation density, marked out on a 1:100K or 1:250K hydrography. Each interval is assigned a single value representing the bottom of a 10% canopy coverage or shade class as described below (adapted from the CWE process, IDL, 2000). For example, if we estimate that canopy cover for a particular stretch of stream is somewhere between 50% and 59%, we assign the value of 50% to that section of stream. The estimate is based on a general intuitive observation about the kind of vegetation present, its density, and the width of the stream. The typical vegetation type (see below) shows the kind of landscape a particular cover class usually falls into for a stream 5m wide or less. For example, if a section of a 5m wide stream is identified as 20% cover class, it is usually because it is in agricultural land, meadows, open areas, or clear-cuts. However, that does not mean that the 20% cover class cannot occur in shrublands and forests, because it does on wider streams.

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

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

## *Stream Morphology*

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

The only factor not developed from the aerial photo work presented above is channel width (i.e., near stream disturbance zone [NSDZ] or Bankfull Width). Accordingly, this parameter must be estimated from available information. We use regional curves for the major basins in Idaho from data compiled by Diane Hopster of Idaho Department of Lands (Figure 5.1).

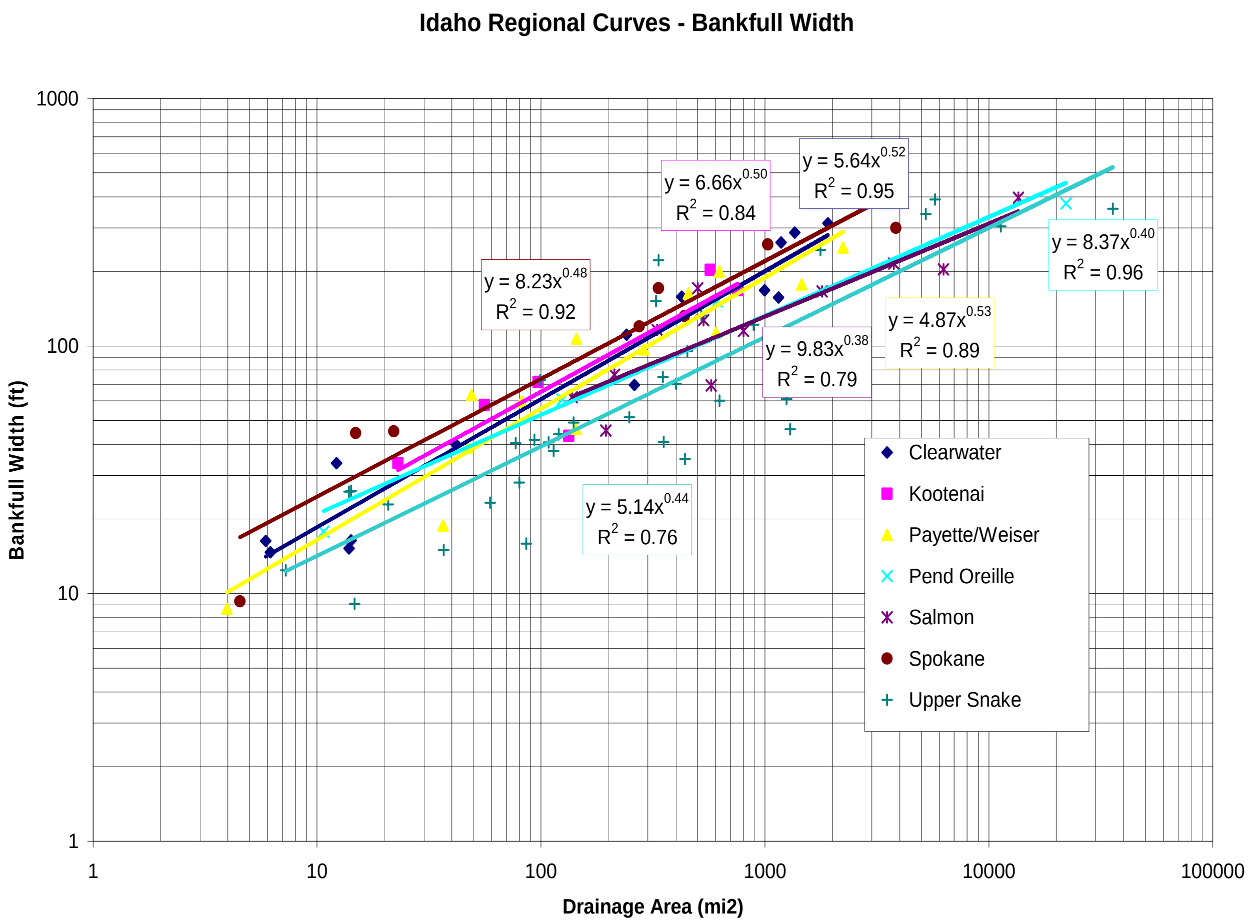



**Figure 5.1. Bankfull Width as a Function of Drainage Area**

For each stream evaluated in the loading analysis, bankfull width is estimated based on drainage area of the Payette/Weiser curve from Figure 5.1. The Payette/Weiser curve data was gathered from gaging station information. Additionally, existing width is evaluated from available data. If the stream's existing width is equal to or wider than that predicted by the Payette/Weiser curve in Figure 5.1, then the Figure estimate of bankfull width is used in the loading analysis. If existing width is smaller, then existing width is used in the loading analysis. In all cases, the curve-estimated widths used in this TMDL are very similar to existing widths. Thus, the Payette/Weiser regional curve estimate of bankfull width was used in this analysis. Table 5.1 shows bankfull widths estimated by the regional curve and existing measurements for several locations in the watershed.

**Table 5.1. Bankfull Widths in Meters (m) as Estimated by the Payette/Weiser (P/W) Regional Curve and by Existing Field Measurements**

| Location | Area (sq mi) | P/W (m) | Existing |
|---|---|---|---|
| Bear Creek at mouth | 89.6 | 16 | 15 |
| Lick Creek at mouth | 43.8 | 11 | 10 |
| Crooked River at mouth | 23.4 | 8 | 8 |
| Wildhorse headwaters | 113 | 18 | 20 |
| Wildhorse above No Business Creek | 154.9 | 21 | Not Available |
| Wildhorse at mouth | 176.9 | 23 | 24 |

## Design Conditions

The Wildhorse River originates at the confluence of Bear Creek and Crooked River and then flows generally southwest through Snake River canyon country, emptying into the Snake River just below Brownlee Dam. Bear Creek and its tributary Lick Creek originate in Blue Mountain Ecoregion highlands just south of the Seven Devils Mountains and flow south-southwest to Wildhorse River. The Crooked River originates on the north face of Cuddy Mountain and flows predominantly north before turning west to join Bear Creek, which then forms the Wildhorse River.

All of these tributaries to the Wildhorse River originate in mixed conifer forests of Douglas fir (*Pseudotsuga menziesii*), grand fir (*Abies grandis*), ponderosa pine (*Pinus ponderosa*), and subalpine fir (*Abies lasiocarpa*) typical of the Blue Mountain Ecoregion. As the streams descend in elevation, their riparian community tends to become more deciduous shrub dominated, first with a conifer/shrub mix and then with a community that is mostly deciduous shrubs. The riparian community along the Wildhorse River in canyon country is predominantly deciduous shrubs.

Thus, targets are developed to simulate three riparian plant community types: 1) a mixed conifer type, 2) a conifer/shrub type for the upper portions of Bear Creek, Lick Creek, and the Crooked River, and 3) a mixed deciduous shrub type for the lower portions of tributaries and for the Wildhorse River.

## Target Selection

To determine potential natural vegetation shade targets for the Wildhorse River and its tributaries, effective shade curves from several existing temperature TMDLs were examined. These TMDLs had previously used vegetation community modeling to produce these shade curves. Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis. As a stream becomes wider, a given vegetation type loses its ability to shade wider and wider streams. Although these TMDLs reflect a wide variety of geomorphologies and topographies, effective shades at the same stream width were remarkably similar. For streams in the Wildhorse TMDL, curves for the most similar vegetation type were selected for shade target determinations. Because no two landscapes are exactly the same, shade targets were derived by taking an average of the various shade curves available. Thus, the selected shade curves represent a range of shade conditions that presumably the riparian community of interest in this TMDL falls into.

The effective shade calculations are based on a six month period from April through September. This time period coincides with the critical time period when temperatures affect beneficial uses such as spring and fall salmonid spawning and when cold water aquatic life criteria may be exceeded during summer months. Spring salmonid spawning typically occurs between March 15 and July 15. Fall salmonid spawning begins in September. Late July and early August typically represent a period of highest stream temperatures. Solar gains can begin early in the spring and affect not only the highest temperatures reached later on in the summer, but also solar loadings affect salmonid spawning temperatures in spring and fall. Thus, solar loading in these streams is evaluated from spring (April) to early fall (September).

For canyon areas on lower Bear Creek and Wildhorse River, target shade values were increased to compensate for topographic shade. Targets for lower Bear Creek increased by 10%, and by 20% for Wildhorse River.

### *Shade Targets*

For the Wildhorse River TMDL, an attempt was made to match the various vegetation types using effective shade curves from a variety of Northwest TMDLs based on similar vegetative community types. Although these TMDLs reflect a wide variety of geomorphologies and topographies, effective shades at the same stream width were remarkably similar. Tables 5.2 through 5.4 show derivations of shade targets at natural stream widths (e.g., 1m = 1 meter wide) encountered in the loading analysis for each vegetation type. Numbers in these tables are percent shade. The average percent shade for the curve values in a column is converted to a target (%) after rounding to the nearest whole number.

For the conifer/shrub community (Table 5.2), four shade curves were used to produce shade targets. Two curves are mixed forest/shrub types for geomorphic provinces (Qff2 and Qbf) in the Willamette TMDL. The Qbf type is 47% forest, 30% savanna, and 23% prairie, with an average height of 72.2 ft and a stand density of 68%. The Qff2 type is 43% forest, 35% savanna, and 22% prairie, with an average height of 70.6 ft and a stand density of 66%. Additionally, two curves from Idaho TMDLs were used. The ponderosa pine community from the Salmon-Chamberlain (Crooked Creek) TMDL has an average height of 59 ft and an average canopy cover of 58%. The vegetation response unit #10 from the SF Clearwater TMDL was comprised of alder, subalpine fir, and grand fir that were 25% large trees, 40% medium trees, 10% pole trees, and 25% non-forest.

**Table 5.2. Shade Targets as 10% Class Intervals for the Conifer/Shrub Vegetation Type at Two Stream Widths**

| Conifer/Shrub | 1m | 2m | 3m | 4m | 5m | 6m | 7m | 8m | 10m | 12m | 16m |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Qff2 (ODEQ, 2004a) | 88 | 85 | 82 | 80 | 78 | 75 | 72 | 69 | 66 | 60 | 49 |
| Qbf (ODEQ, 2004a) | 90 | 85 | 83 | 80 | 77 | 75 | 73 | 70 | 66 | 60 | 50 |
| ponderosa pine (IDEQ, 2002) | 83 | 80 | 77 | 75 | 74 | 72 | 69 | 65 | 59 | 55 | 48 |
| VRU10 (IDEQ, 2004) | 91 | 88 | 85 | 82 | 78 | 75 | 74 | 72 | 67 | 64 | 48 |
| Average | 88 | 84.5 | 81.75 | 79.25 | 76.75 | 74.25 | 72 | 69 | 64.5 | 59.75 | 48.75 |
| **Target (%)** | **88** | **85** | **82** | **79** | **77** | **74** | **72** | **69** | **65** | **60** | **49** |

For the mixed conifer community (Table 5.3), four shade curves were used to make targets. The subalpine fir type from the Salmon-Chamberlain (Crooked Creek) TMDL has an average height of 83 ft and an average canopy cover of 80%. The mixed conifer type from the Matolle River TMDL had a buffer height of 35m (115 ft) and a buffer width of 30m (98 ft). The vegetation response unit #3 from the SF Clearwater TMDL was comprised of grand fir and Douglas fir that was 40% large trees, 20% non-forest, and 40% medium trees. The conifer zone from the Walla Walla TMDL had an average height of 24m (79 ft) and an average density of 80%.

**Table 5.3. Shade Targets as 10% Class Intervals for the Mixed Conifer Vegetation Type at Various Stream Widths**

| Mixed Conifer | 1m | 2m | 4m | 6m | 8m | 10m | 12m |
|---|---|---|---|---|---|---|---|
| subalpine fir (IDEQ, 2002) | 95 | 95 | 92 | 88 | 85 | 81 | 78 |
| mixed conifer (CRWQCB, 2002) | 94 | 94 | 93 | 91 | 89 | 87 | 85 |
| VRU3 (IDEQ, 2004) | 95 | 95 | 92 | 89 | 85 | 80 | 78 |
| Conifer zone (ODEQ, 2004b) | 94 | 94 | 86 | 80 | 76 | 72 | 70 |
| Average | 94.5 | 94.5 | 90.75 | 87 | 83.75 | 80 | 77.75 |
| **10% Class Interval** | **90** | **90** | **90** | **80** | **80** | **80** | **70** |

Shade targets for the mixed deciduous shrub community (Table 5.4) were developed from three shade curves, two from the Alvord Lake TMDL and one from the SF Clearwater TMDL. The mountain alder type from the Willow-Whitehorse ecological province had an average height of 25 ft and an average density of 30%. The willow/alder type from the Trout Creek ecological province had an average height of 24 ft and an average density of 75%. The vegetation response unit #12/16 was a non-forest, shrub type with 80% shrubs (average height = 8.4 ft) and 20% grass (average height = 1 ft) with 90% stream bank cover.

**Table 5.4. Shade Targets as 10% Class Intervals for the Mixed Shrub Vegetation Type at Various Stream Widths**

| Deciduous Shrub Mix | 1m | 2m | 3m | 4m | 5m | 6m | 7m | 8m | 9m | 10m | 11m |
|---|---|---|---|---|---|---|---|---|---|---|---|
| mountain alder (ODEQ, 2003) | 91 | 89 | 85 | 80 | 72 | 63 | 60 | 54 | 50 | 47 | 45 |
| willow/alder (ODEQ, 2003) | 90 | 86 | 79 | 70 | 65 | 57 | 51 | 50 | 44 | 40 | 36 |
| VRU12/16 (IDEQ, 2004) | 87 | 71 | 45 | 37 | 33 | 26 | 23 | 21 | 19 | 17 | 16 |
| Average | 89.333 | 82 | 69.667 | 62.333 | 56.667 | 48.667 | 44.667 | 41.667 | 37.67 | 34.667 | 32.33 |
| **Target (%)** | **89** | **82** | **70** | **62** | **57** | **49** | **45** | **42** | **38** | **35** | **32** |

| Deciduous Shrub Mix | 12m | 13m | 14m | 15m | 16m | 18m | 19m | 20m | 21m | 22m | 23m |
|---|---|---|---|---|---|---|---|---|---|---|---|
| mountain alder (ODEQ, 2003) | 42 | 40 | 39 | 38 | 36 | 34 | 33 | 32 | 31 | 30 | 29 |
| willow/alder (ODEQ, 2003) | 33 | 30 | 28 | 26 | 25 | 23 | 22 | 21 | 20 | 19 | 18 |
| VRU12/16 (IDEQ, 2004) | 14 | 13 | 12 | 11 | 10 | 10 | 10 | 9 | 9 | 9 | 9 |
| Average | 29.667 | 27.667 | 26.333 | 25 | 23.667 | 22.333 | 21.667 | 20.667 | 20 | 19.333 | 18.67 |
| **Target (%)** | **30** | **28** | **26** | **25** | **24** | **22** | **22** | **21** | **20** | **19** | **19** |

### Monitoring Points

The accuracy of the aerial photo interpretations were field verified with a solar pathfinder with 110 traces taken at 11 sites located on all four streams. These data showed that the original aerial photo interpretations underestimated shade on the Wildhorse River with a mean difference of 25% ± 3.6 (mean ± 95% C.I.), and overestimated shade on two other streams (27% ± 2.9 for Crooked River and 24% ± 7.7 for Lick Creek). As a result, the original aerial photo estimates were modified accordingly. Wildhorse River estimates increased generally by two 10% class intervals, and the others decreased by the same amount. Estimates for Bear Creek were accurate and not changed. Existing shade values presented in this document are those corrected values after field verification.

In addition to field verification, an F-2 class tornado touched down within the Bear Creek watershed during the summer of 2006. The tornado took down a large number of trees throughout the forest, including the riparian area along Bear Creek. As a result, that portion of Bear Creek affected, as delineated by the Payette National Forest, was removed from the loading analysis.

Effective shade monitoring can take place on any reach throughout the Wildhorse River and its tributaries and compared to estimates of existing shade seen on Figure 5.3 and described in Tables 5.5 through 5.8. Those areas with the largest disparity between existing shade estimates and shade targets should be monitored with solar pathfinders to verify the existing shade levels and to determine progress towards meeting shade targets. It is important to note that many existing shade estimates have not been field verified, and may require adjustment during the implementation process. Stream segments for each change in existing shade vary in length depending on land use or landscape that has affected that shade level. It is appropriate to monitor within a given existing shade segment to see if that segment has increased its existing shade towards target levels. Ten equally spaced solar pathfinder measurements within that segment averaged together should suffice to determine new shade levels in the future.

## 5.2 Load Capacity

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

We obtained solar load data for flat plate collectors from National Renewable Energy Laboratory (NREL) weather stations near by. In this case, data from the Boise, Idaho station was used. The solar loads used in this TMDL are spring/summer averages, thus, we use an average load for the six month period from April through September. These months coincide with the time of year when stream temperatures are increasing and when deciduous vegetation is in leaf. Tables 5.5 through 5.8 (and Figure 5.2) show the PNV shade targets (identified as Target or Potential Shade) and their corresponding potential summer load (in kWh/m$^2$/day and kWh/day) that serve as the loading capacities for the streams.

Loading capacities varied from 1.7 million kWh/day on the Wildhorse River, the largest stream (Table 5.5), to 179,806 kWh/day on Crooked River (Table 5.8).

## 5.3 Estimates of Existing Pollutant Loads

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

Existing loads in this temperature TMDL come from estimates of existing shade as determined from aerial photo interpretations (see Figure 5.3). Like target shade, existing shade was converted to a solar load by multiplying the fraction of open stream by the solar radiation measured on a flat plate collector at the NREL weather stations. Existing shade data are presented in Tables 5.5 through 5.8. Like loading capacities (potential loads), existing loads in Tables 5.5 through 5.8 are presented on an area basis (kWh/m$^2$/day) and as a total load (kWh/day).

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

Existing loads varied from two million kWh/day on Wildhorse River (Table 5.5) to 219,013 kWh/day on Crooked River (Table 5.8).

# Table 5.5. Existing and Potential Solar Loads for Wildhorse River

| Segment Length (meters) | Existing Shade (fraction) | Existing Summer Load ($kWh/m^2/day$) | Potential Shade (fraction) | Potential Summer Load ($kWh/m^2/day$) | Potential Load minus Existing load ($kWh/m^2/day$) | Existing Stream Width (m) | Natural Stream Width (m) | Existing Segment Area ($m^2$) | Existing Summer Load (kWh/day) | Natural Segment Area ($m^2$) | Potential Summer Load (kWh/day) | Potential Load minus Existing Load (kWh/day) | **Wildhorse River** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 130 | 0.2 | 5.104 | 0.42 | 3.7004 | -1.40 | 18 | 18 | 2340 | 11,943 | 2340 | 8,659 | -3,284 | mxd shrub |
| 180 | 0.3 | 4.466 | 0.42 | 3.7004 | -0.7656 | 18 | 18 | 3240 | 14,470 | 3240 | 11,989 | -2,481 | |
| 510 | 0.2 | 5.104 | 0.42 | 3.7004 | -1.4036 | 18 | 18 | 9180 | 46,855 | 9180 | 33,970 | -12,885 | |
| 690 | 0.3 | 4.466 | 0.42 | 3.7004 | -0.7656 | 18 | 18 | 12420 | 55,468 | 12420 | 45,959 | -9,509 | |
| 250 | 0.2 | 5.104 | 0.42 | 3.7004 | -1.4036 | 18 | 18 | 4500 | 22,968 | 4500 | 16,652 | -6,316 | |
| 250 | 0.3 | 4.466 | 0.42 | 3.7004 | -0.7656 | 18 | 18 | 4500 | 20,097 | 4500 | 16,652 | -3,445 | |
| 190 | 0.2 | 5.104 | 0.42 | 3.7004 | -1.4036 | 18 | 18 | 3420 | 17,456 | 3420 | 12,655 | -4,800 | |
| 270 | 0.3 | 4.466 | 0.42 | 3.7004 | -0.7656 | 18 | 18 | 4860 | 21,705 | 4860 | 17,984 | -3,721 | |
| 410 | 0.4 | 3.828 | 0.42 | 3.7004 | -0.1276 | 18 | 18 | 7380 | 28,251 | 7380 | 27,309 | -942 | |
| 200 | 0.2 | 5.104 | 0.42 | 3.7004 | -1.4036 | 18 | 18 | 3600 | 18,374 | 3600 | 13,321 | -5,053 | |
| 510 | 0.3 | 4.466 | 0.42 | 3.7004 | -0.7656 | 18 | 18 | 9180 | 40,998 | 9180 | 33,970 | -7,028 | |
| 150 | 0.2 | 5.104 | 0.42 | 3.7004 | -1.4036 | 18 | 18 | 2700 | 13,781 | 2700 | 9,991 | -3,790 | |
| 1790 | 0.2 | 5.104 | 0.42 | 3.7004 | -1.4036 | 19 | 19 | 34010 | 173,587 | 34010 | 125,851 | -47,736 | |
| 450 | 0.4 | 3.828 | 0.42 | 3.7004 | -0.1276 | 19 | 19 | 8550 | 32,729 | 8550 | 31,638 | -1,091 | |
| 380 | 0.2 | 5.104 | 0.42 | 3.7004 | -1.4036 | 19 | 19 | 7220 | 36,851 | 7220 | 26,717 | -10,134 | |
| 420 | 0.3 | 4.466 | 0.42 | 3.7004 | -0.7656 | 19 | 19 | 7980 | 35,639 | 7980 | 29,529 | -6,109 | |
| 170 | 0.2 | 5.104 | 0.42 | 3.7004 | -1.4036 | 19 | 19 | 3230 | 16,486 | 3230 | 11,952 | -4,534 | |
| 620 | 0.3 | 4.466 | 0.42 | 3.7004 | -0.7656 | 19 | 19 | 11780 | 52,609 | 11780 | 43,591 | -9,019 | |
| 480 | 0.2 | 5.104 | 0.42 | 3.7004 | -1.4036 | 19 | 19 | 9120 | 46,548 | 9120 | 33,748 | -12,801 | |
| 1130 | 0.3 | 4.466 | 0.41 | 3.7642 | -0.7018 | 20 | 20 | 22600 | 100,932 | 22600 | 85,071 | -15,861 | |
| 180 | 0.2 | 5.104 | 0.41 | 3.7642 | -1.3398 | 20 | 20 | 3600 | 18,374 | 3600 | 13,551 | -4,823 | |
| 740 | 0.3 | 4.466 | 0.41 | 3.7642 | -0.7018 | 20 | 20 | 14800 | 66,097 | 14800 | 55,710 | -10,387 | |
| 450 | 0.4 | 3.828 | 0.41 | 3.7642 | -0.0638 | 20 | 20 | 9000 | 34,452 | 9000 | 33,878 | -574 | |
| 180 | 0.2 | 5.104 | 0.41 | 3.7642 | -1.3398 | 20 | 20 | 3600 | 18,374 | 3600 | 13,551 | -4,823 | |
| 200 | 0.3 | 4.466 | 0.41 | 3.7642 | -0.7018 | 20 | 20 | 4000 | 17,864 | 4000 | 15,057 | -2,807 | |
| 200 | 0.4 | 3.828 | 0.41 | 3.7642 | -0.0638 | 20 | 20 | 4000 | 15,312 | 4000 | 15,057 | -255 | |
| 390 | 0.3 | 4.466 | 0.41 | 3.7642 | -0.7018 | 20 | 20 | 7800 | 34,835 | 7800 | 29,361 | -5,474 | |
| 310 | 0.2 | 5.104 | 0.41 | 3.7642 | -1.3398 | 20 | 20 | 6200 | 31,645 | 6200 | 23,338 | -8,307 | |
| 140 | 0.5 | 3.19 | 0.41 | 3.7642 | 0.5742 | 20 | 20 | 2800 | 8,932 | 2800 | 10,540 | 1,608 | |
| 350 | 0.2 | 5.104 | 0.4 | 3.828 | -1.276 | 21 | 21 | 7350 | 37,514 | 7350 | 28,136 | -9,379 | |
| 750 | 0.4 | 3.828 | 0.4 | 3.828 | 0 | 21 | 21 | 15750 | 60,291 | 15750 | 60,291 | 0 | |
| 270 | 0.3 | 4.466 | 0.4 | 3.828 | -0.638 | 21 | 21 | 5670 | 25,322 | 5670 | 21,705 | -3,617 | |
| 820 | 0.4 | 3.828 | 0.4 | 3.828 | 0 | 21 | 21 | 17220 | 65,918 | 17220 | 65,918 | 0 | |
| 250 | 0.2 | 5.104 | 0.4 | 3.828 | -1.276 | 21 | 21 | 5250 | 26,796 | 5250 | 20,097 | -6,699 | |
| 340 | 0.4 | 3.828 | 0.4 | 3.828 | 0 | 21 | 21 | 7140 | 27,332 | 7140 | 27,332 | 0 | |
| 140 | 0.2 | 5.104 | 0.4 | 3.828 | -1.276 | 21 | 21 | 2940 | 15,006 | 2940 | 11,254 | -3,751 | |
| 200 | 0.3 | 4.466 | 0.4 | 3.828 | -0.638 | 21 | 21 | 4200 | 18,757 | 4200 | 16,078 | -2,680 | |
| 330 | 0.4 | 3.828 | 0.4 | 3.828 | 0 | 21 | 21 | 6930 | 26,528 | 6930 | 26,528 | 0 | |
| 170 | 0.2 | 5.104 | 0.4 | 3.828 | -1.276 | 21 | 21 | 3570 | 18,221 | 3570 | 13,666 | -4,555 | |
| 170 | 0.4 | 3.828 | 0.4 | 3.828 | 0 | 21 | 21 | 3570 | 13,666 | 3570 | 13,666 | 0 | |
| 90 | 0.2 | 5.104 | 0.4 | 3.828 | -1.276 | 21 | 21 | 1890 | 9,647 | 1890 | 7,235 | -2,412 | |
| 420 | 0.4 | 3.828 | 0.4 | 3.828 | 0 | 21 | 21 | 8820 | 33,763 | 8820 | 33,763 | 0 | |
| 1350 | 0.3 | 4.466 | 0.39 | 3.8918 | -0.5742 | 22 | 22 | 29700 | 132,640 | 29700 | 115,586 | -17,054 | |
| 2200 | 0.4 | 3.828 | 0.39 | 3.8918 | 0.0638 | 22 | 22 | 48400 | 185,275 | 48400 | 188,363 | 3,088 | |
| 1450 | 0.5 | 3.19 | 0.39 | 3.8918 | 0.7018 | 23 | 23 | 33350 | 106,387 | 33350 | 129,792 | 23,405 | |
| 950 | 0.1 | 5.742 | 0.19 | 5.1678 | -0.5742 | 23 | 23 | 21850 | 125,463 | 21850 | 112,916 | -12,546 | |
| 180 | 0 | 6.38 | 0.19 | 5.1678 | -1.2122 | 23 | 23 | 4140 | 26,413 | 4140 | 21,395 | -5,019 | **% Reduction** |
| | | | | | | | **Total** | **455,350** | **2,008,571** | **455,350** | **1,760,971** | **-247,600** | **-12** |

# Table 5.6. Existing and Potential Solar Loads for Bear Creek

| Segment Length (meters) | Existing Shade (fraction) | Existing Summer Load (kWh/m²/day) | Potential Shade (fraction) | Potential Summer Load (kWh/m²/day) | Potential Load minus Existing load (kWh/m²/day) | Existing Stream Width (m) | Natural Stream Width (m) | Existing Segment Area (m²) | Existing Summer Load (kWh/day) | Natural Segment Area (m²) | Potential Summer Load (kWh/day) | Potential Load minus Existing Load (kWh/day) | **Bear Creek** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1530 | 0.8 | 1.276 | 0.95 | 0.319 | -0.96 | 1 | 1 | 1530 | 1,952 | 1530 | 488 | -1,464 | mxd conifer |
| 590 | 0.6 | 2.552 | 0.88 | 0.7656 | -1.7864 | 1 | 1 | 590 | 1,506 | 590 | 452 | -1,054 | conifer/shrub |
| 1430 | 0.7 | 1.914 | 0.95 | 0.319 | -1.595 | 2 | 2 | 2860 | 5,474 | 2860 | 912 | -4,562 | mxd conifer |
| 500 | 0.6 | 2.552 | 0.95 | 0.319 | -2.233 | 2 | 2 | 1000 | 2,552 | 1000 | 319 | -2,233 | |
| 470 | 0.8 | 1.276 | 0.95 | 0.319 | -0.957 | 2 | 2 | 940 | 1,199 | 940 | 300 | -900 | |
| 1150 | 0.7 | 1.914 | 0.92 | 0.5104 | -1.4036 | 3 | 3 | 3450 | 6,603 | 3450 | 1,761 | -4,842 | |
| 510 | 0.5 | 3.19 | 0.82 | 1.1484 | -2.0416 | 3 | 3 | 1530 | 4,881 | 1530 | 1,757 | -3,124 | conifer/shrub |
| 1190 | 0.6 | 2.552 | 0.82 | 1.1484 | -1.4036 | 3 | 3 | 3570 | 9,111 | 3570 | 4,100 | -5,011 | |
| 3950 | 0.7 | 1.914 | 0.79 | 1.3398 | -0.5742 | 4 | 4 | 15800 | 30,241 | 15800 | 21,169 | -9,072 | |
| 320 | 0.6 | 2.552 | 0.77 | 1.4674 | -1.0846 | 5 | 5 | 1600 | 4,083 | 1600 | 2,348 | -1,735 | |
| 5800 | 0 | 0 | 0 | 0 | 0 | 6.5 | 6.5 | 37700 | 0 | 37700 | 0 | 0 | tornado zone |
| 290 | 0.2 | 5.104 | 0.42 | 3.7004 | -1.4036 | 8 | 8 | 2320 | 11,841 | 2320 | 8,585 | -3,256 | mxd shrub |
| 110 | 0.3 | 4.466 | 0.42 | 3.7004 | -0.7656 | 8 | 8 | 880 | 3,930 | 880 | 3,256 | -674 | |
| 230 | 0.2 | 5.104 | 0.42 | 3.7004 | -1.4036 | 8 | 8 | 1840 | 9,391 | 1840 | 6,809 | -2,583 | |
| 350 | 0.5 | 3.19 | 0.42 | 3.7004 | 0.5104 | 8 | 8 | 2800 | 8,932 | 2800 | 10,361 | 1,429 | |
| 2300 | 0.2 | 5.104 | 0.35 | 4.147 | -0.957 | 10 | 10 | 23000 | 117,392 | 23000 | 95,381 | -22,011 | |
| 1970 | 0.3 | 4.466 | 0.32 | 4.3384 | -0.1276 | 11 | 11 | 21670 | 96,778 | 21670 | 94,013 | -2,765 | |
| 400 | 0.4 | 3.828 | 0.32 | 4.3384 | 0.5104 | 11 | 11 | 4400 | 16,843 | 4400 | 19,089 | 2,246 | |
| 360 | 0.3 | 4.466 | 0.3 | 4.466 | 0 | 12 | 12 | 4320 | 19,293 | 4320 | 19,293 | 0 | |
| 60 | 0.1 | 5.742 | 0.3 | 4.466 | -1.276 | 12 | 12 | 720 | 4,134 | 720 | 3,216 | -919 | |
| 1280 | 0.3 | 4.466 | 0.3 | 4.466 | 0 | 12 | 12 | 15360 | 68,598 | 15360 | 68,598 | 0 | canyon |
| 960 | 0.4 | 3.828 | 0.4 | 3.828 | 0 | 12 | 12 | 11520 | 44,099 | 11520 | 44,099 | 0 | |
| 2530 | 0.4 | 3.828 | 0.36 | 4.0832 | 0.2552 | 14 | 14 | 35420 | 135,588 | 35420 | 144,627 | 9,039 | |
| 1810 | 0.3 | 4.466 | 0.34 | 4.2108 | -0.2552 | 16 | 16 | 28960 | 129,335 | 28960 | 121,945 | -7,391 | **% Reduction** |
| | | | | | | | **Total** | **223,780** | **733,757** | **223,780** | **672,876** | **-60,881** | **-8** |

# Table 5.7. Existing and Potential Solar Loads for Lick Creek

| Segment Length (meters) | Existing Shade (fraction) | Existing Summer Load (kWh/m²/day) | Potential Shade (fraction) | Potential Summer Load (kWh/m²/day) | Potential Load minus Existing load (kWh/m²/day) | Existing Stream Width (m) | Natural Stream Width (m) | Existing Segment Area (m²) | Existing Summer Load (kWh/day) | Natural Segment Area (m²) | Potential Summer Load (kWh/day) | Potential Load minus Existing Load (kWh/day) | **Lick Creek** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 300 | 0.8 | 1.276 | 0.88 | 0.7656 | -0.51 | 1 | 1 | 300 | 383 | 300 | 230 | -153 | conifer/shrub |
| 1050 | 0.9 | 0.638 | 0.95 | 0.319 | -0.319 | 1 | 1 | 1050 | 670 | 1050 | 335 | -335 | mxd conifer |
| 1460 | 0.8 | 1.276 | 0.95 | 0.319 | -0.957 | 2 | 2 | 2920 | 3,726 | 2920 | 931 | -2,794 | |
| 3840 | 0.6 | 2.552 | 0.79 | 1.3398 | -1.2122 | 4 | 4 | 15360 | 39,199 | 15360 | 20,579 | -18,619 | conifer/shrub |
| 230 | 0.5 | 3.19 | 0.77 | 1.4674 | -1.7226 | 5 | 5 | 1150 | 3,669 | 1150 | 1,688 | -1,981 | |
| 110 | 0.7 | 1.914 | 0.77 | 1.4674 | -0.4466 | 5 | 5 | 550 | 1,053 | 550 | 807 | -246 | |
| 230 | 0.6 | 2.552 | 0.77 | 1.4674 | -1.0846 | 5 | 5 | 1150 | 2,935 | 1150 | 1,688 | -1,247 | |
| 320 | 0.5 | 3.19 | 0.77 | 1.4674 | -1.7226 | 5 | 5 | 1600 | 5,104 | 1600 | 2,348 | -2,756 | |
| 1350 | 0.6 | 2.552 | 0.77 | 1.4674 | -1.0846 | 5 | 5 | 6750 | 17,226 | 6750 | 9,905 | -7,321 | |
| 1070 | 0.5 | 3.19 | 0.74 | 1.6588 | -1.5312 | 6 | 6 | 6420 | 20,480 | 6420 | 10,649 | -9,830 | |
| 560 | 0.4 | 3.828 | 0.74 | 1.6588 | -2.1692 | 6 | 6 | 3360 | 12,862 | 3360 | 5,574 | -7,289 | |
| 330 | 0.5 | 3.19 | 0.74 | 1.6588 | -1.5312 | 6 | 6 | 1980 | 6,316 | 1980 | 3,284 | -3,032 | |
| 710 | 0.7 | 1.914 | 0.72 | 1.7864 | -0.1276 | 7 | 7 | 4970 | 9,513 | 4970 | 8,878 | -634 | |
| 810 | 0.5 | 3.19 | 0.72 | 1.7864 | -1.4036 | 7 | 7 | 5670 | 18,087 | 5670 | 10,129 | -7,958 | |
| 910 | 0.7 | 1.914 | 0.72 | 1.7864 | -0.1276 | 7 | 7 | 6370 | 12,192 | 6370 | 11,379 | -813 | |
| 760 | 0.2 | 5.104 | 0.45 | 3.509 | -1.595 | 7 | 7 | 5320 | 27,153 | 5320 | 18,668 | -8,485 | mxd shrub |
| 420 | 0.3 | 4.466 | 0.42 | 3.7004 | -0.7656 | 8 | 8 | 3360 | 15,006 | 3360 | 12,433 | -2,572 | |
| 200 | 0.6 | 2.552 | 0.69 | 1.9778 | -0.5742 | 8 | 8 | 1600 | 4,083 | 1600 | 3,164 | -919 | conifer/shrub |
| 1850 | 0.4 | 3.828 | 0.42 | 3.7004 | -0.1276 | 8 | 8 | 14800 | 56,654 | 14800 | 54,766 | -1,888 | mxd shrub |
| 650 | 0.3 | 4.466 | 0.38 | 3.9556 | -0.5104 | 9 | 9 | 5850 | 26,126 | 5850 | 23,140 | -2,986 | |
| 2180 | 0.1 | 5.742 | 0.38 | 3.9556 | -1.7864 | 9 | 9 | 19620 | 112,658 | 19620 | 77,609 | -35,049 | |
| 440 | 0.2 | 5.104 | 0.35 | 4.147 | -0.957 | 10 | 10 | 4400 | 22,458 | 4400 | 18,247 | -4,211 | |
| 650 | 0.1 | 5.742 | 0.35 | 4.147 | -1.595 | 10 | 10 | 6500 | 37,323 | 6500 | 26,956 | -10,368 | |
| 130 | 0 | 6.38 | 0.35 | 4.147 | -2.233 | 10 | 10 | 1300 | 8,294 | 1300 | 5,391 | -2,903 | |
| 100 | 0.2 | 5.104 | 0.35 | 4.147 | -0.957 | 10 | 10 | 1000 | 5,104 | 1000 | 4,147 | -957 | |
| 480 | 0.2 | 5.104 | 0.35 | 4.147 | -0.957 | 10 | 10 | 4800 | 24,499 | 4800 | 19,906 | -4,594 | |
| 220 | 0.1 | 5.742 | 0.35 | 4.147 | -1.595 | 10 | 10 | 2200 | 12,632 | 2200 | 9,123 | -3,509 | |
| 370 | 0.2 | 5.104 | 0.32 | 4.3384 | -0.7656 | 11 | 11 | 4070 | 20,773 | 4070 | 17,657 | -3,116 | |
| 180 | 0.1 | 5.742 | 0.32 | 4.3384 | -1.4036 | 11 | 11 | 1980 | 11,369 | 1980 | 8,590 | -2,779 | **% Reduction** |
| | | | | | | | **Total** | **136,400** | **537,547** | **136,400** | **388,202** | **-149,345** | **-28** |

# Table 5.8. Existing and Potential Solar Loads for Crooked River

| Segment Length (meters) | Existing Shade (fraction) | Existing Summer Load (kWh/m²/day) | Potential Shade (fraction) | Potential Summer Load (kWh/m²/day) | Potential Load minus Existing load (kWh/m²/day) | Existing Stream Width (m) | Natural Stream Width (m) | Existing Segment Area (m²) | Existing Summer Load (kWh/day) | Natural Segment Area (m²) | Potential Summer Load (kWh/day) | Potential Load minus Existing Load (kWh/day) | **Crooked River** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 7760 | 0.9 | 0.638 | 0.95 | 0.319 | -0.32 | 2 | 2 | 15520 | 9,902 | 15520 | 4,951 | -4,951 | mxd conifer |
| 1630 | 0.8 | 1.276 | 0.92 | 0.5104 | -0.7656 | 3 | 3 | 4890 | 6,240 | 4890 | 2,496 | -3,744 | |
| 700 | 0.9 | 0.638 | 0.92 | 0.5104 | -0.1276 | 3 | 3 | 2100 | 1,340 | 2100 | 1,072 | -268 | |
| 1260 | 0.8 | 1.276 | 0.91 | 0.5742 | -0.7018 | 4 | 4 | 5040 | 6,431 | 5040 | 2,894 | -3,537 | |
| 1400 | 0.7 | 1.914 | 0.79 | 1.3398 | -0.5742 | 4 | 4 | 5600 | 10,718 | 5600 | 7,503 | -3,216 | conifer/shrub |
| 500 | 0.5 | 3.19 | 0.77 | 1.4674 | -1.7226 | 5 | 5 | 2500 | 7,975 | 2500 | 3,669 | -4,307 | |
| 870 | 0.6 | 2.552 | 0.57 | 2.7434 | 0.1914 | 5 | 5 | 4350 | 11,101 | 4350 | 11,934 | 833 | mxd shrub |
| 400 | 0.4 | 3.828 | 0.57 | 2.7434 | -1.0846 | 5 | 5 | 2000 | 7,656 | 2000 | 5,487 | -2,169 | |
| 520 | 0.5 | 3.19 | 0.57 | 2.7434 | -0.4466 | 5 | 5 | 2600 | 8,294 | 2600 | 7,133 | -1,161 | |
| 350 | 0.4 | 3.828 | 0.57 | 2.7434 | -1.0846 | 5 | 5 | 1750 | 6,699 | 1750 | 4,801 | -1,898 | |
| 220 | 0.5 | 3.19 | 0.57 | 2.7434 | -0.4466 | 5 | 5 | 1100 | 3,509 | 1100 | 3,018 | -491 | |
| 480 | 0.3 | 4.466 | 0.49 | 3.2538 | -1.2122 | 6 | 6 | 2880 | 12,862 | 2880 | 9,371 | -3,491 | |
| 1970 | 0.5 | 3.19 | 0.49 | 3.2538 | 0.0638 | 6 | 6 | 11820 | 37,706 | 11820 | 38,460 | 754 | |
| 680 | 0.2 | 5.104 | 0.49 | 3.2538 | -1.8502 | 6 | 6 | 4080 | 20,824 | 4080 | 13,276 | -7,549 | |
| 4680 | 0.7 | 1.914 | 0.72 | 1.7864 | -0.1276 | 7 | 7 | 32760 | 62,703 | 32760 | 58,522 | -4,180 | conifer/shrub |
| 330 | 0.7 | 1.914 | 0.69 | 1.9778 | 0.0638 | 8 | 8 | 2640 | 5,053 | 2640 | 5,221 | 168 | **% Reduction** |
| | | | | | | | **Total** | **101,630** | **219,013** | **101,630** | **179,806** | **-39,206** | **-18** |

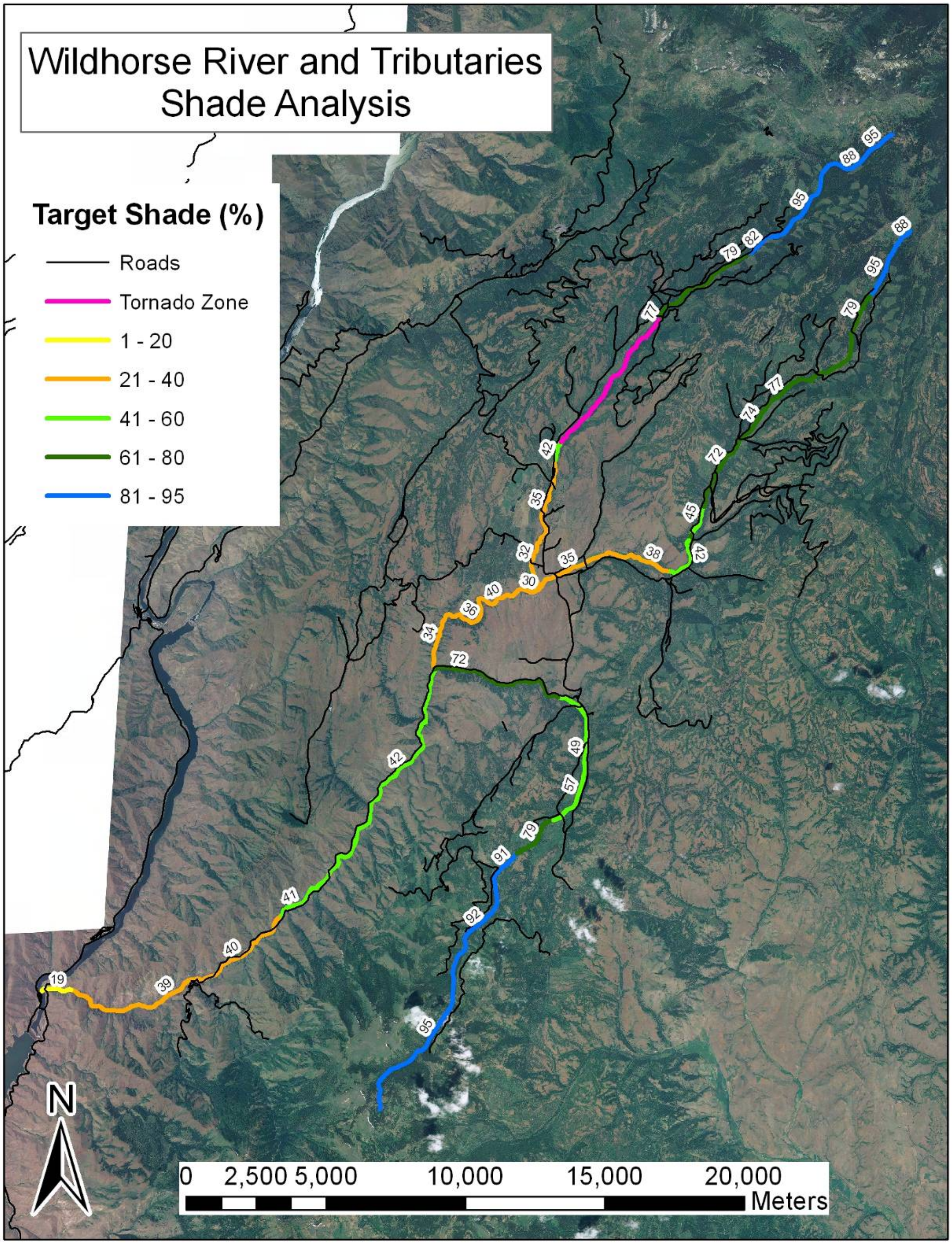



**Figure 5.2. Target Shade for Wildhorse River and its Tributaries**

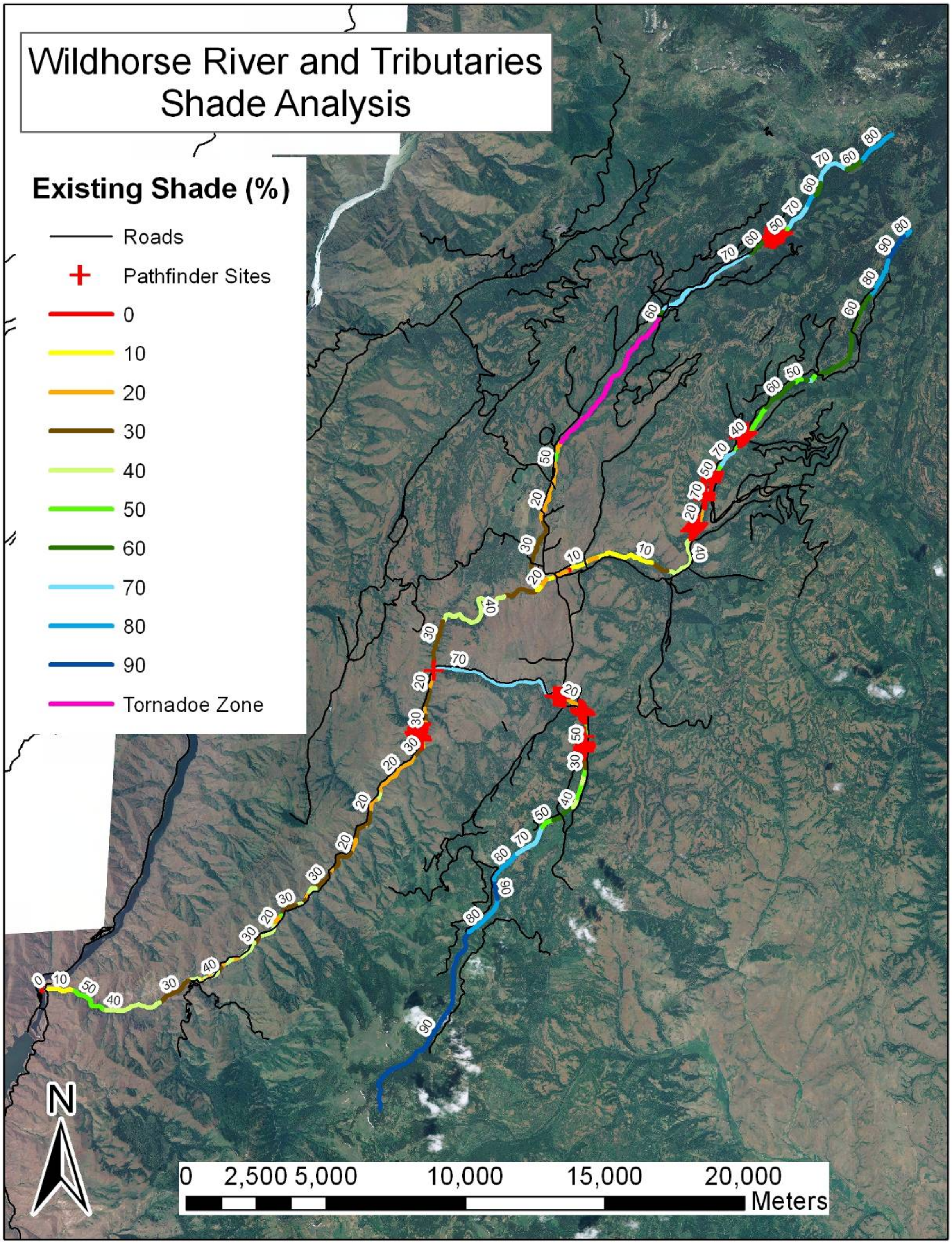



**Figure 5.3. Existing Cover Estimated for Wildhorse River by Aerial Photo Interpretation**

## 5.4 Load Allocation

Because this TMDL is based on potential natural vegetation, which is equivalent to background loading, the load allocation is essentially the desire to achieve background conditions. However, in order to reach that objective, load allocations are assigned to nonpoint source activities that have or may affect riparian vegetation and shade. Load allocations are therefore stream reach specific and are dependent upon the target load for a given reach. Tables 5.5 through 5.8 show the target or potential shade which is converted to a potential summer load by multiplying the inverse fraction (1-shade fraction) by the average loading to a flat plate collector for the months of April through September. That is the loading capacity of the stream, and it is necessary to achieve background conditions. There is no opportunity to allocate shade removal to an activity.

The difference between existing shade and target shade is depicted in Figure 5.4. In general, the existing shade on the Wildhorse River is at target levels or within 10-20%. Crooked River is in similar condition, with the majority of the stream slightly below target levels. Lick Creek and Bear Creek show some evidence of reduced shade, with levels 20% to 30% below target levels in some areas. These results are reflected in the percent reduction in solar loading necessary to achieve background conditions.

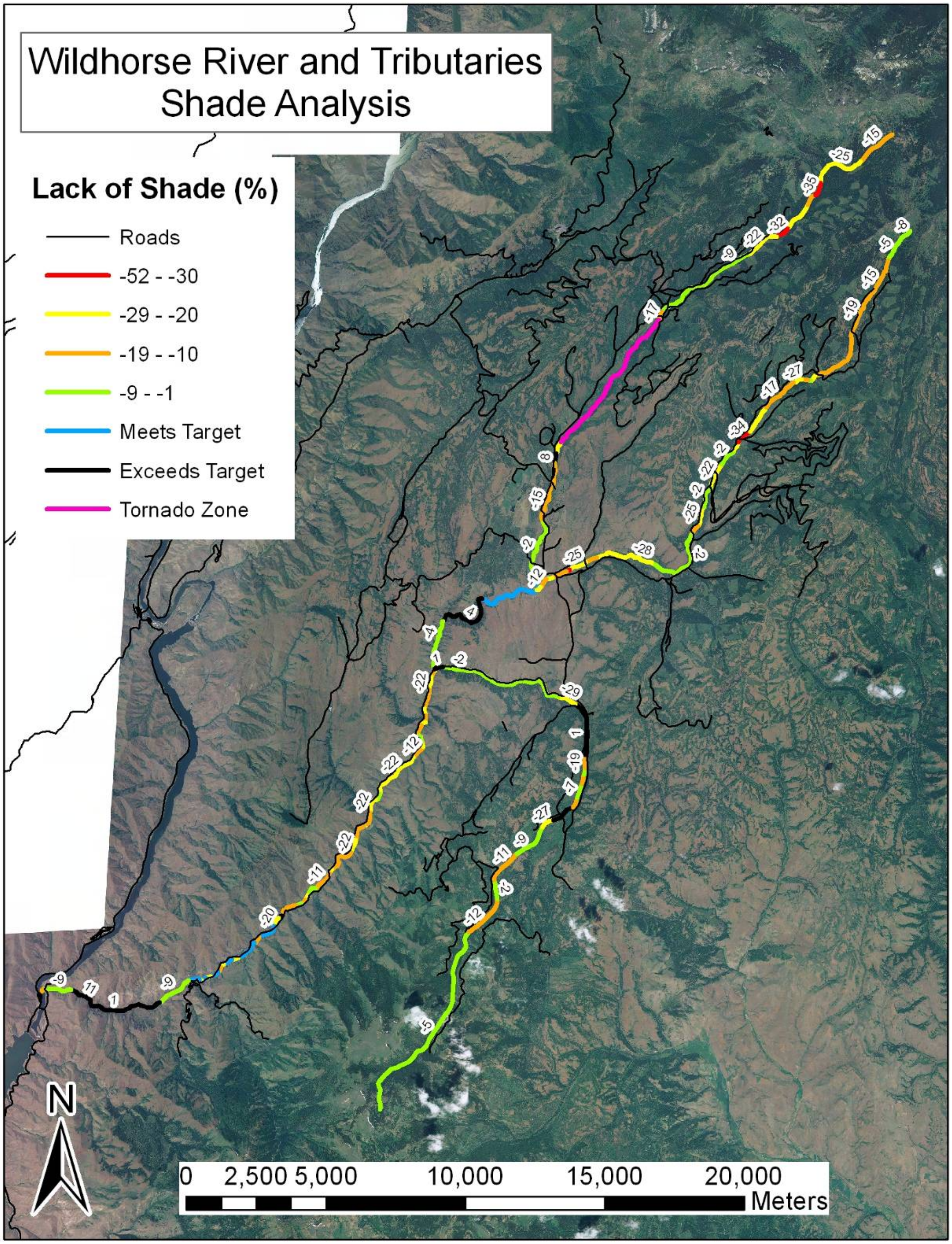



**Figure 5.4. Lack of Shade (Difference between Existing Shade and Target Shade) for Wildhorse River**

Table 5.9 shows the excess heat load (kWh/day) experienced by each water body examined and the percent reduction necessary to bring that water body back to target load levels. The size of a stream influences the size of the excess load. Large streams have higher existing and target loads by virtue of their larger channel widths as compared to smaller streams. Table 5.9 lists the tributaries in order of their excess loads from highest to lowest. Therefore, large tributaries tend to be listed first and small tributaries are listed last.

**Table 5.9. Excess Solar Loads and Percent Reductions for All Tributaries**

| Water Body | Excess Load (kWh/day) | Percent Reduction |
|---|---|---|
| Wildhorse River | 247,600 | 12% |
| Lick Creek | 149,345 | 28% |
| Bear Creek | 60,881 | 8% |
| Crooked River | 39,206 | 18% |

Wildhorse River has the highest excess load at 247,600 kWh/day, but one of the lowest percent reductions (12%) necessary to achieve target loads. Lick Creek has the second highest excess load and the highest percent reduction needed. Crooked River is the smallest of the four and appears to have the lowest excess load. For the purposes of prioritizing any implementation efforts geared towards improving shade, streams with percent reductions needed below 20% should be considered of lower priority. These percent reductions that are below 20% likely represent vegetative communities that will not need any additional planting or other riparian management work and will reach PNV on their own. However, riparian management techniques may be able to hasten this process.

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

## Margin of Safety

The margin of safety in this TMDL is considered implicit in the design. Because the target is essentially background conditions, there are no loads allocated to specific sources or activities. Although the loading analysis used in this TMDL involves gross estimations that are likely to have large variances, there are no load allocations that may benefit or suffer from that variance.

## Seasonal Variation

This TMDL is based on average summer loads. All loads have been calculated to be inclusive of the six month period from April through September. This time period was chosen because it represents the time period when the combination of increasing air and water temperatures coincides with increasing solar inputs and increasing vegetative shade. The critical time period is June, when spring salmonid spawning is occurring, July and August, when maximum temperatures exceed cold water aquatic life criteria, and September, during fall salmonid spawning. Water temperature is not likely to be a problem for beneficial uses outside of this time period because of cooler weather and lower sun angle.

## Construction Storm Water and TMDL Waste Load Allocations

### *Construction Storm Water*

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

### *The Construction General Permit (CGP)*

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

### *Storm Water Pollution Prevention Plan (SWPPP)*

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

### *Construction Storm Water Requirements*

When a stream is on Idaho's §303(d) list and has a TMDL developed, DEQ may incorporate a gross waste load allocation (WLA) for anticipated construction storm water activities. This was not done for this particular TMDL because no significant activity is anticipated at this time. TMDLs developed in the past that did not have a WLA for construction storm water activities are considered in compliance with provisions of the TMDL if they obtain a CGP under the NPDES program and implement the appropriate BMPs. An entity that obtains a construction stormwater NPDES permit will be considered in compliance with this TMDL so long as they adhere to Idaho's Stormwater BMPs and any other applicable laws and ordinances governing such construction stormwater management.

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

## 5.5 Implementation Strategies

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

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

## Time Frame

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

## Approach

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

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

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

DEQ recognizes that expedited implementation of TMDLs will be socially and economically challenging.

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

### Responsible Parties

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

### Monitoring Strategy

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

## 5.6 Conclusion

The Wildhorse River from the Bear Creek/Crooked River confluence to the Snake River is listed on the 2002 §303(d) list for problems associated with stream temperature (Table 5.10). An analysis of shade reveals that the Wildhorse River is slightly below target shade levels and would require a 12% reduction in its own solar load to achieve background conditions. Additionally, the heat loading in the river is compounded by the excess solar loading to Lick Creek, Bear Creek, and Crooked River. Most streams appear to be in relatively good condition and should be considered of relatively low priority for implementation. Appendix E shows historic shading for Lick and Bear Creeks and indicates that over the past 30 years, riparian shading has steadily been improving. Lick Creek appears to have some excess heat loading that will be investigated further.

**Table 5.10. Summary of Assessment Outcomes**

| Water Body Segment/ AU | Pollutant | TMDL(s) Completed | Recommended Changes to §303(d) List | Justification |
|---|---|---|---|---|
| Wildhorse River/ ID17050201SW015_04 | Temperature | Yes | n.a. | Existing shade |

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### *GIS Coverages*

# Glossary

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

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

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

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

**Alevin**
A newly hatched, incompletely developed fish (usually a salmonid) still in nest or inactive on the bottom of a water body, living off stored yolk.

**Algae**
Non-vascular (without water-conducting tissue) aquatic plants that occur as single cells, colonies, or filaments.

**Alluvium**
Unconsolidated recent stream deposition.

**Anoxia**
The condition of oxygen absence or deficiency.

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

**Anti-Degradation**
Refers to the U.S. Environmental Protection Agency's interpretation of the Clean Water Act goal that states and tribes

maintain, as well as restore, water quality. This applies to waters that meet or are of higher water quality than required by state standards. State rules provide that the quality of those high quality waters may be lowered only to allow important social or economic development and only after adequate public participation (IDAPA 58.01.02.051). In all cases, the existing beneficial uses must be maintained. State rules further define lowered water quality to be 1) a measurable change, 2) a change adverse to a use, and 3) a change in a pollutant relevant to the water's uses (IDAPA 58.01.02.003.61).

**Aquatic**

Occurring, growing, or living in water.

**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, which are recognized in water quality standards.

**Beneficial Use Reconnaissance Program (BURP)**

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

**Benthic**

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

**Best Management Practices (BMPs)**

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

**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.

**Biotic**

A term applied to the living components of an area.

**Clean Water Act (CWA)**

The Federal Water Pollution Control Act (commonly known as the Clean Water Act), as last reauthorized by the Water Quality Act of 1987, establishes a process for states to use to develop information on, and control the quality of, the nation's water resources.

**Coliform Bacteria**

A group of bacteria predominantly inhabiting the intestines of humans and animals but also found in soil. Coliform bacteria are commonly used as indicators of the possible presence of pathogenic organisms (also see Fecal Coliform Bacteria, *E. coli*, and Pathogens).

**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 U.S. Environmental Protection Agency develops criteria guidance; states establish criteria.

**Cubic Feet per Second**

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

**Depth Fines**

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

**Designated Uses**
Those water uses identified in state water quality standards that must be achieved and maintained as required under the Clean Water Act.

**Dissolved Oxygen (DO)**
The oxygen dissolved in water. Adequate DO is vital to fish and other aquatic life.

**Disturbance**
An event(s) that disrupts ecosystem, community, or population structure, altering the physical environment.

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

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

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

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

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

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

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

**Ephemeral Stream**

A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long continued supply from melting snow or other sources. Its channel is at all times above the water table (

**Erosion**

The wearing away of areas of the earth's surface by water, wind, ice, and other forces.

**Exceedance**

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

**Existing Beneficial Use or Existing Use**

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

**Exotic Species**

A species that is not native (indigenous) to a region.

**Feedback Loop**

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

**Flow**

The amount of water flowing in the stream channel at the time of measurement. Usually expressed as cubic feet per second (cfs).

**Fluvial**

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

**Fully Supporting**

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

**Fully Supporting Cold Water**

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

**Fully Supporting but Threatened**

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

**Geographical Information Systems (GIS)**

A georeferenced database.

**Geometric Mean**

A back-transformed mean of the logarithmically transformed numbers often used to describe highly variable, right-skewed data (a few large values), such as bacterial data.

**Gradient**

The slope of the land, water, or streambed surface.

**Habitat**

The living place of an organism or community.

**Headwater**

The origin or beginning of a stream.

**Hydrologic Unit**

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

**Hydrologic Unit Code (HUC)**

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

**Hydrology**

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

**Instantaneous**

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

**Intergravel Dissolved Oxygen**

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

**Intermittent Stream**

1) A stream that flows only part of the year, such as when the ground water table is high or when the stream receives water from

springs or from surface sources such as melting snow in mountainous areas. The stream ceases to flow above the streambed when losses from evaporation or seepage exceed the available stream flow. 2) A stream that has a period of zero flow for at least one week during most years.

**Irrigation Return Flow**

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

**Key Watershed**

A watershed that has been designated in Idaho Governor Batt's *State of Idaho Bull Trout Conservation Plan* (1996) as critical to the long-term persistence of regionally important trout populations.

**Load Allocation (LA)**

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

**Load(ing)**

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

**Load(ing) Capacity (LC)**

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

**Lotic**

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

**Macroinvertebrate**

An invertebrate animal (without a backbone) large enough to be seen without magnification and retained by a 500µm 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 the uncertainly about the relationship between the pollutant loads and the quality of the receiving water body. This is a required component of a total maximum daily load (TMDL) and is often incorporated into conservative assumptions used to develop the TMDL (generally within the calculations and/or models). The MOS is not allocated to any sources of pollution.

**Mean**

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

**Metric**

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

**Milligrams per Liter (mg/L)**

A unit of measure for concentration. In water, it is essentially equivalent to parts per million (ppm).

**Monitoring**

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

**Mouth**

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

**Natural Condition**

The condition that exists with little or no anthropogenic influence.

**Nonpoint Source**

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

**Not Assessed (NA)**

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

**Not Attainable**

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

**Not Fully Supporting**

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

**Not Fully Supporting Cold Water**

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

**Nuisance**

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

**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, such as temperature, dissolved oxygen, and fish populations are parameters of a stream or lake.

**Perennial Stream**

A stream that flows year-around in most years.

**pH**

The negative $\log_{10}$ of the concentration of hydrogen ions, a measure which in water ranges from very acid (pH=1) to very alkaline (pH=14). A pH of 7 is neutral. Surface waters usually measure between pH 6 and 9.

**Pollutant**

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

**Pollution**

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

**Population**

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

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

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

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

**Resident**
A term that describes fish that do not migrate.

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

**Riparian Habitat Conservation Area (RHCA)**
A U.S. Forest Service description of land within the following number of feet up-slope of each of the banks of streams:

- 300 feet from perennial fish-bearing streams
- 150 feet from perennial non-fish-bearing streams
- 100 feet from intermittent streams, wetlands, and ponds in priority watersheds.

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

**Runoff**
The portion of rainfall, melted snow, or irrigation water that flows across the surface, through shallow underground zones (interflow), and through ground water to creates streams.

**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.

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

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

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

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

**Subbasin Assessment (SBA)**
A watershed-based problem assessment that is the first step in developing a total maximum daily load in Idaho.

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

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

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

**Total Maximum Daily Load (TMDL)**

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

**Tributary**

A stream feeding into a larger stream or lake.

**Water Body**

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

**Water Column**

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

**Water Pollution**

Any alteration of the physical, thermal, chemical, biological, or radioactive properties of any waters of the state, or the discharge of any pollutant into the waters of the state, which will or is likely to create a nuisance or to render such waters harmful, detrimental, or injurious to public health, safety, or welfare; to fish and wildlife; or to domestic, commercial, industrial, recreational, aesthetic, or other beneficial uses.

**Water Quality**

A term used to describe the biological, chemical, and physical characteristics of water with respect to its suitability for a beneficial use.

**Water Quality Criteria**

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

**Water Quality Limited**

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

**Water Quality Limited Segment (WQLS)**

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

**Water Quality Modeling**

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

**Water Quality Standards**

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

**Watershed**

1) All the land which contributes runoff to a common point in a drainage network, or to a lake outlet. Watersheds are infinitely nested, and any large watershed is composed of smaller "subwatersheds." 2) The whole geographic region which contributes water to a point of interest in a water body.

**Water Body Identification Number (WBID)**

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

**Young of the Year**

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

# Appendix A. Unit Conversion Chart

## Table A.1 Metric-English Unit Conversions

| | English Units | Metric Units | To Convert |
|---|---|---|---|
| **Distance** | Miles (mi) | Kilometers (km) | 1 mi = 1.61 km<br>1 km = 0.62 mi |
| **Length** | Inches (in)<br>Feet (ft) | Centimeters (cm)<br>Meters (m) | 1 in = 2.54 cm<br>1 cm = 0.39 in<br>1 ft = 0.30 m<br>1 m = 3.28 ft |
| **Area** | Acres (ac)<br>Square Feet ($ft^2$)<br>Square Miles ($mi^2$) | Hectares (ha)<br>Square Meters ($m^2$)<br>Square Kilometers ($km^2$) | 1 ac = 0.40 ha<br>1 ha = 2.47 ac<br>1 $ft^2$ = 0.09 $m^2$<br>1 $m^2$ = 10.76 $ft^2$<br>1 $mi^2$ = 2.59 $km^2$<br>1 $km^2$ = 0.39 $mi^2$ |
| **Volume** | Gallons (gal)<br>Cubic Feet ($ft^3$) | Liters (L)<br>Cubic Meters ($m^3$) | 1 gal = 3.78 L<br>1 L= 0.26 gal<br>1 $ft^3$ = 0.03 $m^3$<br>1 $m^3$ = 35.32 $ft^3$ |
| **Flow Rate** | Cubic Feet per Second (cfs)[a] | Cubic Meters per Second ($m^3$/sec) | 1 cfs = 0.03 $m^3$/sec<br>1 $m^3$/sec = 35.31cfs |
| **Concentration** | Parts per Million (ppm) | Milligrams per Liter (mg/L) | 1 ppm = 1 mg/L[b] |
| **Weight** | Pounds (lbs) | Kilograms (kg) | 1 lb = 0.45 kg<br>1 kg = 2.20 lbs |
| **Temperature** | Fahrenheit (°F) | Celsius (°C) | °C = 0.55 (F - 32)<br>°F = (C x 1.8) + 32 |

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

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

# Appendix B. Data Sources

**Table B.1. Data Sources for Wildhorse Subbasin Assessment**

| Water Body | Data Source | Type of Data | When Collected |
|---|---|---|---|
| Wildhorse River | USFS-Payette | Temperature | 1999-2005 |
| Bear Creek | USFS-Payette | Temperature | 1999-2005 |
| Lick Creek | USFS | Habitat, Temperature | 1999-2005 |
| Crooked River | USFS | Temperature | 1999-2005 |
| Crooked River | USFS | Habitat | 1999-2005 |

# Appendix C. Distribution List

Wildhorse WAG

Adams County Soil Conservation District

Kalissa Copeland, IASCD

John Lillehaug, Idaho Department of Lands

Adams County Natural Resources Group

Tom Yankey, NRCS

Russ Manwaring, West Central Highlands RC and D

Bill Gamble, USFS

Council Library

# Appendix D. Additional Data

**Bear Creek**

Table D.1 gives support status for Bear Creek.

**Table D.1. DEQ Water Body Assessment Scores: Bear Creek**

| Stream Site ID | SMI | SFI | SHI | Support Status |
|---|---|---|---|---|
| 1993SBOIA013 | 3 | | 1 | 2 (Full Support) |
| 1994SBOIA027 Upper Bear Creek | 3 | | 3 | 3 (Full Support) |
| 1999SBOIA054 | 3 | | 3 | 3 (Full Support) |

*Habitat Data*

Information presented below was gathered before the 2006 tornado.

**Bank Stability**

Bank stability is rated by observing existing or potential detachment of soil from upper and lower stream banks and its potential movement into the stream. Measurements of bank angle and bank height may also be taken. Generally, steeper banks are more subject to erosion and correspondingly streams with largely unstable banks will often have poor in-stream habitat. Eroding banks can result in sedimentation, excessively wide streams, decreased depth and lack of vegetative cover. Banks that are protected by plant root systems or boulder/rock material are less susceptible to erosion.

**Surface Fines**

The particle size of the substrate directly affects the flow resistance of the channel, stability of the streambed, and the amount of aquatic habitat. If the substrate is predominantly composed of fines, then the spaces between the particles are too small to provide refuge for most organisms. The greatest number of species, and thus the greatest diversity, is found with a complex substrate of boulders, stone, gravels, and sand. Coarse materials such as gravels provide a variety of small niches for juvenile fish and benthic invertebrates. Because salmonids have adapted to the natural size distributions of substrate materials, no single sized particle class will provide the optimum conditions for all life stages of salmonids. A mix of gravel with a small amount of fine sediment and small rubble creates optimal conditions for fish spawning. When small fines (<6.35 mm) exceed 20-25% of the total substrate, embryo survival and emergence of swim-up fry is reduced by 50% (Bjornn and Reiser 1991).

**Stream Bank Stability**

In 1999, about 75% of the streams, including most perennial streams, within the analysis area were inventoried for Rosgen type, flow regime, vegetative condition, and bank stability using a R1/R4 Level II Riparian Inventory (Table D.2). Channel stability was rated “good” for most reaches based on vegetation and bank conditions at the time of the survey. Portions of the Upper Bear Creek Headwaters were rated as “fair,” possibly due to logging or road impacts. Sensitivity to disturbance is dependent upon Rosgen channel type (Rosgen 1994).

**Table D.2. Channel Stability and Rosgen Stream Type for Major Tributaries**

| Stream | Rosgen Channel Type[1] | Channel Stability[2] |
|---|---|---|
| Upper Bear Headwaters | A4 | Fair/Good |
| Wesley Creek | A3 | Good |
| Mickey Creek | A4 | Good |
| Little Bear Creek | A3 | Good |
| Bessie Gulch | A2 | Good |
| Drainage 6 | A4 | Good |
| Drainage 8 | A4 | Good |
| Upper Bear Creek[3] | B4 | Good |

[1] Rosgen 1996, [2] Pfankuch Stream Channel Stability Score (Pfankuch 1975), [3] Main Stem at mouth of analysis area.

Table D.3 compares the percent fines in the streams to similar Rosgen type reference streams. Since all the percent fine scores are below the reference condition for percent fines, it indicates that there is not excess sediment in areas that would likely be used for fish spawning. Surface fines were low throughout the watershed and bank stability measurements were high.

**Table D.3. Surface Fines Levels by Reach for Streams within the Project Area**

| Stream | Current Condition | Natural Conditions Database |
|---|---|---|
| Bear Creek Reach 10 | 9 | <27% |
| Bear Creek Reach 11 | 5 | <25% |
| Bear Creek Reach 12 | 9 | <25% |
| Bear Creek Reach 13 | 8 | <25% |
| Bear Creek Reach 14 | 7 | <25% |
| Little Bear Creek Reach 1 | 13 | <25% |
| Little Bear Creek Reach 2 | 10 | <25% |
| Unnamed Tributary "G" | 5 | <25% |
| Bessie Gulch | 18 | <25% |
| Mickey Creek Reach 1 | 4 | <27% |
| Mickey Creek Reach 2 | 4 | <27% |
| Wesley Creek | 6 | <27% |

Table D.4 summarizes stream habitat data for the Upper Bear analysis area.

**Table D.4. Summary of Stream Habitat Data for the Upper Bear Analysis Area**

| Stream | Reach | Channel Type | Bull Trout Observed | Length (miles) | Surface Fines (% < 6mm) | Bank Stability (%) | Disturbance Noted |
|---|---|---|---|---|---|---|---|
| Bear Creek | 10 | B | No | 2.5 | 9 | 81 | Recreational use |
| Bear Creek | 11 | A | Yes | 0.9 | 5 | 98 | Trail crossing |
| Bear Creek | 12 | A | Yes | 0.4 | 9 | 100 | None |
| Bear Creek | 13 | A | Yes | 1.7 | 8 | 89 | None |
| Bear Creek | 14 | A | Yes | 1.4 | 7 | 83 | None |
| Little Bear Cr. | 1 | A | No | 1.2 | 13 | 100 | None |
| Little Bear Cr. | 3 | A | No | 0.4 | 10 | 99 | None |
| Bessie Gulch | 1 | A | No | 0.01 | 18 | 91 | None |
| Mickey Creek | 1 | A | No | 0.4 | 4 | 98 | None |
| Mickey Creek | 2 | A | No | 0.04 | 4 | 99 | None |
| Wesley Creek | 1 | A | Yes | 2.0 | 6 | 97 | Culvert barrier FR 130 |

**Temperature**

Tables D.5 and D.6 show exceedances of Idaho's salmonid spawning water quality temperature criteria and EPA bull trout temperature criteria.

**Table D.5 Bear Creek Water Temperatures at Little Bear Creek**

| Year | Month | Period | Days | Max | Avg | Min | Days Max>13 | Days Avg>9 | Days Max>22 | Days Avg>19 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2005 | June | First Half | 12 | 12.1 | 6.2 | 3.4 | 0 | 0 | 0 | 0 |
| 2005 | June | Second Half | 15 | 13.9 | 9.1 | 4.3 | 7 | 8 | 0 | 0 |
| 2005 | July | First Half | 15 | 16.1 | 10.9 | 6.7 | 12 | 14 | 0 | 0 |
| 2005 | July | Second Half | 16 | 17.2 | 12.3 | 7.6 | 16 | 16 | 0 | 0 |
| 2005 | August | First Half | 15 | 17.6 | 12.7 | 8.2 | 15 | 15 | 0 | 0 |
| 2005 | August | Second Half | 16 | 15.5 | 10.8 | 6.3 | 10 | 16 | 0 | 0 |
| 2005 | September | First Half | 15 | 13.3 | 8.7 | 4.3 | 2 | 9 | 0 | 0 |
| 2005 | September | Second Half | 15 | 9.7 | 6.3 | 2.9 | 0 | 0 | 0 | 0 |
| 2005 | October | First Half | 2 | 7.9 | 6.1 | 4.2 | 0 | 0 | 0 | 0 |

**Table D.6 Bear Creek Water Temperatures at Huckleberry Campground**

| Year | Month | Period | Days | Max | Avg | Min | Days Max>13 | Days Avg>9 | Days Max>22 | Days Avg>19 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2001 | May | Second Half | 8 | 11.5 | 7.2 | 2.2 | 0 | 0 | 0 | 0 |
| 2001 | June | First Half | 15 | 11.0 | 6.1 | 2.4 | 0 | 0 | 0 | 0 |
| 2001 | June | Second Half | 15 | 12.5 | 8.7 | 4.0 | 4 | 7 | 0 | 0 |
| 2001 | July | First Half | 15 | 15.1 | 11.2 | 8.5 | 12 | 15 | 0 | 0 |
| 2001 | July | Second Half | 16 | 14.7 | 9.7 | 6.7 | 5 | 11 | 0 | 0 |
| 2001 | August | First Half | 10 | 16.5 | 11.2 | 6.4 | 5 | 9 | 0 | 0 |

**Tornado Exclusion Area Temperature Information**

While the tornado blowdown area was excluded from the temperature analysis in Section 5, it is included here for informational purposes, as shown in Figures D.1 to D.3.Figure D.1 shows existing cover estimated for the Wildhorse River by aerial photo interpretation, including the tornado area. Figure D.2 shows target shade for the Wildhorse River, including the tornado area, and Figure D.3 shows lack of shade (the difference between existing shade and target shade) for the Wildhorse River, including the tornado area.

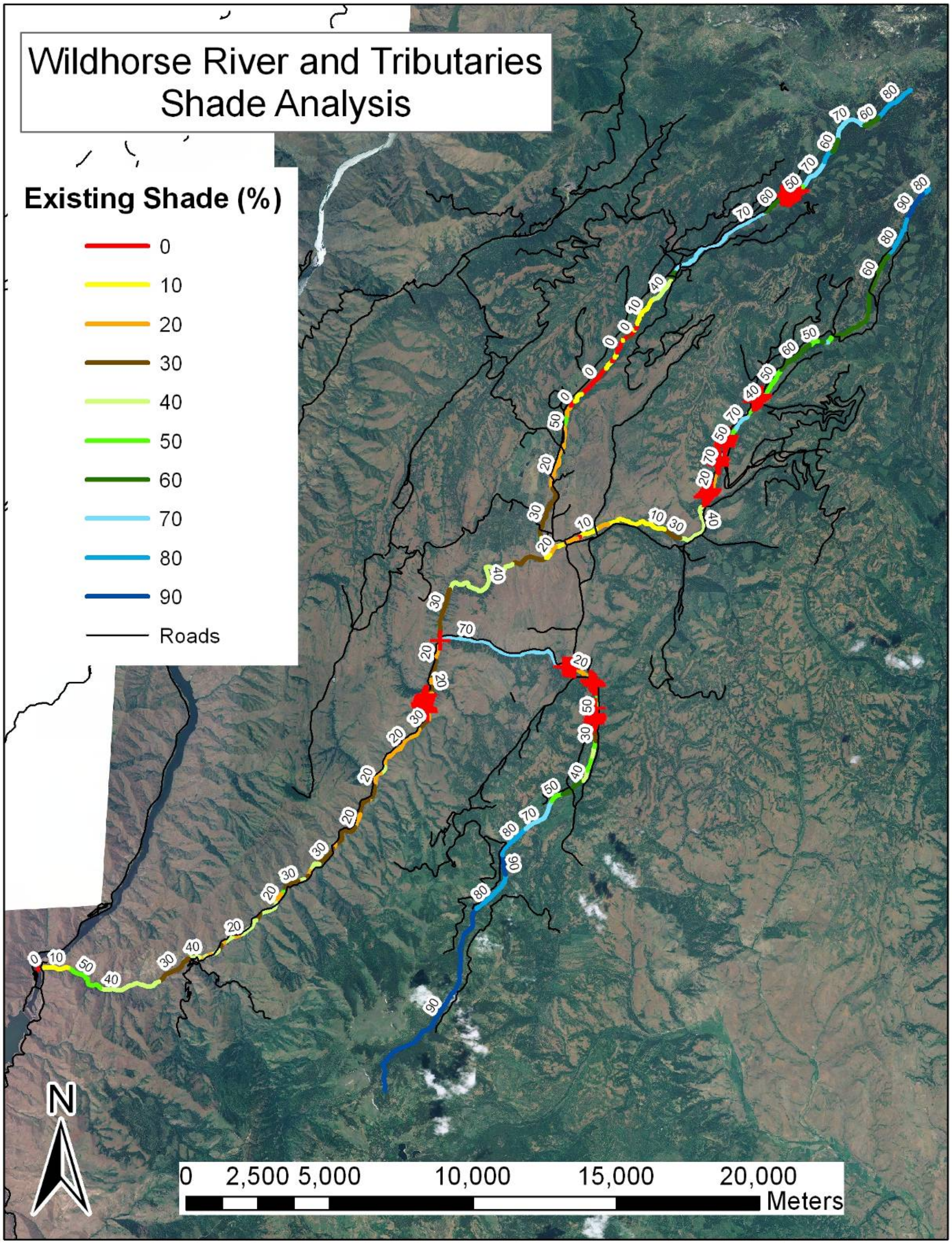


**Figure D.1. Existing Cover Estimated for Wildhorse River by Aerial Photo Interpretation, Including Tornado Area**

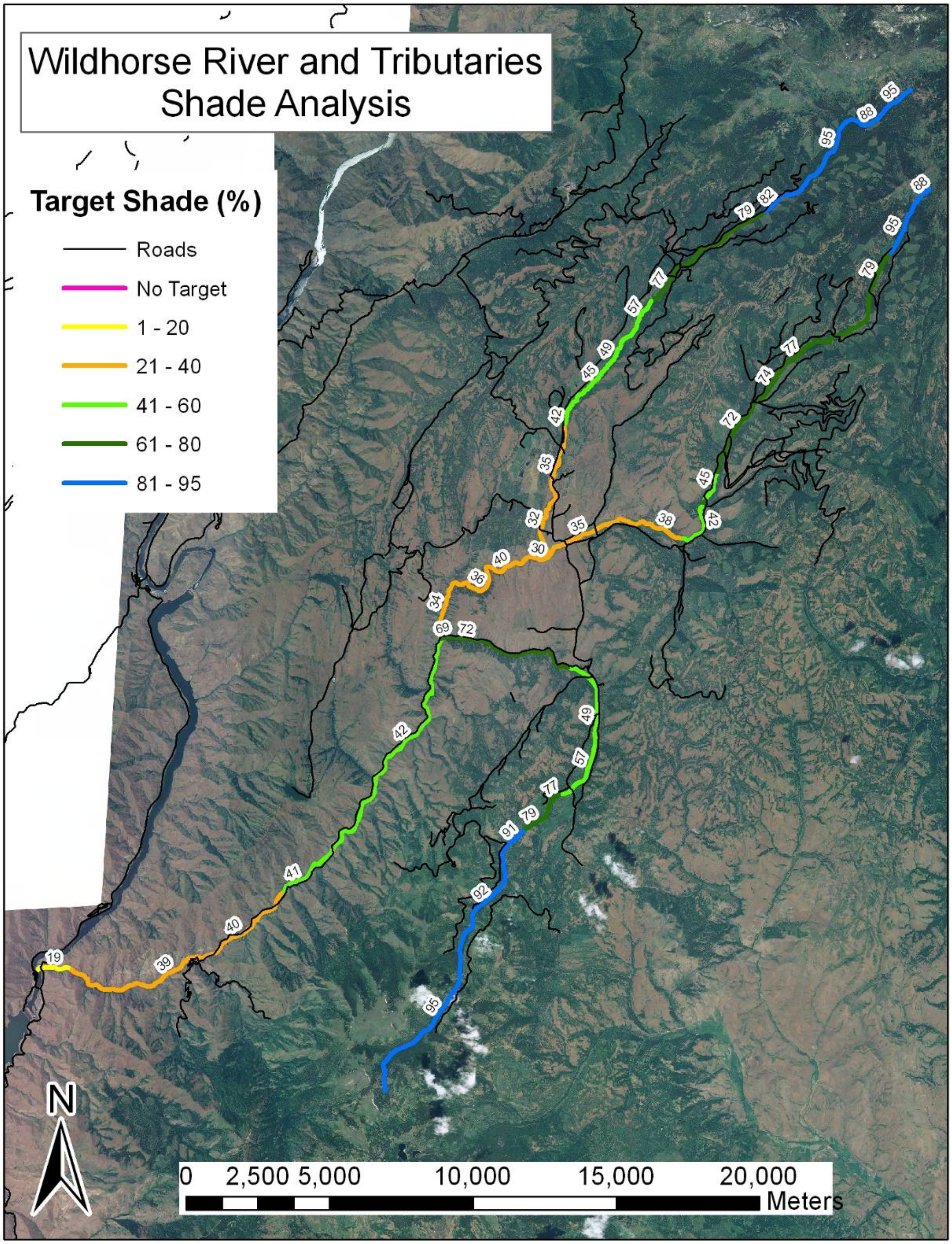


**Figure D.2. Target Shade for Wildhorse River and its Tributaries, Including Tornado Area**

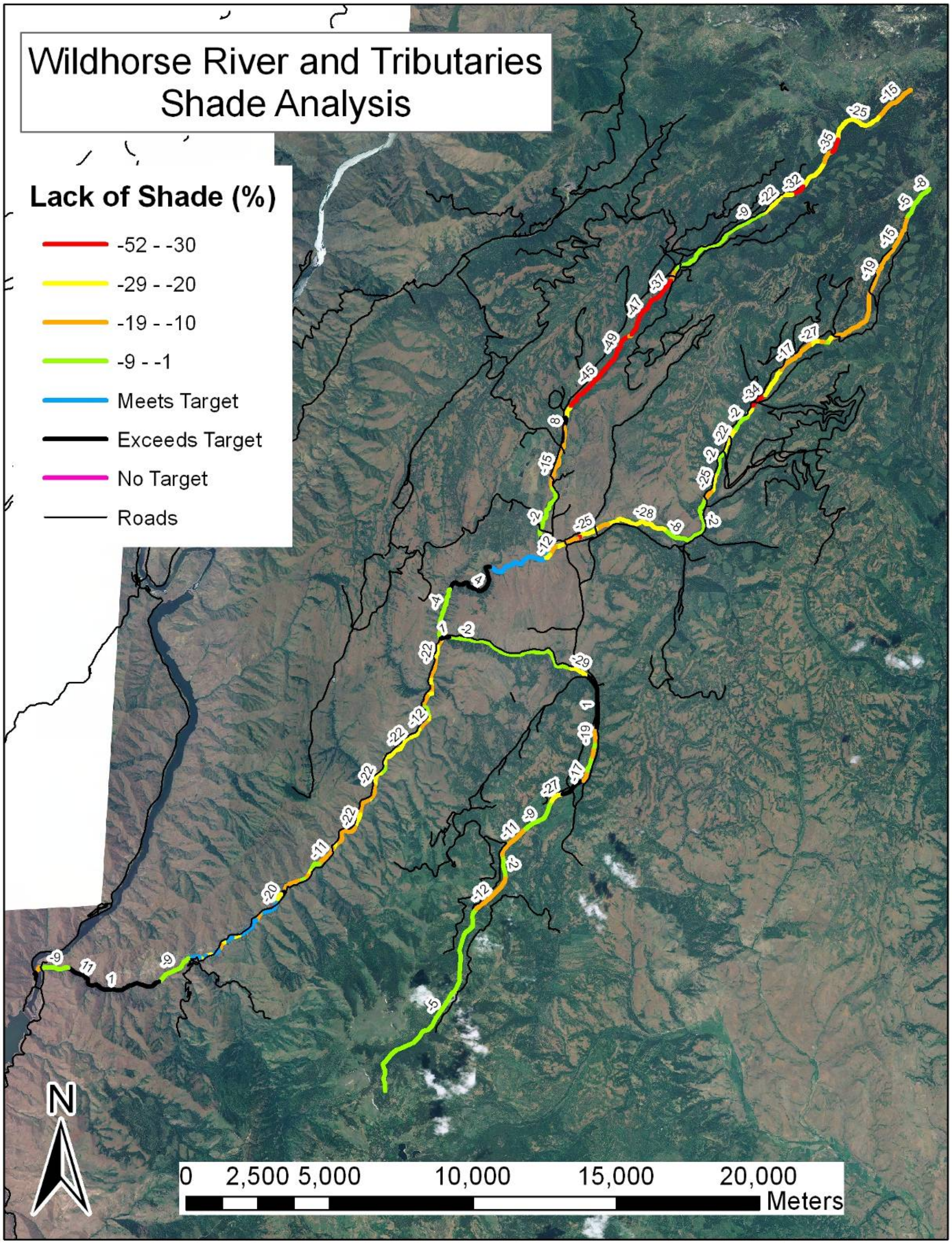


**Figure D.3. Lack of Shade (Difference between Existing Shade and Target Shade) for Wildhorse River, Including Tornado Area**

**Crooked River**

Overall, Crooked River shows moderate to low levels of surface fine and good bank stability, with the exception of Dick Ross and Moonshine Creeks (Table D.7). Tables D.8 and D.9 show water temperature data that shows that salmonid spawning temperature criteria and EPA bull trout temperature criteria are not met.

**Table D.7. Summary of Stream Habitat Data for Crooked River**

| Stream | Reach | Channel Type | Bull Trout Observed | Length (miles) | Width (m) | Surface Fines (% < 6mm) | Bank Stability (%) | Disturbance Noted |
|---|---|---|---|---|---|---|---|---|
| Crooked River | 4 | C | No | 1.3 | 3.8 | 20 | 87 | Cattle use |
| Crooked River | 5 | C | No | 0.3 | 1.6 | 20 | 84 | Cattle use |
| Crooked River | 9 | B | Yes | 7.2 | 2.3 | 19 | 98 | Cattle use. ATV use. Trees cut in riparian. |
| Dick Ross Creek | 1 | C | No | 0.2 | 2.0 | 30 | 78 | Cattle use |
| Dick Ross Creek | 3 | B | No | 1.2 | 1.2 | 68 | 53 | Cattle use |
| Moonshine Creek | 2 | B | No | 0.8 | 1.2 | 81 | 67 | Cattle use |

**Table D.8 Crooked River Water Temperatures at Coyote Gulch**

| Year | Month | Period | Days | Max | Avg | Min | Days Max>13 | Days Avg>9 | Days Max>22 | Days Avg>19 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2005 | June | First Half | 15 | 17.3 | 10.3 | 5.2 | 9 | 13 | 0 | 0 |
| 2005 | June | Second Half | 15 | 20.5 | 14.2 | 7.3 | 14 | 15 | 0 | 0 |
| 2005 | July | First Half | 15 | 23.4 | 16.1 | 10.3 | 15 | 15 | 6 | 0 |
| 2005 | July | Second Half | 16 | 24.4 | 17.2 | 9.3 | 16 | 16 | 12 | 1 |
| 2005 | August | First Half | 15 | 23.7 | 16.7 | 9.8 | 15 | 15 | 8 | 0 |
| 2005 | August | Second Half | 16 | 21.4 | 14.2 | 7.5 | 16 | 16 | 0 | 0 |
| 2005 | September | First Half | 15 | 18.6 | 11.3 | 5.2 | 13 | 13 | 0 | 0 |
| 2005 | September | Second Half | 15 | 14.9 | 9.2 | 4.2 | 5 | 8 | 0 | 0 |
| 2005 | October | First Half | 2 | 10.7 | 8.5 | 6.6 | 0 | 1 | 0 | 0 |

**Table D.9 Crooked River Water Temperatures at Coyote Gulch**

| Year | Month | Period | Days | Max | Avg | Min | Days Max>13 | Days Avg>9 | Days Max>22 | Days Avg>19 |
|---|---|---|---|---|---|---|---|---|---|---|
| 2003 | June | First Half | 12 | 18.4 | 12.3 | 7.3 | 12 | 12 | 0 | 0 |
| 2003 | June | Second Half | 15 | 24.0 | 13.8 | 6.8 | 15 | 15 | 3 | 0 |
| 2003 | July | First Half | 6 | 25.2 | 15.5 | 11.2 | 6 | 6 | 3 | 0 |
| 2003 | July | Second Half | 10 | 26.6 | 19.3 | 13.3 | 10 | 10 | 9 | 7 |
| 2003 | August | First Half | 15 | 24.2 | 17.0 | 11.2 | 15 | 15 | 12 | 0 |
| 2003 | August | Second Half | 16 | 23.0 | 15.9 | 9.5 | 16 | 16 | 4 | 0 |
| 2003 | September | First Half | 15 | 20.6 | 13.0 | 5.4 | 14 | 14 | 0 | 0 |
| 2003 | September | Second Half | 13 | 16.1 | 10.0 | 4.3 | 10 | 11 | 0 | 0 |

**Lick Creek**

In 1989, a microburst occurred in T20N R2W Section 28, running directly up Lick Creek. This area was within a larger timber sale, and a salvage sale occurred after the microburst. No specific National Environmental Policy Act (NEPA) process or Environmental Assessment was performed specifically on the microburst since it was already in a larger timber sale. (Bill Florence, personal communication, Council Ranger District, 2007).

The Payette NF has sampled Lick Creek at two locations for *E. coli* for the past 7 years. The lower site is located at the forest boundary above the OX Ranch, and the upper site is located above the confluence with Cold Springs Creek. This monitoring has identified violations of the *E. coli* standard for secondary contact recreation at the lower site during the mid-season livestock grazing period in all but year 2004. During 2004, the Lick Creek pasture was rested. Given that sampling before and after livestock grazing each season has not identified exceedances, and 2004 had no violations, livestock are presumed to be the primary source of *E. coli* violations. Figures D.4 and D.5 show graphical summaries of this past sampling for the lower site.

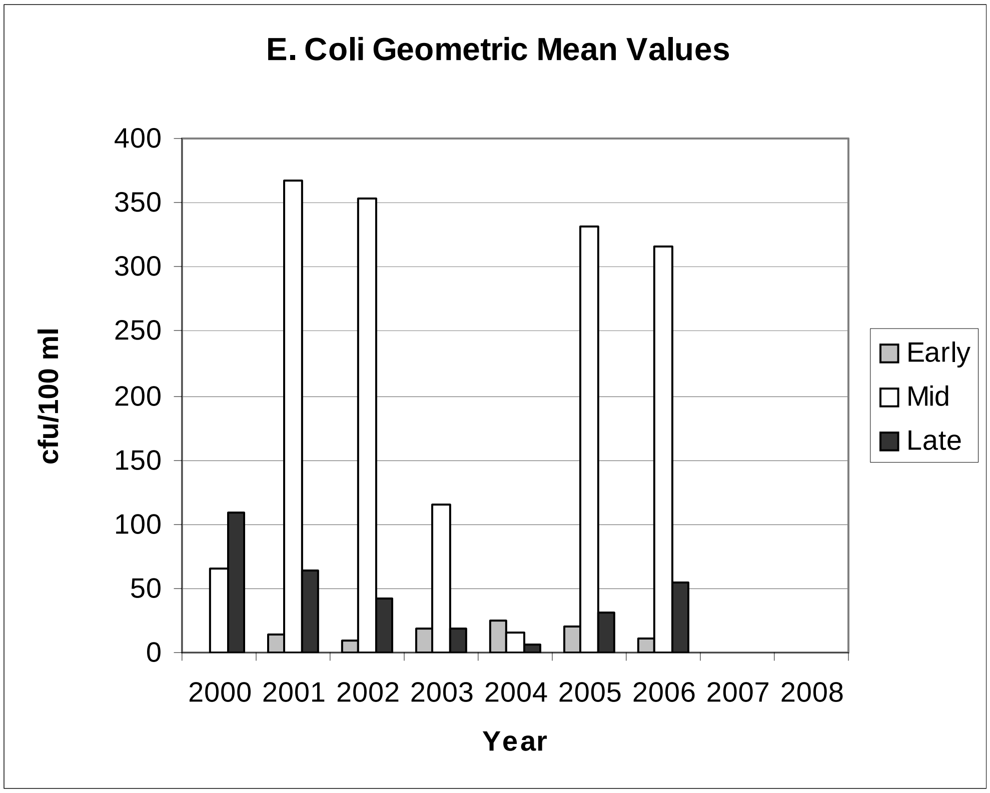


**Figure D.4. Lick Creek at Forest Boundary above OX Ranch**

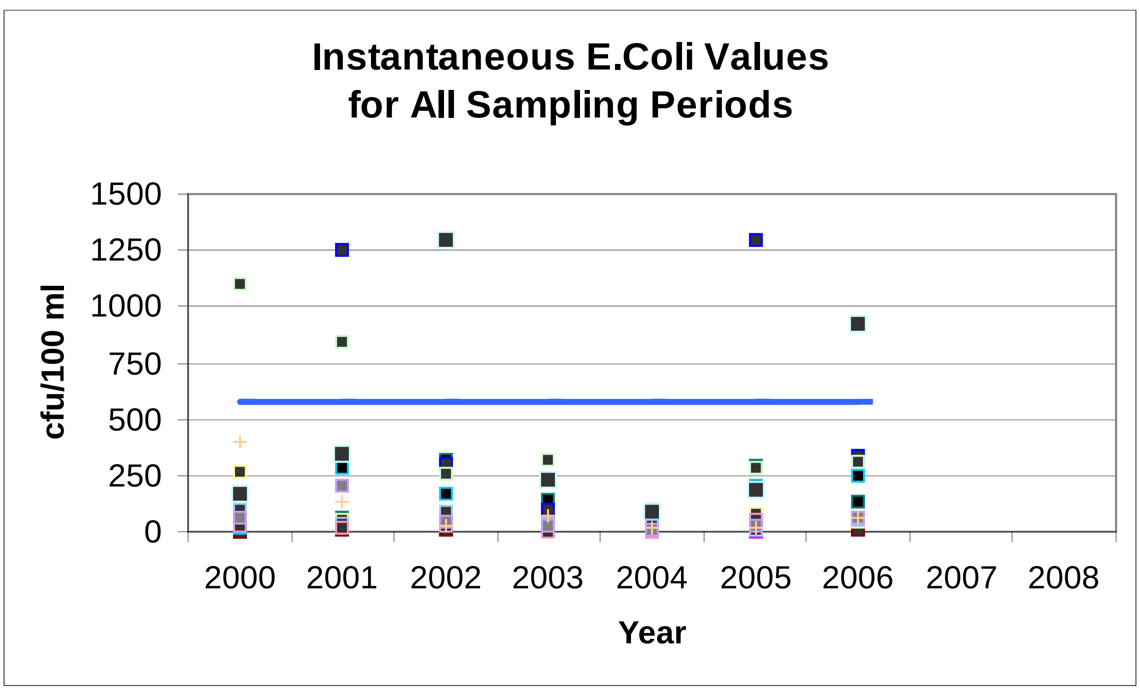


**Figure D.5. Lick Creek at Lower Site (Forest Boundary above OX Ranch)**

The habitat information available for Lick Creek indicates that it is in good condition (Table D.9 and D.10), with overall stable banks and that percent fines are within the range of reference conditions for streams of a similar type. The fishery in Lick Creek is dominated by brook trout and, to a lesser extent, rainbow trout.

**Table D.10 DEQ Water Body Assessment Scores for Lick Creek**

| Stream Site ID | SMI | SFI | SHI | Support Status |
|---|---|---|---|---|
| 2004SBOI099 (Lick Creek above confluence with Fawn Creek) | 3 | 3 | 3 | 3 (Full Support) |

**Table D.11 Summary of Stream Habitat Data for Lick Creek**

| Stream | Reach | Stream Length (miles) | Stream Bank Stability (mean) | Wetted Width/Depth Ratio | Surface Fines (mean) |
|---|---|---|---|---|---|
| Lick Creek | 1 | 0.4 | 88 | 20 | 31 |
| | 2 | 3.1 | 86 | 18 | 16 |
| | 3 | 0.4 | 88 | 27 | 13 |
| | 4 | 1.7 | 83 | 19 | 26 |
| | 5 | 0.9 | 94 | 18 | 19 |
| | 6 | 1.1 | 94 | 18 | 12 |
| | 7 | 1.4 | 99 | 19 | 28 |
| | Summary | 9.0 | 91 | 19 | 26 |

**Table D 12. Lick Cr Water Temperatures at Upper Exclosure**

| Year | Month | Period | Days | Max | Avg | Min | Days Max>13 | Days Avg>9 |
|---|---|---|---|---|---|---|---|---|
| 2000 | June | Second Half | 11 | 17.7 | 11.9 | 6.0 | 11 | 11 |
| 2000 | July | First Half | 15 | 19.4 | 12.5 | 6.4 | 13 | 15 |
| 2000 | July | Second Half | 16 | 20.7 | 14.8 | 9.1 | 16 | 16 |
| 2000 | August | First Half | 15 | 21.2 | 15.0 | 9.1 | 15 | 15 |
| 2000 | August | Second Half | 16 | 18.0 | 12.1 | 7.2 | 15 | 16 |
| 2000 | September | First Half | 15 | 15.9 | 9.4 | 5.0 | 4 | 6 |
| 2000 | September | Second Half | 15 | 15.9 | 8.5 | 1.7 | 4 | 6 |
| 2000 | October | First Half | 8 | 11.2 | 5.5 | 1.1 | 0 | 1 |

## Wildhorse River

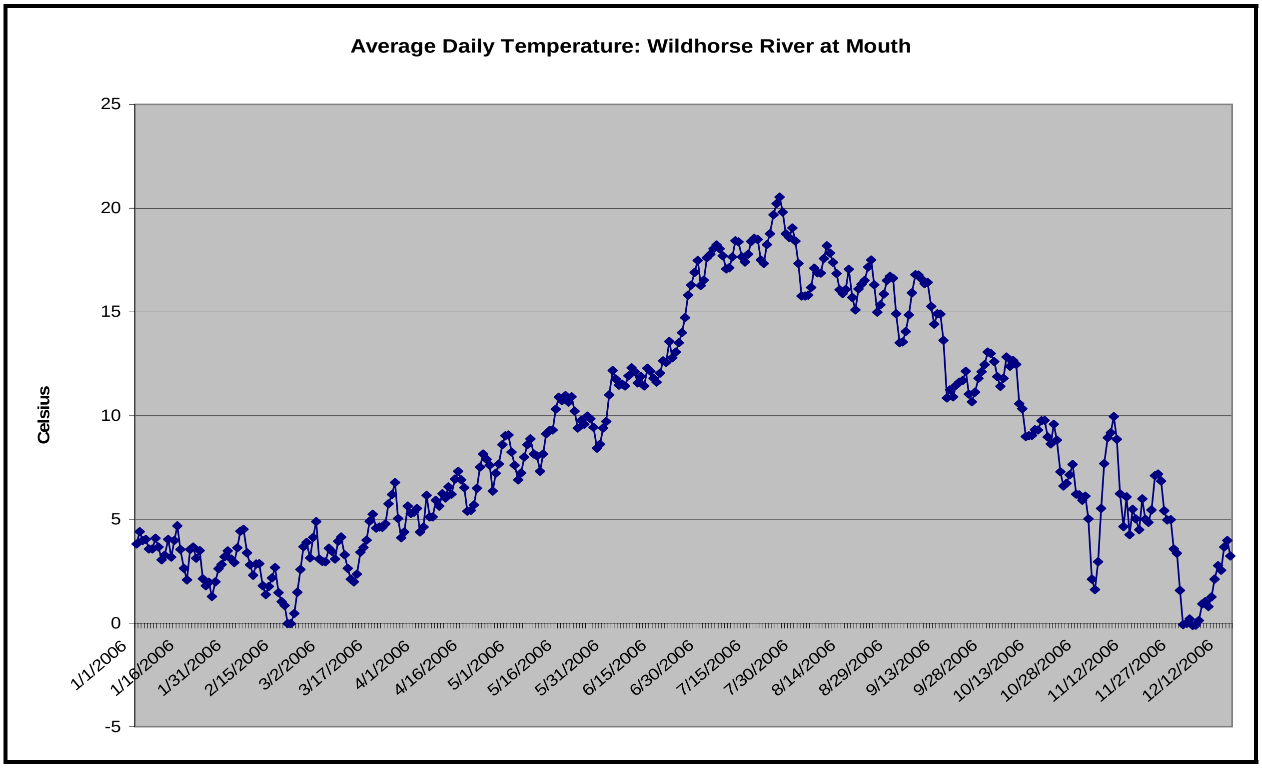


**Figure D.6 Average Daily River Temperature: Wildhorse River near Mouth**

# Appendix E. Historic Shade Values

Figures E.1 and E.2 show historical shading values for the Bear and Lick Creek drainages. Overall, improvement was shown in shading over time between 1976 and 1994–1995. It is more difficult to compare the 1994–1995 values to those in 2004 because there are improvements in some areas and decreases of shade in others. However, overall, it appears the trend in shade is upward.

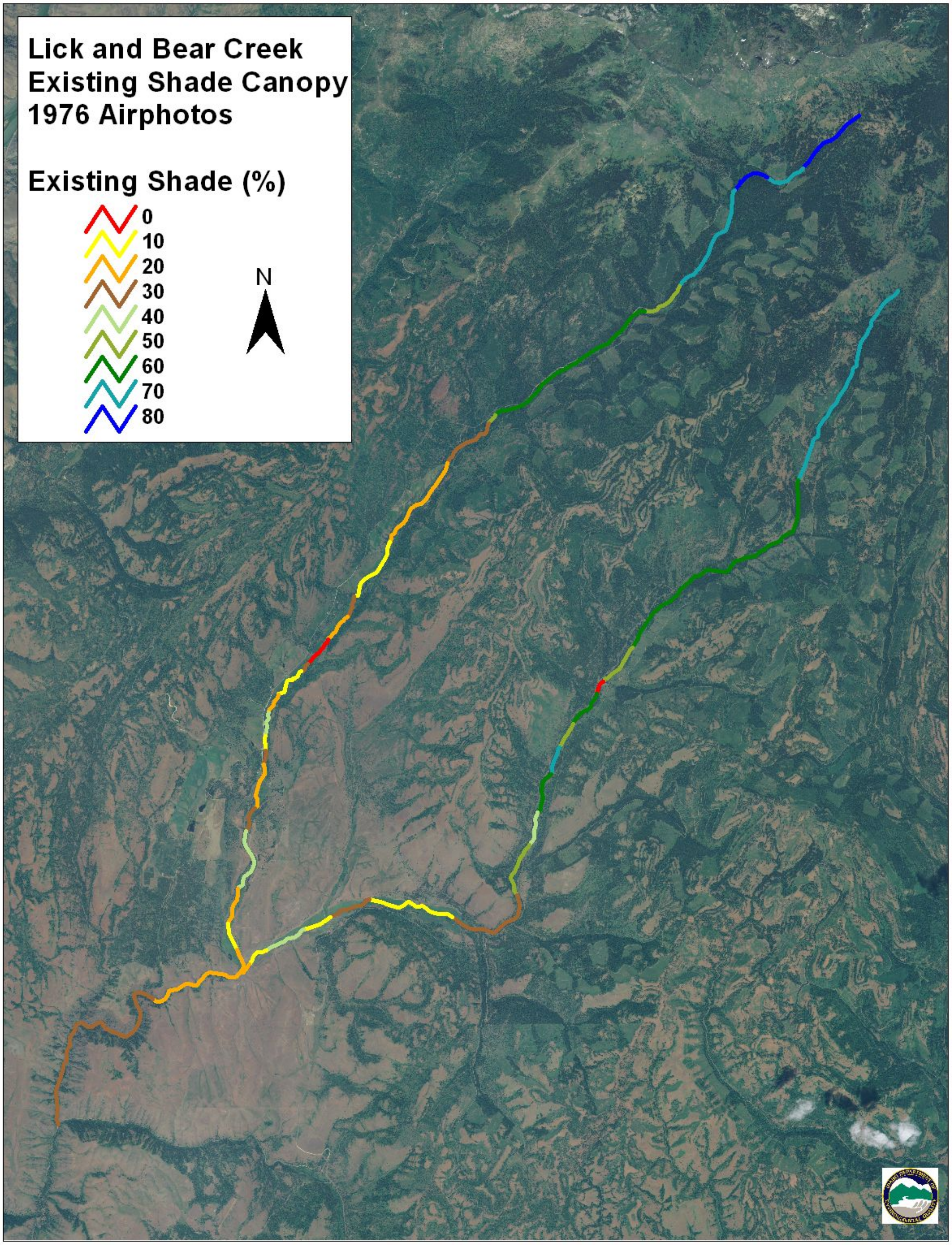


**Figure E.1. 1976 Shade Values: Bear and Lick Creeks**

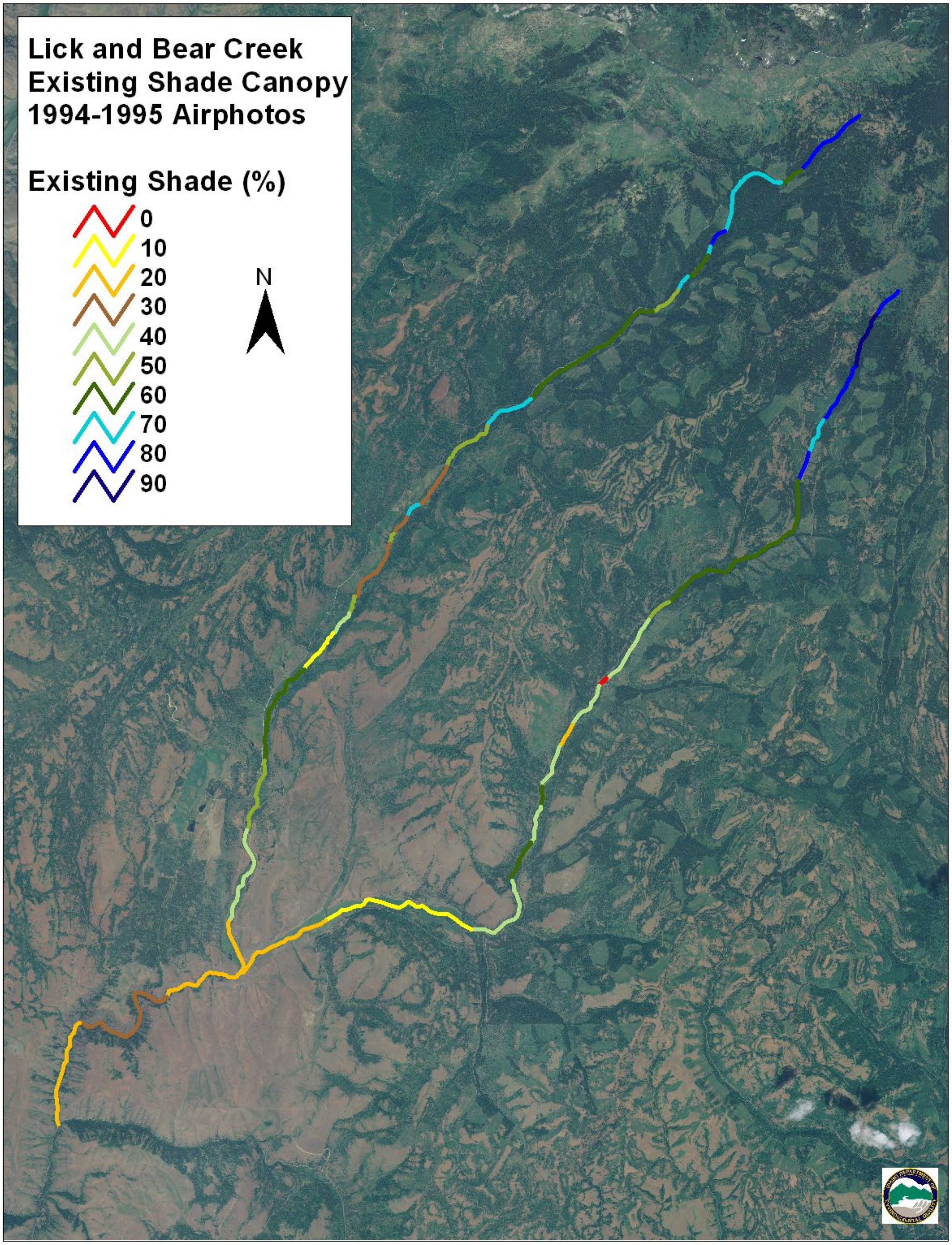


**Figure E.2. 1994-95 Shade Values: Bear and Lick Creeks**

# Appendix F. Public Participation and Comment

August 22, 2006: WAG meeting.

September 28, 2006: WAG meeting and field trip to ground truth temperature analysis, Bear, Idaho.

October 19, 2006: WAG officially approved by BAG.

November 9, 2006: WAG voted unanimously to send the document out for public comment.

November 29, 2006-January 4, 2007 Public Comment Period. Ad placed in Adams County Register.

February 6, 2007: WAG, by consensus, agreed to submittal of document to EPA.

Table F.1 gives comments from reviewers of an earlier draft of this document, along with the author's responses.

**Table F.1. Comments on Wildhorse TMDL Draft**

| Person/Agency Commenting | Comment | Response |
|---|---|---|
| Donna Walsh, EPA | Page xvi: The sentence "Most streams appear to be in relatively good condition and should be considered of relatively low priority for implementation." should be further explained. It gives the impression that it is not necessary to carry through with implementation of the TMDL. This statement works as a disincentive for landowners to implement the TMDL: the TMDL should be the incentive to inspire landowners to complete the work necessary to restore the waters. Though the state can choose to prioritize TMDL implementation by working on more polluted streams first, the waters in the Wildhorse drainage are water quality limited and must also be brought into compliance with the standards. Fortunately, there is not as much work to do on these waters to meet water quality standards as in some other places, but the TMDL must still show the intent of bringing the waters back into compliance with the standards. This paragraph should be revised with this intent. | The intent was not to give the impression that it was not necessary to carry through with the implementation of the TMDL, but rather that they could choose to focus their efforts where there would be significant gains in reducing instream water temperatures. A sentence will be added to clarify that any actions taken anywhere in the watershed to reduce instream temperatures would be beneficial. |

**Table F.1, continued**

| Person/Agency Commenting | Comment | Response |
|---|---|---|
| Donna Walsh, EPA | Page 21, Table 2.2: The first sentence states that Wildhorse River is designated for cold water aquatic life, salmonid spawning, and primary contact recreation. The first full paragraph on page 9 states that bull trout are believed to be resident fish. Does the bull trout criteria apply to Wildhorse River and its tributaries? | Yes, the bull trout criteria applies to the upper reaches of these streams. Since we are using shade as a surrogate for temperature, the TMDL allocations would mean that the waters would meet bull trout criteria or natural background temperature if that exceeds the bull trout criteria. |
| | Page 21, Table 2.2: Tables 2.2 and 2.3 are used to show which waters are 303(d) listed and which waters are not, but the tables were not completely clear. Crooked River is included in Table 2.2 of "Wildhorse…303(d) listed streams." Is Crooked River on the Idaho 303(d) list? I did not see it on the list. Or was it determined during the course of the TMDL that Crooked River is water quality limited for temperature? | The assessment unit for the Wildhorse River includes Crooked River which is why Crooked River is included in the table regarding designated uses. However, only the fourth order section of the Wildhorse River is on the 303(d) list, thus Crooked River is not on the 303(d) list. I can separate out the fourth order section from the rest of the Wildhorse Drainage to make this more clear. |
| | Table 2.3 is titled "Wildhorse…non 303(d) listed streams," but Lick Creek is not listed in Table 2.3. The temperature analysis shows Lick Creek meets water quality standards. Should Lick Creek be included in Table 2.3? | The assessment unit for Bear Creek includes its tributary Lick Creek. This has been clarified in the table. |
| | Page 41 Stream Morphology: This page discusses the existing bankfull width and its similarity to the Payette Weiser regional curve, but does not relate the existing bankfull width to the natural bankfull width. This section should discuss the natural bankfull width of the Wildhorse River and how it relates to the existing width. If the Payette Weiser regional curve is assumed to be similar to the natural bankfull width of the Wildhorse area, the reasons for this should be described. | That section should state that whichever bankfull width is smaller, the regional curve estimate or existing is what we use for natural. Language will be added to clarify this. |
| | Page 49, Table 5.6: I believe the % reduction for Bear Creek should be 11% rather than 8%. (The excess load is 80,881 and the existing load is 733,757 giving a load reduction of 11%). Table 5.9 on page 55 should be changed to reflect this also. | I think you may have misread the table—the excess load is 60,881 not 80,881 |

**Table F.1, continued**

| Person/Agency Commenting | Comment | Response |
|---|---|---|
| Donna Walsh, EPA | Page 56, Margin of Safety: Could you expand on the concept of the margin of safety being implicit in the design? The margin of safety accounts for the uncertainty concerning the relationship between the pollutant loading and the receiving water quality. It is not clear how the design of the TMDL provides a margin of safety. Please describe the conservative approach (trying to reach natural vegetation levels) or any conservative assumptions used in developing the TMDL. | The margin of safety is that you cannot achieve higher shade levels than the target. The target is the best you can get, you can't add another 10% to the target. |
| | *Other comments*<br>Page 5, Figure 1.1, Land use map: Figure 1.1 is referenced on page 4 to show the Wildhorse River being formed by the confluence of Crooked River and Bear Creek. In the draft I have, Figure 1.1 is a land use map that doesn't show the names of the waters and doesn't seem to be the best map to show the confluence. Also, Figure 1.1 is referenced on page 25 (fourth full paragraph) as showing the BURP sites. I wondered if the wrong map was put in Figure 1.1. A map of the Wildhorse drainage with the main features that are referenced later in the document such as the communities of Bear and Council, Bear Falls and the Brownlee Dam would be especially useful here. | Figure B is referenced instead. |
| | Page 18, last sentence: Though there are no active mines in the watershed, did former mines change the channel width or riparian vegetation in ways that are still evident? | No, there is no evidence of this. |
| | Page 25, 2nd and 3rd full paragraphs and Table 2.7: These paragraphs are helpful in giving a brief description of the indices used in measuring beneficial uses, but they do not explain how the scores relate to beneficial use–i.e., how full support is determined. The third site on Table 2.7 shows a SMI score of 3, a SFI score of less than minimum threshold, and a SHI score of 1. It appears that there are two of the lowest scores here and only 1 "high" score, and the support status column shows 2 (Full Support). An explanation of how the support status is determined would be useful. (Also, the second site does not show anything in the SHI column. Should this box be filled in with a score if one is available or Not measured if there is no score?) | You are right about the third site—this has been corrected to show not full support in 1994.<br><br>The missing SHI score has been added to Table 2.7. |

**Table F.1, continued**

| Person/Agency Commenting | Comment | Response |
|---|---|---|
| Donna Walsh, EPA | Page 26, Conclusion, fifth sentence: It is not possible to tell from the previous page when each of the indices data were collected, so the terms "the 1994-95 …measurements" or the "higher 2003 score," are not meaningful to the reader. This sentence appears to imply that the scores of the indices vary depending on when the data was collected. Is this true? If so, how is this accounted for in using the indices? If the month the measurements are taken can affect the index score, the dates of data collection for each of the indices should be shown on the previous page. | Overall, since the BURP program runs through the summer months, the effects of collection month do not unduly influence the score. This particular sentence was just meant to show that in this instance, the fact that we were seeing a higher SFI score was likely because fish had moved back into the system due to cooler water temperatures. However, that is simply a conjecture. |
| | Page 28, 3rd paragraph: Does the Bear Creek irrigation ditch flow into Bear Creek? Is the temperature in the ditch known, and does it affect the temperature in Bear Creek? | The temperature of the ditch is not known, but the effect on Bear Creek is minimal (most of the ditch runs through the area affected by the tornado that was excluded from analysis). The return water from the ditch primarily goes into ponds. |
| | Page 29, first full sentence: This sentence notes the average summer temperatures of Bear Creek range from 5.6 to 10.1 degrees Celsius. It is not clear where these numbers come from. Tables 2.8 to 2.11 show average summer temperatures from 4.8 degrees at the upper site to 11.3 degrees at Huckleberry campground. (An average temperature of 3 degrees is shown in October, but I did not count October as a summer month.) | That sentence came from a USFS biological assessment. Since I presented additional data then referenced in that report, I will delete that sentence to prevent confusion. |
| | Page 33, 1st paragraph under Water Temperature Data: Second sentence should include June; i.e., the standard is exceeded "in July and sometimes in June and August." (Tables 2.18 to 2.20 show exceedances in June.) | Correction has been made. |
| | Page 43, last paragraph: It makes sense that the salmonid spawning time period would be one of the critical time periods to be considered. Is it possible to state the dates of salmonid spawning so the reader can see it occurs between April and September? | Clarification will be added, particularly regarding spring salmonid spawning periods. |

**Table F.1, continued**

| Person/Agency Commenting | Comment | Response |
|---|---|---|
| Donna Walsh, EPA | Page 56, Construction Storm Water and TMDL Waste Load Allocations: The paragraphs under this section are a little confusing since they are general and don't seem to relate to this specific TMDL. If these sources exist in this watershed, this section would be more helpful if it discussed the specifics of these sources in relation to this TMDL and watershed. For example, if there are any anticipated construction storm water activities that may need a wasteload allocation in the future, they could be discussed here. | This is standard TMDL wording for construction storm water. A clarifying sentence will be added to clarify that there are no pending construction activities that would need a wasteload allocation. |
| Bill Gamble, USFS Hydrologist | One aspect that may be worth mentioning is beaver influence on watershed processes and condition. There are known active beaver colonies in the Crooked River, Bear Creek and Lick Creek drainages. | This information will be added. |
| | Does the listing of Wildhorse River from headwaters to mouth include segments of Bear Creek, Crooked River, and Lick Creek? Temperature monitoring indicates violation in other segments, so these should be included. | While the listing does not include those tributaries, the pollutant loading allocation takes them into account (see Section 5) and assigns shading targets to them to account for the elevated heat load they contribute to the Wildhorse. Hopefully, this inclusion in the load allocation will allow these streams to rise up higher in watershed restoration priority listings.<br><br>As an addendum to USFS comments, additional temperature data was submitted that DEQ had not included in the TMDL. Information from lower Bear Creek near the mouth will be added to the TMDL. This data shows elevated temperatures. Other data submitted was similar to what was already presented. |
| | What about sediment? High road densities, history of active management (harvest, grazing) has resulted in excess sediment and alterations of stream channels throughout the watershed. Surface fine data in Lick Creek has levels that are very high and a concern to fisheries. Crooked River is similar. | DEQ stream inventory information for Lick Creek and Crooked River indicates full support of beneficial uses. The information on tributaries submitted by the USFS showed high percent fines in tributaries to these reaches. |

**Table F.1, continued**

| Person/Agency Commenting | Comment | Response |
|---|---|---|
| Bill Gamble, USFS Hydrologist | The Payette NF has sampled Lick Creek at two locations for *E. coli* for the past 7 years. The lower site is located at the forest boundary above the OX Ranch, and the upper site is located above the confluence with Cold Springs Creek. This monitoring has identified violations of the *E. coli* standard for secondary contact recreation at the lower site during the mid-season livestock grazing period in all but year 2004. During 2004 the Lick Creek pasture was rested. Given sampling before and after livestock grazing each season has not identified exceedances, and 2004 had no violations, livestock are presumed to be the primary source of *E. coli* violations. | A discussion amongst the Watershed Advisory Group, particularly between OX Ranch representatives and the USFS representative, resulted in the conclusion that the USFS lower sampling site would need to be moved to below the riparian pasture in order to more accurately assess the *E. coli* situation. The results from Summer 2007 will be used to determine whether a 303(d) listing or TMDL is warranted. |
| | Bacteria data was submitted with these comments to DEQ. | DEQ will add this bacteria information to the appendix. |
| Kalissa Copeland, IASCD and Adams Soil Conservation District | Page 10, "the affected area…": Is this section addressed in the TMDL? As far as the listed portion? | Yes, we excluded the portion of the affected area (Bear Creek) from the temperature analysis in Section 5 but provided, for informational purposes, a temperature analysis in Appendix D. |
| | Page 14, "The drainage may show…": Suggestion: possibly put in a statement in there as to specifically what months there may be a rain-on-snow period | Added a clarifying sentence. |
| | Page 17, "It boasted a post office…": Suggestion: repetition on post office statements, could combine them. | Removed repetitive statement. |
| | Page 21, Support of Beneficial Uses: Suggestion: Could provide a table or some kind of reference, reporting whether or not beneficial uses are supported for the Wildhorse River, Lick Creek, Bear Creek, and Crooked River. | Tables A and B cover 303(d) listed assessment units and any changes to the 303(d) list. Any stream (the fourth order segment of the Wildhorse River) listed in here does not support beneficial uses. All other assessment units are presumed to support beneficial uses. Thus, Lick Creek, Bear Creek, and Crooked River support beneficial uses. |
| | Page 26, Bear Creek Irrigation, 750 acres: Question: Is this acreage a little high for the 22 users? Please check. | It is approximately 750 acres. |
| | Page 28, Lick Creek, Crooked River and Bear Creek: Suggestion: A statement providing information on the effects that the blowdown had on the temperature and shade of creeks. | At start of section, referred reader back to Section 1 for this information. |

**Table F.1, continued**

| Person/Agency Commenting | Comment | Response |
|---|---|---|
| Kalissa Copeland, IASCD and Adams Soil Conservation District | Page 36, "Depending how much…": Suggestion: Sentence doesn't make sense. It says vertical elevation also surrounds the stream, vegetation further away from the riparian corridor can provide shade. Could say: Depending on how much vertical elevation surrounding the stream, vegetation… | This is supposed to refer to topographical relief and how the steeper the hillside, the more likely that vegetation farther away will cast shade onto the stream channel. Will clarify sentence. |
| | Page 37, Pathfinder Methodology: Point of Information: At each sampling location ISCC/IASCD places the solar pathfinder 6 inches off of the water, not at bankfull width. Then take cross section measurements at bankfull width. | DEQ measurements were the only measurements used in ground truthing, which is why the DEQ protocol was described. This difference in protocol could be mentioned in the implementation plan. |
| | Page 39: In last paragraph is there a Table 1? Answer: Table 5.1 instead? | This has been corrected. |
| | Page 42: Check Table numbers | This has been corrected. |
| | Page 44, Paragraph 2: Answer: its tributaries and ARE compared…. | The intent of the sentence is correct as originally written. |
| | Page 45: Tables don't correspond. | This has been corrected. |
| | Page 53, Paragraph 2: Question: Where is figure 4? | This has been corrected. |
| | Page 55, Construction Storm Water Requirements: Suggestion: Make a statement regarding if Adams County has any stormwater ordinances yet, construction site BMPs or what actions are being taken if any to enforce them. | Adams County does not have a stormwater ordinance. |
| | Please add information regarding the 1989 blowdown (microburst) in the Lick Creek area. | We will add this information once we have it finalized. |
| Tina Warner | Wanted to know how tornado area was being addressed. | The area was excluded from the analysis because TMDLs focus on human activities. However, information was included in the appendix regarding the decrease in shading due to the tornado. This information was added at the request of the WAG. |