Big Lost River Subbasin
Total Maximum Daily Loads

Addendum to the Big Lost River Watershed Subbasin Assessment and TMDL

Public Comment Draft

Idaho Department of Environmental Quality

August 2011

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Acknowledgments

Cover photo of Leadbelt Creek in August 2009 (Mark Shumar, Idaho Department of Environmental Quality).

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Abbreviations, Acronyms, and Symbols

§	Section (usually a section of federal or state rules or statutes)
§303(d)	Refers to section 303 subsection (d) of the Clean Water Act, or a list of impaired water bodies required by this section
AU	assessment unit
BAG	basin advisory group
BLM	United States Bureau of Land Management
BMP	best management practice
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
DEQ	Idaho Department of Environmental Quality
DWS	domestic water supply
EPA	United States Environmental Protection Agency
F	Fahrenheit
GIS	geographic information systems
HUC	hydrologic unit code
IDAPA	Refers to citations of Idaho administrative rules
IDFG	Idaho Department of Fish and Game
IDL	Idaho Department of Lands
km	kilometer
km^2	square kilometer
LA	load allocation
LC	load capacity
m	meter
m^3	cubic meter
mi	mile
mi^2	square miles
mg/L	milligrams per liter
mm	millimeter
MOS	margin of safety
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PCR	primary contact recreation

PNV potential natural vegetation

ppm part(s) per million

SCR secondary contact recreation

SS salmonid spawning

TMDL total maximum daily load

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*

WLA wasteload allocation

Executive Summary

This total maximum daily load (TMDL) analysis has been developed to address impaired water bodies in the Big Lost River subbasin. This document is an addendum to the Big Lost River Watershed Subbasin Assessment and TMDL approved by the U.S. Environmental Protection Agency (EPA) in 2004.

Regulatory Requirements

This document has been prepared in accordance with federal and state regulations. 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 2 years. For waters identified on this list, states and tribes must develop a TMDL for the pollutants, set at a level to achieve water quality standards.

Subbasin at a Glance

The Big Lost River subbasin (hydrologic unit code 17040218) is located in central Idaho and includes the town of Arco. The Big Lost River originates as the North Fork Big Lost River and the East Fork Big Lost River on the west side of the Boulder and Pioneer Mountains. The river drains northeast until the Thousand Springs Creek confluence, where it flows southeast through Mackay Reservoir. Below the reservoir, the Big Lost River flows southeast until the Moore Diversion, approximately 11 miles north of Arco, Idaho. The channel downstream of the Moore Diversion remains dry except for a short period in the spring and occasionally longer periods in wet years. This channel extends in an arc northward into the Snake River Plain toward the Idaho National Laboratory and terminates in a system of sinks and playas on the desert floor. Therefore, the drainage of this subbasin is disconnected with Snake River drainages. Instead, the infiltration to ground water joins an aquifer that flows slowly southwest and surfaces as the Thousand Springs area near Hagerman, Idaho.

This document addresses 13 assessment units (AUs) listed in Category 5 for impaired waters on Idaho's current 2008 Integrated Report (Figure A). Additional AUs have been evaluated for possible temperature violations (Figure B). The subbasin assessment examines the status, extent of impairment, and causes of water quality limitations throughout the subbasin. The TMDL determines pollutant loads and allocates load reductions needed to return listed waters to a condition meeting water quality standards.

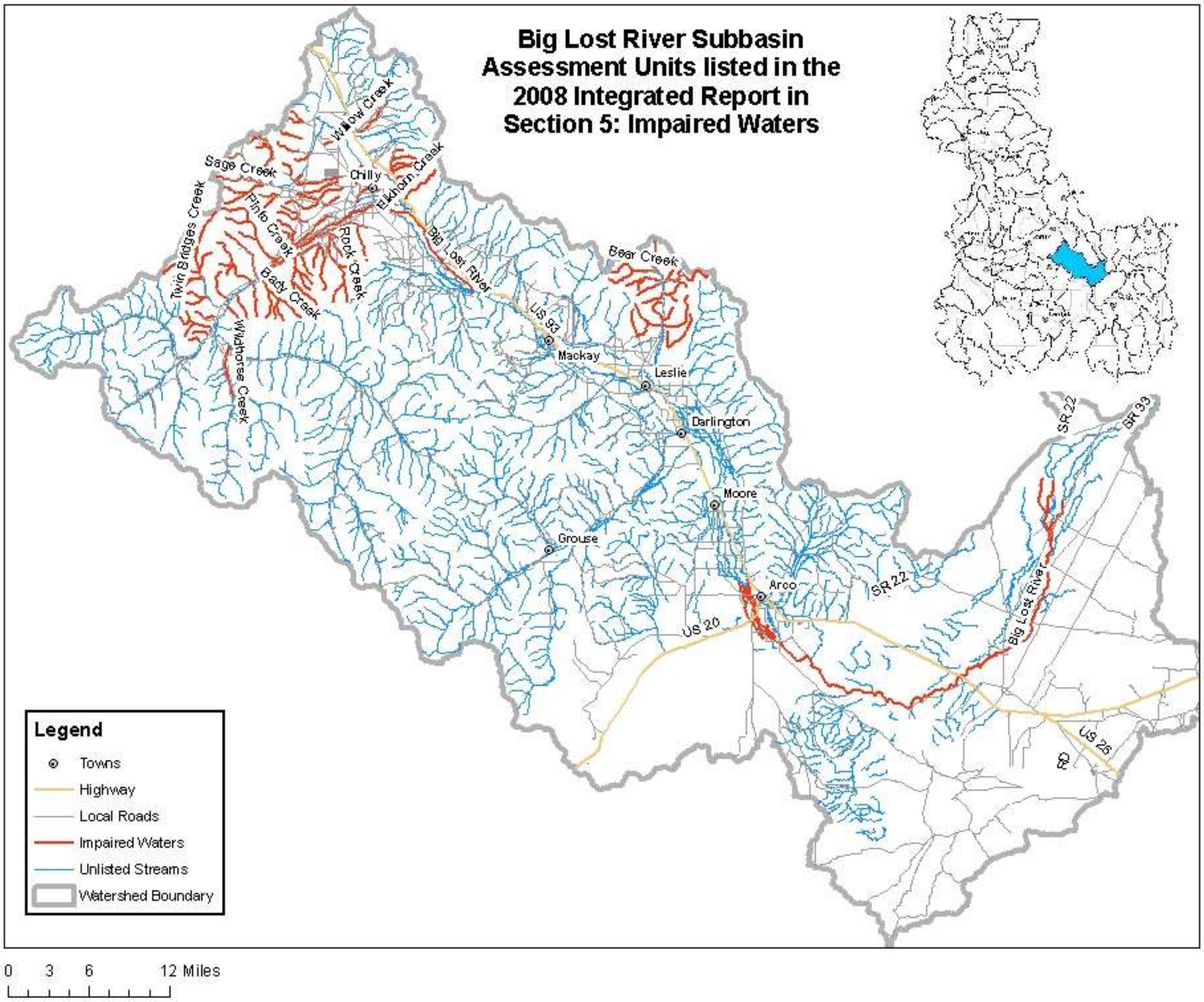

Figure A. Impaired waters listed in Category 5 of the 2008 Integrated Report

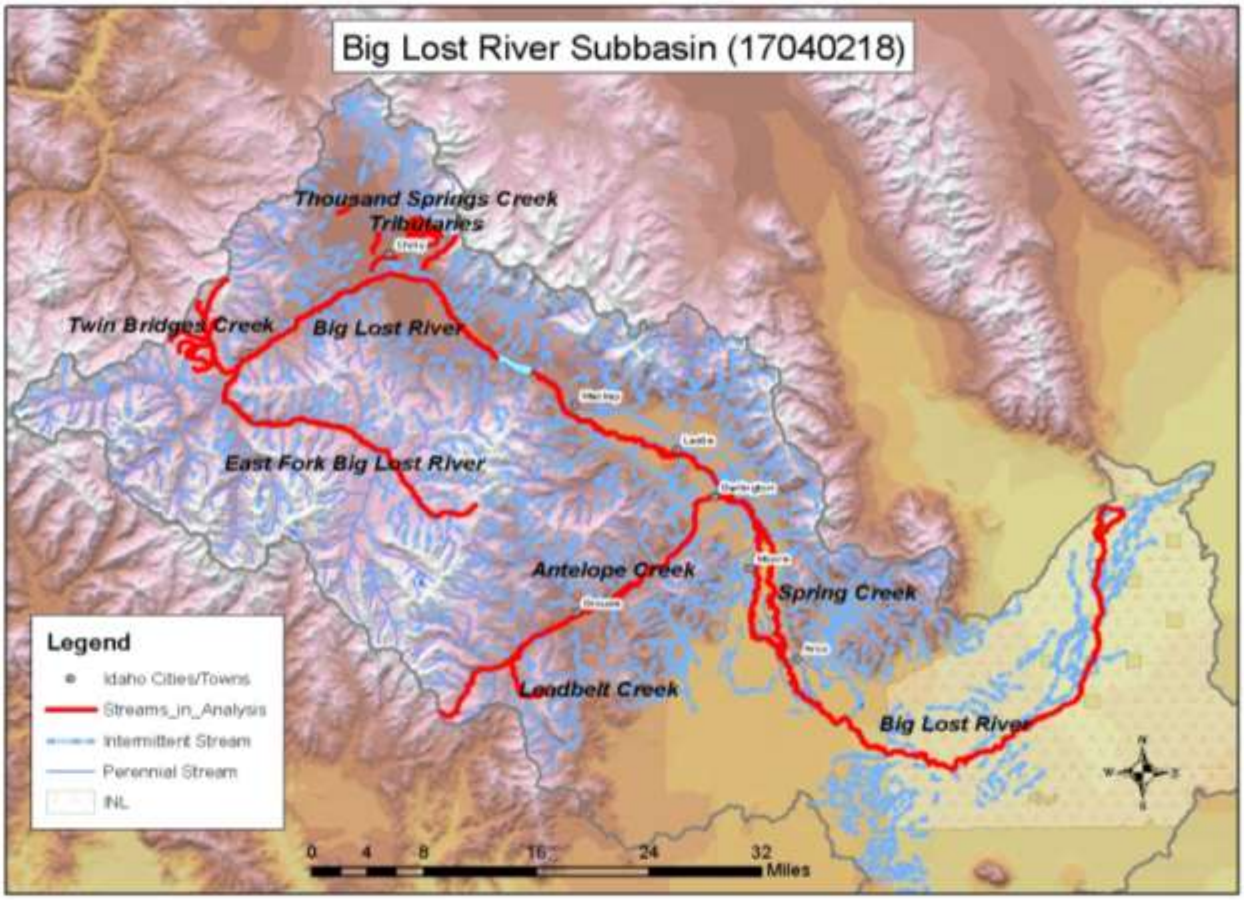

Figure B. Waters investigated for temperature impairment

Key Findings

In this addendum, 13 AUs listed as impaired waters in Category 5 of Idaho's 2008 Integrated Report were investigated for suspected water quality impairments. Investigation by the Idaho Department of Environmental Quality (DEQ) showed that sediment was the main cause of impairment and that excess erosion in this subbasin is more significant from unstable, eroding streambanks than from upland erosion. Excess streambank erosion generally occurs during snowmelt and runoff in early spring, so the stability characteristics of streambanks were measured by DEQ at bankfull widths to determine rates of excess erosion above natural background levels. This investigation showed water quality targets are being met in Bear Creek, Pinto Creek, Grant Creek, Garden Creek, Twin Bridges Creek, and Wildhorse Creek. Excess sediment was determined to be impairing water quality in two reaches of the Big Lost River: the reach above Bartlett Point Road (ID17040218SK024_05) needing a 55% reduction and the reach above Mackay Reservoir (ID17040218SK013_05 and ID17040218SK015_05) requiring a 97% reduction. Bacteria was found to exceed the target for supporting secondary contact recreation as a beneficial use in Sage Creek, and an 86% reduction will be needed to meet the load allocation in that watershed. Assessment outcomes for listed pollutants in the 2008 Integrated Report are given in Table A.

Table A. Summary of assessment outcomes for waters listed in 2008 Integrated Report

Water Body Segment/ Assessment Unit	Listed Pollutant(s)	TMDL Completed	Recommended Changes to Idaho's Integrated Report	Justification
Big Lost River, Spring Creek to Big Lost River Sinks ID17040218SK002_06	Sediment; Temperature; Cause unknown (suspected nutrient impairment)	No	Delist sediment, temperature, and cause unknown as pollutants; List in 4c for flow and habitat alteration	Reach is dewatered due to upstream diversions, groundwater withdrawals and unique hydrology
Pass Creek, source to mouth ID17040218SK009_02 (includes Bear Creek)	Combined biota/habitat bioassessments	No	Delist for combined biota/habitat bioassessments as pollutant; List in Category 2	Meets water quality targets
Big Lost River, Jones Creek to Mackay Reservoir ID17040218SK013_05 and Big Lost River, Thousand Springs Creek to Jones Creek ID17040218SK015_05	Sediment; Cause unknown (suspected nutrient impairment)	Yes	List in Category 4a for sediment and temperature; change cause unknown to temperature	Sediment load allocation; potential natural vegetation temperature TMDL completed
Thousand Spring Creek, source to mouth ID17040218SK016_02	Temperature	Yes	List in Category 4a for temperature; this 2nd-order assessment unit does not contain any portion of Thousand Springs Creek but is in fact dry washes and springs adjacent to the creek	Potential natural vegetation temperature TMDL completed
Willow Creek, source to mouth ID17040218SK020_03	Combined biota/habitat bioassessments	No	List in Category 4c for flow alteration; delist for combined biota/habitat bioassessments as pollutant	Channel dry on most field investigations from diversions, ground water withdrawals, and unique hydrology
Sage Creek, source to mouth ID17040218SK022_02	Fecal coliform	Yes	List in Category 4A; change bacteria type from fecal coliform to *E. coli*	Bacteria TMDL completed
Big Lost River, Burnt Creek to Thousand Springs Creek ID17040218SK024_02	Combined biota/habitat bioassessments	No	List in Category 2; delist combined biota/habitat bioassessment as a pollutant	Meets water quality targets
Big Lost River, Burnt Creek to Thousand Springs Creek ID17040218SK024_03	Combined biota/habitat bioassessments	No	List in Category 2, delist combined biota/habitat bioassessment as a pollutant	Meets water quality targets
Big Lost River, Burnt Creek to Thousand Springs Creek ID17040218SK024_05	Sediment	Yes	List in Category 4a	Sediment TMDL completed
Big Lost River, Summit Creek to and including Burnt Creek ID17040218SK025_02	Combined biota/habitat bioassessments	No	List in Category 2; delist combined biota/habitat bioassessment as pollutant	Meets water quality targets

Water Body Segment/ Assessment Unit	Listed Pollutant(s)	TMDL Completed	Recommended Changes to Idaho's Integrated Report	Justification
Twin Bridge Creek, source to mouth ID17040218SK026_02	Cause unknown, (nutrients suspected impairment)	No	Keep in Category 4a for sediment; delist cause unknown as suspected pollutant	Sediment TMDL approved by U.S. Environmental Protection Agency in 2004 and no evidence of nutrient, temperature, or further impairment
Twin Bridge Creek, source to mouth ID17040218SK026_02	Temperature	Yes	List in Category 4a	Potential natural vegetation temperature TMDL completed
Wildhorse Creek, source to mouth ID17040218SK030_04	Fecal coliform	No	Keep in Category 4a for sediment and temperature; delist fecal coliform as a listed pollutant	Sediment and temperature TMDLs approved by U.S. Environmental Protection Agency in 2004 and no evidence of bacterial or further impairment

Further investigation for temperature criteria violations was made on 7 water bodies (25 AUs) in the watershed (Table B).

Table B. Streams investigated for temperature as a pollutant

Stream	Pollutant(s)
Antelope Creek	Temperature
Big Lost River	Temperature
East Fork Big Lost River	Temperature
Leadbelt Creek	Temperature
Spring Creek	Temperature
Twin Bridges Creek	Temperature
Thousand Springs Creek Tributaries	Temperature

Effective shade targets were established for these streams based on the concept that maximum shading under potential natural vegetation (PNV) results in natural background temperature levels. Shade targets were derived from effective shade curves developed for similar vegetation types in the Northwest. Existing shade was determined from aerial photo interpretation field verified with solar pathfinder data.

Some streams in the analysis lacked shade to some degree. Several of these streams were listed in previous integrated reporting cycles on the §303(d) list but are not currently listed or were identified in the 2004 Big Lost River TMDL as potentially impaired. Twin Bridges Creek and Leadbelt Creek have extensive beaver workings and dewatered segments that showed the largest relative impacts, needing solar load reductions varying from 33% to 43%. A substantial amount of shade loss in these watersheds is likely due to non-anthropogenic sources (beaver dams) that need to be investigated further. Antelope Creek, Spring Creek (above Leslie), East Fork Big Lost River, and Big Lost River will need load reductions from 18% to 28%. Thousand Springs Creek tributaries (also called Elkhorn Creek) appear to have been listed in error, as they are primarily dry ephemeral washes and spring-fed wetlands in very good condition. Some confusion exists regarding "Spring Creek," as there are 3 reaches referred to as Spring Creek, 2 of which intertwine with the Big Lost River, and 1 of which is a tributary of Antelope Creek. We have included in this analysis the flowing portion of Spring Creek above Leslie that branches along the Big Lost River (AU ID17040218SK007_05)

Target shade levels for individual reaches should be the goal managers strive for with future implementation plans. Managers should focus on the largest differences between existing and target shade as locations to prioritize implementation efforts. Table C identifies the AUs for which temperature TMDLs were developed.

The four known point sources in the watershed do not require wasteload allocations for temperature because they either do not affect listed waters, are too small to affect listed waters, or are no longer a functioning facility with a discharge.

Table C. Summary of assessment outcomes for unlisted waters impaired by temperature

Water Body Segment/ Assessment Unit	Pollutant	TMDL(s) Completed	Recommended Changes to Idaho's Integrated Report	Justification
Big Lost River ID17040218SK025_05 ID17040218SK024_05 ID17040218SK015_05 ID17040218SK013_05 ID17040218SK011_05 ID17040218SK010_05 ID17040218SK007_05 ID17040218SK006_06	Temperature	Yes	Move to Category 4a	PNV TMDL completed; SK025_05 and SK024_05 have U.S. Environmental Protection Agency approved temperature TMDL in 2004; potential natural vegetation applies shade targets
East Fork Big Lost River ID17040218SK039_02 ID17040218SK039_03 ID17040218SK033_02 ID17040218SK033_03 ID17040218SK033_04	Temperature	Yes	Move to Category 4a	PNV TMDL completed; SK033_02 and SK033_04 have U.S. Environmental Protection Agency approved temperature TDML in 2004; potential natural vegetation applies shade targets
Antelope Creek ID17040218SK057_02 ID17040218SK057_03 ID17040218SK052_04 ID17040218SK047_04 ID17040218SK049_04 ID17040218SK049_05 ID17040218SK047_05 ID17040218SK046_05	Temperature	Yes	Move to Category 4a	PNV TMDL completed
Leadbelt Creek ID17040218SK058_02	Temperature	Yes	Move to Category 4a	PNV TMDL completed
Twin Bridges Creek ID17040218SK026_02 ID17040218SK026_03	Temperature	Yes	Move to Category 4a	PNV TMDL completed
Thousand Springs Creek Tributaries ID17040218SK016_02 (also known as Elkhorn Creek)	Temperature	Yes	Move to Category 4a	This assessment unit is dry washes and spring-fed wetlands. Existing shade.

1. Subbasin Assessment—Watershed Characterization

This document presents an addendum for the Big Lost River subbasin assessment and total maximum daily load (TMDL) (DEQ 2004). This addendum addresses assessment units (AUs) currently listed in Category 5 of the 2008 Integrated Report.

1.1. Introduction—Regulatory Requirements

This document was prepared in compliance with both federal and state regulatory requirements, as described below.

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. For waters identified on this list, states and tribes must develop a TMDL for the pollutants, set at a level to achieve water quality standards.

This document addresses 13 AUs listed in Category 5 for impaired waters on Idaho's current 2008 Integrated Report. An additional 25 AUs were assessed for temperature impairment. The 2004 subbasin assessment examines the status, extent of impairment, and causes of water quality limitation throughout the subbasin (DEQ 2004). The TMDL analyses in this addendum quantify pollutant loads and allocate load reductions needed to return listed waters to a condition meeting water quality standards.

1.2. Public Participation and Comment Opportunities

The development of this addendum to the Big Lost River subbasin assessment and TMDL will include a public comment period on this draft document.

1.3. Physical and Biological Characteristics

A detailed discussion of the physical and biological characteristics is provided in the *Big Lost River Watershed Subbasin Assessment and TMDL* (DEQ 2004). In summary, this watershed lies on the northern edge of the Snake River Plain and has a complex geology based on volcanism and range uplift. The Big Lost River subbasin is one of five central valley drainages that collectively make up the Sinks Drainages, meaning the surface water disappears into valley fill material and does not exit the subbasin.

1.3.1. Climate

A detailed climate discussion is provided in the *Big Lost River Watershed Subbasin Assessment and TMDL*. The valley bottom is high desert with less than 10 inches of annual precipitation. The surrounding mountains average 25 inches of annual precipitation, mostly as snowfall (DEQ 2004).[1]

1.3.2. Subbasin Characteristics

Since the original TMDL, a major change in the land area included in this subbasin (hydrologic unit code [HUC] 17040218) was implemented by the Idaho watershed boundary data set delineation project, which includes members from the Idaho Department of Water Resources (IDWR) and the United States Geological Survey (USGS). The technical working group determined that portions of the American Falls and Lake Walcott subbasins drain into the Big Lost River subbasin, separated by the Twin Buttes ridgeline. In addition, the sinks in the upper Snake River Plain, including Big Lost and Little Lost River sinks, include multiple faint depression contours and closed basins. The group's investigation of 2-foot contour maps showed that man-made features such as railroad beds and roads can become hydrologic divides due to lack of relief. As a result of the investigations by the technical working group, almost 500,000 acres have been added to the Big Lost River subbasin. Closed basins that were in between the Big Lost and Little Lost River sinks were re-delineated based on flow direction if hypothetical stormwater should ever fill the basins.

The Big Lost River watershed is one of four watersheds known in central Idaho as the Sinks Drainages. Any surface water that is not utilized for irrigation infiltrates to ground water in the lowest reaches (AU ID17040218SK002_06—the Big Lost River Sinks). This aquifer emerges as spring flow in the Thousand Springs reach of the Snake River near Hagerman, Idaho. Therefore, this watershed is entirely isolated from surface connection with the Snake River (DEQ 2004).

1.3.3. Subwatershed Characteristics

A detailed discussion of the subwatershed characteristics is provided in the *Big Lost River Watershed Subbasin Assessment and TMDL* (DEQ 2004). The 2004 TMDL established sediment and temperature TMDLs for 13 streams (Table 1).

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

Table 1. Streams and pollutants with load allocations developed in 2004

Stream	Total Maximum Daily Load Pollutant/ Load Allocation Percent Reduction Needed
East Fork Big Lost River	Sediment/85.9%; Temperature/39.0%
Corral Creek (East Fork Big Lost tributary)	Sediment/84.4%; Temperature/40.1%
Starhope Creek	Sediment/72.3%; Temperature/36.9%
Wildhorse Creek	Sediment/72.3%; Temperature/22.2%
North Fork Big Lost River	Sediment/80.9%; Temperature/31.6%
Summit Creek	Sediment/68.9%; Temperature/27.0%
Big Lost River, source to Chilly Buttes	Temperature/11.0%
Twin Bridges Creek	Sediment/93.8%
Thousand Springs Creek	Sediment/73.1%
Warm Springs Creek	Temperature/37.8%
Antelope Creek	Sediment/86.7%; Temperature/31.6% at Forest boundary, 44.0% at diversion
Bear Creek	Sediment/67.3%; Temperature/33.0%
Cherry Creek	Sediment/65.9%; Temperature/30.4%

1.3.4. Stream Characteristics

A detailed discussion of each AU is provided in the *Big Lost River Watershed Subbasin Assessment and TMDL* (DEQ 2004).

1.4. Cultural Characteristics

A detailed discussion of the cultural characteristics of the subbasin is provided in the *Big Lost River Watershed Subbasin Assessment and TMDL* (DEQ 2004).

1.4.1. Land Ownership and Population

Most of this subbasin lies within Custer County, with about 25% in Butte County and a small portion in Jefferson County. Since the subbasin boundaries have been re-delineated, land ownership distribution shows different proportions from those listed in the 2004 TMDL document. Table 2 shows current acreage in private and public land ownership.

Table 2. Current land ownership acreage in the Big Lost River subbasin

Land Owner	Current Acreage
Private	**211,497**
Public	**1,357,669**
BLM	454,867
Department of Energy	298,974
National Park Service	50,046
State of Idaho	17,575
USFS	536,206
Total	1,569,166

Figure 1 shows the current distribution of land ownership for this subbasin. The National Park Service acreage that has been added to this subbasin includes part of the Craters of the Moon National Monument. The additional Department of Energy acreage is from the Idaho National Laboratory (INL).

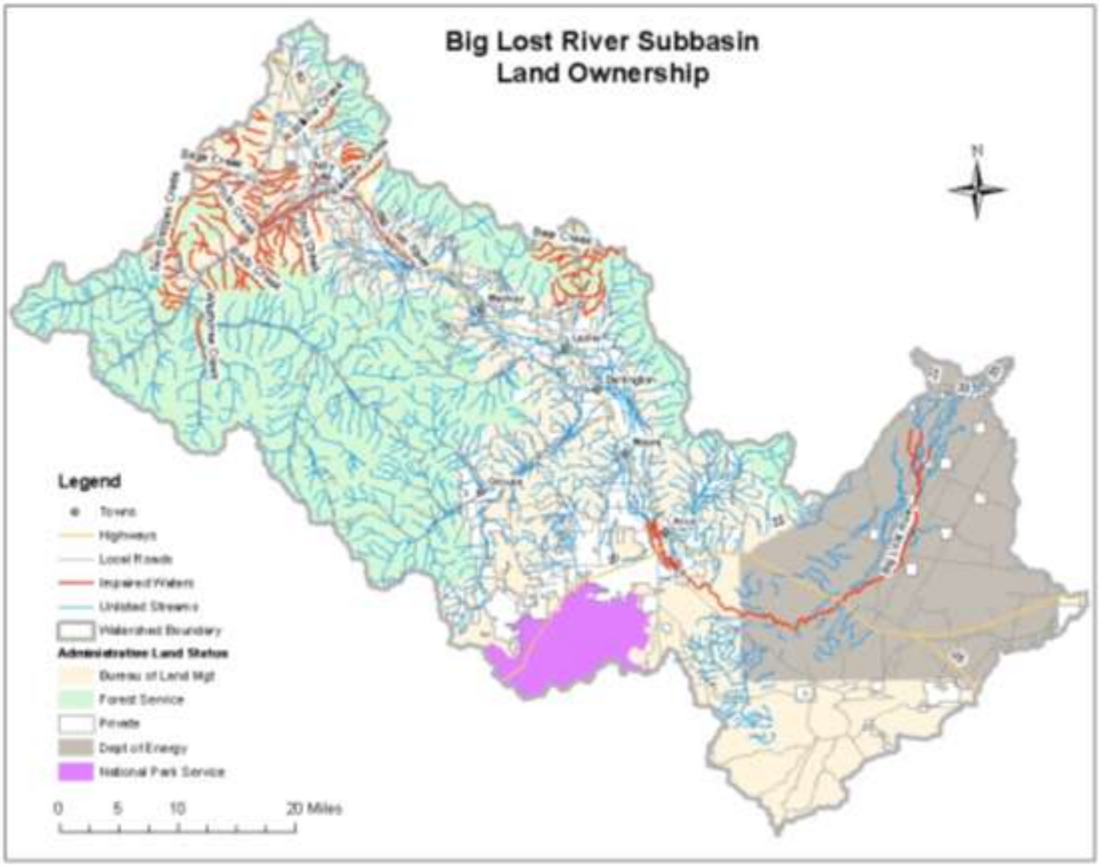

Figure 1. Land owner distribution (U.S. Bureau of Land Management GIS data, 2009)

Population in Custer County declined through 2005 due to mining industry reductions but has increased from 2006 to 2008. Half of the county's jobs are in government or natural resources, since only 5% of the land area is in private ownership. Agriculture employs about 2% of the county's work force (Idaho Department of Labor 2010b).

Population in Butte County declined 7% between 1998 and 2008. Significant layoffs at the INL and the closure of some regional mines resulted in a rise in unemployment rates. As of 2008, 82% of the county's jobs were in professional and business services at the lab, but with recent decommissioning of major INL operations, that figure has likely dropped. Education, health care, and trade are stable, and tourism is developing as an economic factor. Agriculture employs less than 1% of the work force in the county (Idaho Department of Labor 2010a).

1.4.2. Economics

The most significant economic trend in the Big Lost River subbasin since the original TMDL was finalized in 2004 includes a change in operations at the INL. Although one contractor on site is engaged in research and development, most of the remaining site is undergoing decommissioning of the old facilities and storage and stabilization of radioactive waste. Since the INL was historically the major employer in the region, the decline in operations will reduce employment opportunities for residents of Arco and Mackay, the largest population centers in this watershed.

2. Subbasin Assessment—Water Quality Concerns and Status

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.

2.1.1. Idaho's Integrated Report

Table 3 shows the AUs and pollutants that are currently listed in Category 5: Impaired Waters. Table 4 lists the AUs that are impaired by nonpollutants and listed in Category 4c of the Integrated Report. No TMDL will be developed for the AUs in Category 4c, which have altered flow regimes or habitat alteration. Altered flow and habitat are not pollutants as defined by CWA section 502(6), and TMDLs are not required for streams impaired by nonpollutants.

Table 3. Assessment units in 2008 Integrated Report impaired by pollutants

Assessment Unit Name	Assessment Unit ID Number	Impaired Stream Miles	Pollutants	Listing Basis
Big Lost River – Spring Creek to Big Lost River Sinks	ID17040218SK002_06	72.2	Sedimentation/siltation; Temperature; Cause unknown	1994 §303(d) list
Pass Creek – source to mouth	ID17040218SK009_02	50.16	Combined biota/habitat bioassessments	2002 §303(d) list
Big Lost River – Jones Creek to Mackay Reservoir	ID17040218SK013_05	4.03	Sedimentation/siltation; Cause unknown	1994 §303(d) list
Big Lost River – Thousand Springs Creek to Jones Creek	ID17040218SK015_05	4.77	Sedimentation/siltation; Cause unknown	1994 §303(d) list
Thousand Springs Creek – source to mouth	ID17040218SK016_02	20.15	Temperature	2002 §303(d) list
Willow Creek – source to mouth	ID17040218SK020_03	4.05	Combined biota/habitat bioassessments	2002 §303(d) list
Sage Creek – source to mouth	ID17040218SK022_02	35.64	Fecal coliform	2002 §303(d) list
Big Lost River – Burnt Creek to Thousand Springs Creek	ID17040218SK024_02	98.61	Combined biota/habitat bioassessments	2002 §303(d) list
Big Lost River – Burnt Creek to Thousand Springs Creek	ID17040218SK024_03	1.4	Combined biota/habitat bioassessments	2002 §303(d) list
Big Lost River – Burnt Creek to Thousand Springs Creek	ID17040218SK024_05	21.44	Sedimentation/siltation	1998 §303(d) list
Big Lost River – Summit Creek to and including Burnt Creek	ID17040218SK025_02	30.42	Combined biota/habitat bioassessments	2002 §303(d) list
Bridge Creek – source to mouth	ID17040218SK026_02	21.49	Cause unknown	1994 §303(d) list
Wildhorse Creek – Fall Creek to mouth	ID17040218SK030_04	4.95	Fecal coliform	2002 §303(d) list

Table 4. Assessment Units in 2008 Integrated Report impaired by nonpollutants

Assessment Unit Name	Assessment Unit ID Number	Impaired Stream Miles	Pollutants	Listing Basis
Big Lost River – Spring Creek to Big Lost River Sinks	ID17040218SK002_06	72.2	Other flow regime alterations	1994 §303(d) list
Spring Creek – Lower Pass Creek to Big Lost River	ID17040218SK003_06	17.12	Low flow alterations; Physical substrate habitat alterations	2002 §303(d) list
Big Lost River – Burnt Creek to Thousand Springs Creek	ID17040218SK024_05	21.44	Low flow alterations	1998 §303(d) list
Antelope Creek – Spring Creek to mouth	ID17040218SK046_02	49.58	Other flow regime alterations	1994 §303(d) list
Antelope Creek – Dry Fork Creek to Spring Creek	ID17040218SK047_04	3.56	Other flow regime alterations	1994 §303(d) list

Not all of the water bodies listed in Category 5 of the 2008 Integrated Report require a TMDL. However, a thorough investigation using the available data was performed before this conclusion was made.

2.2. Applicable Water Quality Standards and Beneficial Uses

Idaho water quality standards require that surface waters of the state be protected for *beneficial uses*, wherever attainable (IDAPA 58.01.02.054). These beneficial uses are interpreted as existing uses, designated uses, and presumed uses as briefly described in the following paragraphs. The *Water Body Assessment Guidance*, second edition (Grafe et al. 2002), gives a more detailed description of beneficial use identification for use assessment purposes.

2.2.1. Existing Uses

Existing uses under the CWA are "those beneficial uses actually attained in the waterbody 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 58.01.02.054.). Existing uses include uses actually occurring, regardless of whether or not the level of water quality to fully support the uses exists. A practical application of this concept would be to apply the existing use of salmonid spawning to a water that could support salmonid spawning, but where salmonid spawning is not occurring due to other factors, such as dams blocking migration.

2.2.2. 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 a state. In Idaho, these designated uses include aquatic life, recreation in and on the water (i.e., primary or secondary contact recreation), 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.

Designated uses are specifically listed for water bodies in Idaho in tables in the Idaho water quality standards (IDAPA 58.01.02.010.23, in addition to citations for existing uses).

2.2.3. Presumed Uses

In Idaho, most water bodies listed in the tables of designated uses in the water quality standards do not yet have specific designated uses. These undesignated uses are to be designated. In the interim, and without information on existing uses, the Idaho Department of Environmental Quality (DEQ) presumes that most waters in the state will support cold water aquatic life and either primary or secondary contact recreation (IDAPA 58.01.02.100.02). To protect these so-called “presumed uses,” DEQ will apply the numeric cold water aquatic life and primary or secondary contact recreation criteria to undesignated waters.

Because of the requirement to protect water quality for existing uses, if an additional existing use (e.g., salmonid spawning) exists in addition to presumed uses, then the additional numeric criteria for salmonid spawning would also apply (e.g., intergravel dissolved oxygen, temperature). However, if for example, cold water aquatic life is not found to be an existing use, a use designation to that effect is needed before some other aquatic life criteria (such as seasonal cold water) can be applied in lieu of cold water criteria (IDAPA 58.01.02.101.01). Table 5 lists the designated, existing, or presumed beneficial uses for AUs listed in the 2008 Integrated Report for impaired waters.

Table 5. Beneficial uses of impaired waters listed in 2008 Integrated Report

Assessment Unit Name	Assessment Unit ID Number	Designated, Existing, or Presumed Beneficial Uses[a]
Big Lost River – Spring Creek to Big Lost River Sinks	ID17040218SK002_06	CW, SS, PCR, DWS, SRW
Pass Creek – source to mouth	ID17040218SK009_02	CW and PCR or SCR
Big Lost River – Jones Creek to Mackay Reservoir	ID17040218SK013_05	CW, SS, PCR, DWS, SRW
Big Lost River – Thousand Springs Creek to Jones Creek	ID17040218SK015_05	CW, SS, PCR, DWS, SRW
Thousand Springs Creek – source to mouth	ID17040218SK016_02	CW and PCR or SCR
Willow Creek – source to mouth	ID17040218SK020_03	CW and PCR or SCR
Sage Creek – source to mouth	ID17040218SK022_02	CW and PCR or SCR
Big Lost River – Burnt Creek to Thousand Springs Creek	ID17040218SK024_02	CW and PCR or SCR (Pinto Creek)
Big Lost River – Burnt Creek to Thousand Springs Creek	ID17040218SK024_03	CW and PCR or SCR (Grant Creek)
Big Lost River – Burnt Creek to Thousand Springs Creek	ID17040218SK024_05	CW, SS, PCR, DWS, SRW
Big Lost River – Summit Creek to and including Burnt Creek	ID17040218SK025_02	CW and PCR or SCR (Garden Creek)
Bridge Creek – source to mouth	ID17040218SK026_02	CW and PCR or SCR
Wildhorse Creek – Fall Creek to mouth	ID17040218SK030_04	CW and PCR or SCR

[a] CW – cold water, SS – salmonid spawning, PCR – primary contact recreation, SCR – secondary contact recreation, DWS – domestic water supply, SRW – special resource water

2.3. 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 and temperature (IDAPA 58.01.02.200 and 58.01.02.250.).

The narrative sediment criterion is listed in IDAPA 58.01.02.200.08:

> "Sediment shall not exceed quantities specified in Sections 250 and 252, or, in the absence of specific sediment criteria, quantities which impair designated beneficial uses. Determinations of impairment shall be based on water quality monitoring and surveillance and the information utilized as described in Section 350." (4-5-00)

The narrative nutrient criterion is listed in IDAPA 58.01.02.200.06:

> "Surface waters of the state shall be free from excess nutrients that can cause visible slime growths or other nuisance aquatic growths impairing designated beneficial uses." (8-24-94)

Table 6 details the numeric criteria applicable to the impaired waters in the Big Lost River subbasin.

Table 6. Numeric criteria to support beneficial uses for applicable water quality parameters

Water Quality Parameter	Designated and Existing Beneficial Uses			
	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	Less than 126 *E. coli* colonies per 100 milliliters as a geometric mean of 5 samples over 30 days; no sample greater than 406 *E. coli* colonies per 100 milliliters	Less than 126 *E. coli* colonies per 100 milliliters as a geometric mean of 5 samples over 30 days; no sample greater than 576 *E. coli* colonies per 100 milliliters		
Temperature[a]			22 °C or less daily maximum; 19 °C or less daily average	13 °C or less daily maximum; 9 °C or less daily average

[a] Temperature Exemption—Exceeding the temperature criteria will not be considered a water quality standard violation when the air temperature exceeds the 90th percentile of the 7-day average daily maximum air temperature calculated in yearly series over the historic record measured at the nearest weather reporting station.

Figure 2 provides an outline of the stream assessment from DEQ's *Water Body Assessment Guidance* (Grafe et al. 2002) process for determining support status of the beneficial uses of cold water aquatic life, salmonid spawning, and contact recreation.

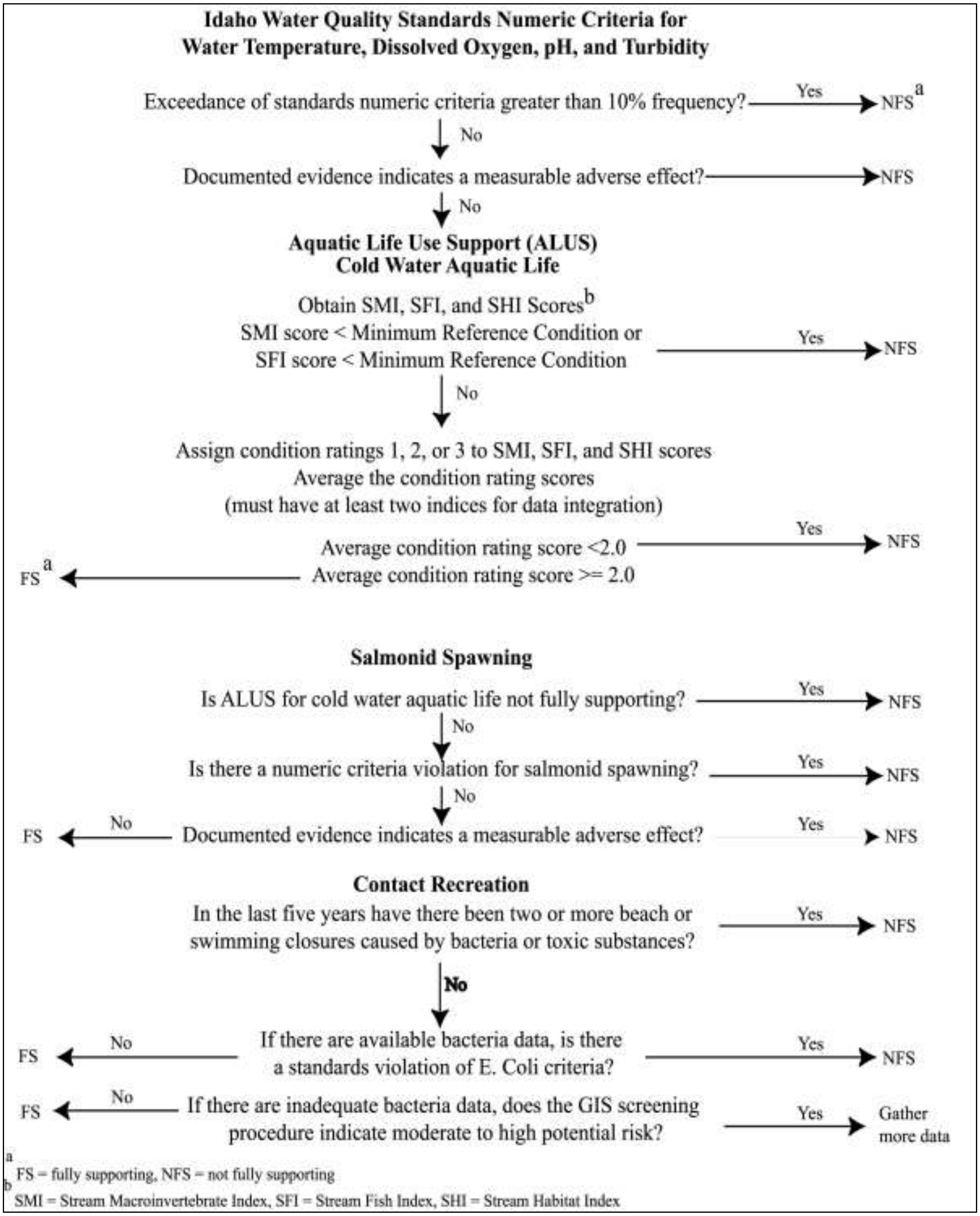

Figure 2. Determination steps and criteria for determining support status of beneficial uses

2.4. Summary and Analysis of Existing Water Quality Data

This section provides additional data collected since the *Big Lost River Watershed Subbasin Assessment and TMDL* (DEQ 2004). A table of data sources is provided in Appendix B.

2.4.1. Flow Characteristics

A detailed discussion of flow characteristics is provided in the original subbasin assessment and TMDL (DEQ 2004). In that document, streamflow data from USGS gages were analyzed for peak flow recurrence and mean monthly flow. The analysis in the original TMDL showed that the 1.5-year recurrent peak flow in upper Big Lost River reaches is 1,700 cubic feet per second (cfs). That flow cycle is important for sediment and temperature TMDLs because bankfull flow that occurs at peak intervals is when sediment is transported most efficiently, eroding stream banks at the highest rate of the year. Therefore, the pollutant analyses are done at bankfull width.

Throughout the Big Lost River watershed, flow is related partly to climate but is most profoundly influenced by geomorphology. Even during years of average or high precipitation, streams are often dry most of the year due to the high hydraulic gradient to the ground water. Some tributaries are perennial in the upstream, more mountainous regions, but the valleys are covered with a fine-grained, unconsolidated alluvial substrate that is thousands of feet thick in some areas and rapidly absorbs huge volumes of flow. Therefore, many tributaries are not connected to the Big Lost River through surface water due to natural alluvial deposits. In addition, extensive irrigation withdrawals further draw down surface flow in many tributaries.

The AU containing the Big Lost River sinks, ID17040218SK002_06, is monitored for streamflow by four USGS stream gages:

- USGS 13132500—Big Lost River near Arco, Idaho
- USGS 13132520—Big Lost River below INL Diversion near Arco, Idaho
- USGS 13132535—Big Lost River at Lincoln Boulevard bridge near Atomic City, Idaho
- USGS 13132565—Big Lost River above Big Lost River sinks near Howe, Idaho

Graphs of the streamflow for these four stream gages show how sporadic the flow is within this AU, due to management of the river above this reach (Figure 3). The water rights accounting system maintained by the IDWR http://maps.idwr.idaho.gov/qWRAccounting/WRA_Select.aspx indicates that water is present in ID17040218SK002_06 only in portions of June and July in approximately 1 out of every 3 years. DEQ investigations, documented as photographs and maps in Appendix C, show that flow is too ephemeral to determine bankfull widths in this dry AU. Photographs 4–9 in Appendix C demonstrate that the east channel of the Big Lost River at the upstream extent of this AU is dry. The west channel at this point is dammed and managed as Munsey Ditch. Without a method to determine bankfull flow, or any evidence of when water may be present, pollutant analyses are not indicative of pollutant transport within the channel to determine near-stream impacts. Also, since the Big Lost River infiltrates the ground and enters the aquifer throughout this AU (i.e., the Big Lost River sinks), the river has no surface connection with the Snake River and can have no pollutant impacts to any other surface water.

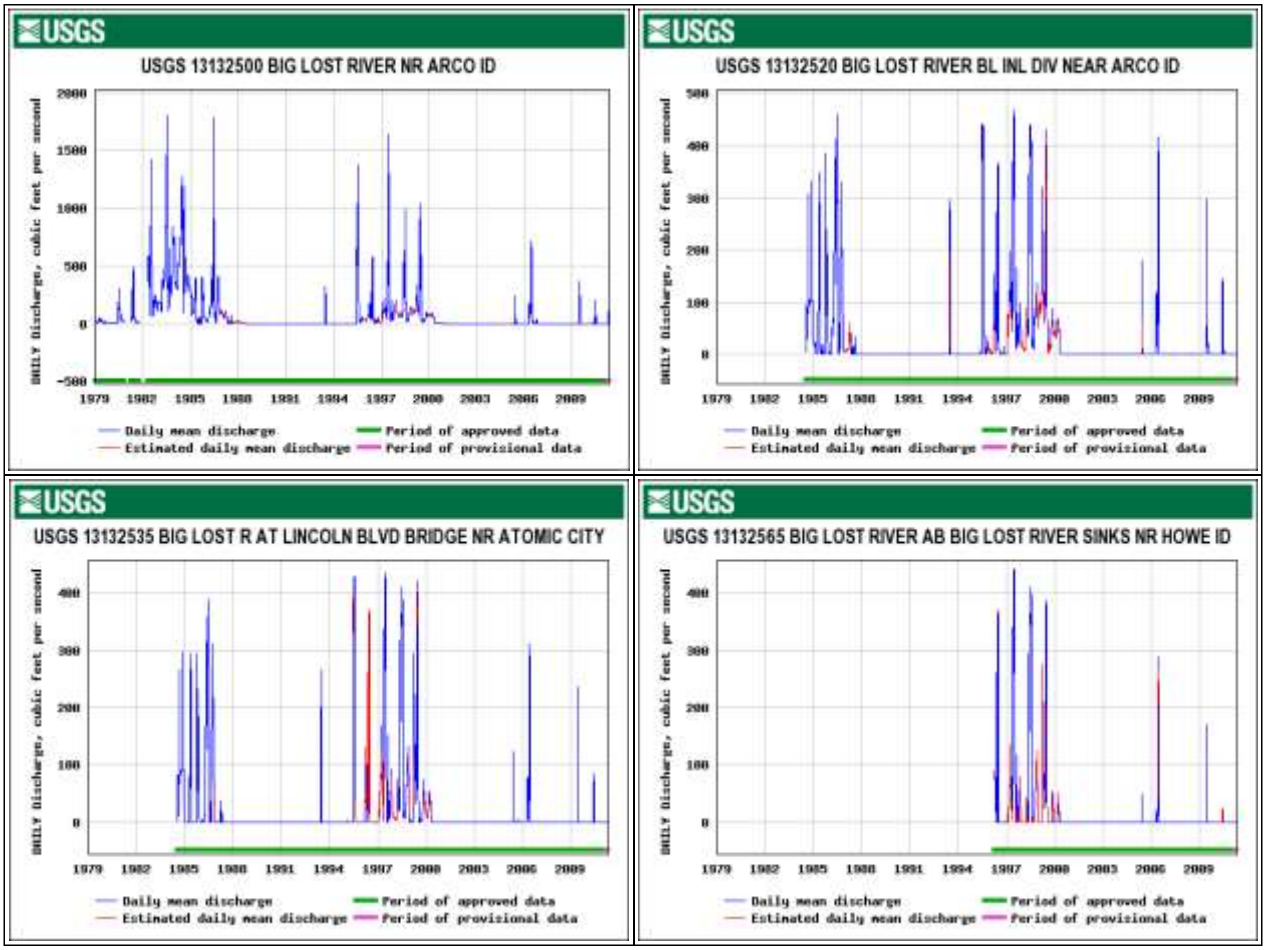

Figure 3. Streamflow at stream gages within the Big Lost River sinks assessment unit, ID17040218SK002_06

2.4.2. Water Quality Data

Table 7 provides sediment, nutrient, and bacteria data collected by DEQ and the Salmon-Challis National Forest since the *Big Lost River Watershed Subbasin Assessment and TMDL* (DEQ 2004) was published.

All temperature data and analyses are presented in section 5.3 of this document with the temperature TMDLs.

Table 7. Water quality data for additional assessment in the Big Lost River subbasin

Analyte	Location	Current Load	Date Collected	Collecting Agency	Exceeds/Meets Targets
Sediment					
Streambank erosion rate	Bear Creek	1 ton/year	7/21/2009	DEQ	Meets
	Big Lost River, Lower	206 tons/year	8/26/2009	DEQ	Exceeds
	Pinto Creek	1 ton/year	7/21/2009	DEQ	Meets
	Grant Creek	0.3 tons/year	7/21/2009	DEQ	Meets
	Big Lost River, Upper	9 tons/year	8/26/2009	DEQ	Exceeds
	Garden Creek	0.3 tons/year	7/22/2009	DEQ	Meets
Subsurface fine sediment	Big Lost River, Lower	35.0%	7/1/2009	DEQ	Exceeds
	Alder Creek	28.9%	2009	U.S. Forest Service, Salmon-Challis	Meets
	Antelope Creek 1R	23.8%	2004	U.S. Forest Service, Salmon-Challis	Meets
	Antelope Creek 2R	16.9%	2007		Meets
		30.9%	2008		Exceeds
		36.1%	2009		Exceeds
	Bear Creek	25.1%	2007	U.S. Forest Service, Salmon-Challis	Meets
	Cherry Creek	42.8%	2004	U.S. Forest Service, Salmon-Challis	Exceeds
		67.9%	2005		Exceeds
		43.6%	2006		Exceeds
		35.3%	2007		Exceeds
	East Fork Big Lost River 1R	29.0%	2004	U.S. Forest Service, Salmon-Challis	Meets
		16.0%	2005		Meets
	East Fork Big Lost River 2R	27.6%	2006		Meets
		24.8%	2007		Meets
	East Fork Big Lost River 3R	19.0%	2004		Meets
		15.9%	2005		Meets
		24.3%	2007		Meets
		27.2%	2008		Meets
	East Fork Navarre Creek	64.2%	2009	U.S. Forest Service, Salmon-Challis	Exceeds
	Muldoon Creek	24.3%	2004	U.S. Forest Service, Salmon-Challis	Meets
		6.6%	2005		Meets
	North Fork Big Lost River 1R	27.6%	2004	U.S. Forest Service, Salmon-Challis	Meets
		17.7%	2005		Meets
	North Fork Big Lost River 2R	33.7%	2004		Exceeds
		21.5%	2005		Meets
		30.1%	2006		Meets
		30.8%	2007		Exceeds
		32.3%	2008		Exceeds
	Pass Creek	21.1%	2004	U.S. Forest Service, Salmon-Challis	Meets
		6.4%	2006		Meets
		23.4%	2007		Meets
		26.0%	2008		Meets
	Star Hope Creek 0R	20.4%	2004	U.S. Forest Service, Salmon-Challis	Meets
	Star Hope Creek 1R	26.6%	2004		Meets
		10.6%	2005		Meets
		15.2%	2007		Meets
	Wildhorse Creek	27.6%	2004	U.S. Forest Service, Salmon-Challis	Meets
		24.4%	2005		Meets
		27.8%	2007		Meets

Analyte	Location	Current Load	Date Collected	Collecting Agency	Exceeds/Meets Targets
Nutrient					
Total Kjeldahl nitrogen	Twin Bridges Creek	<0.5 milligrams/liter	8/10/2009	DEQ	Meets
Total phosphorus	Twin Bridges Creek	0.04 milligrams/liter	8/10/2009	DEQ	Meets
Total Kjeldahl nitrogen	Big Lost River, Lower	<0.5 milligrams/liter	8/26/2009	DEQ	Meets
Total phosphorus	Big Lost River, Lower	0.02 milligrams/liter	8/26/2009	DEQ	Meets
Bacteria					
E. coli	Sage Creek	Geomean[a] = 720 MPN/100 milliliters; Single = 1413.6, 272.3, 648.8, 547.5, and 1413.6 MPN/100 milliliters	8/10/2009 through 9/2/2009	DEQ	Exceeds both geomean and single sample criteria for secondary contact recreation
	Wildhorse Creek	Geomean[a] = 12 MPN/100 milliliters; Single = 5.2, 19.9, 12.1, 11, and 19.9 MPN/100 milliliters	8/10/2009 through 9/2/2009	DEQ	Meets both geomean and single sample criteria for secondary contact recreation

[a] Geometric mean of 5 samples over a period of 30 days, collected 3–7 days apart

Sediment

The Salmon-Challis National Forest also collected percent bank stability for key streams in the Big Lost River subbasin. These data are presented in Appendix D. Since volume of eroding streambank was not measured, a load allocation cannot be calculated based on these data. However, these data show trends from 1995 through 2009 and provide a comparison to the 80% streambank stability target.

The DEQ collected streambank erosion rate data for AUs listed in Category 5 of the 2008 Integrated Report during base flow season in 2009. Of these AUs, only the reaches in the Big Lost River main stem require load allocations for sediment TMDLs. The current load of the site higher in the watershed at Bartlett Point is calculated at 9 tons per year using field data, and the load capacity is 4 tons per year, so the load allocation is to reduce excess sedimentation by 5 tons per year. The current load of the lower reach before entering Mackay Reservoir is 206 tons per year and the load capacity is 6 tons per year, so the load allocation is to reduce excess sedimentation by 200 tons per year. All other AUs investigated for in-stream erosion rates were found to be meeting their target.

The subsurface fine sediment measurements by the Salmon-Challis National Forest from 2004 through 2009 show that Antelope Creek, Cherry Creek, East Fork Navarre Creek, and North Fork Big Lost River are exceeding the 28% subsurface fine sediment target (Hall 1986; McNeil and Ahnell 1964; Reiser and White 1988) for salmonid spawning. However, the presumed beneficial use of these water bodies is not salmonid spawning but cold water aquatic life, and current analytical techniques are not able to determine the subsurface fine sediment target appropriate for these streams. The remaining 7 streams meet the target and fully support beneficial uses.

The subsurface fine sediment measurement made by DEQ in 2009 shows that Big Lost River exceeds the target for salmonid spawning at the lower reach just before the river enters Mackay Reservoir.

Nutrients

In AUs where nutrients were suspected as a pollutant—Pass Creek watershed, Twin Bridges Creek, and Big Lost River—DEQ investigated the watersheds and found only localized, isolated patches of algae near streambanks that did not constitute nuisance conditions according to Idaho's narrative water quality standard. Grab samples confirmed that in-stream water quality had low nitrogen and phosphorus concentrations (Appendix E). The Twin Bridges Creek AU will be moved to Category 2 of the next Integrated Report for "Waters of the State Meeting Some (Most) Standards." Big Lost River is receiving a current load allocation of 206 tons of sediment. The average literature value (Michigan DEQ 1999) of nutrients adsorbing to the sediment particles for 206 tons of silt loam, as exists in the river valley, is 330 pounds of phosphorus and 660 pounds of nitrogen. Therefore, when the load capacity for sediment is reached, the nutrient contribution to the stream will be reduced as well.

Bacteria

Bacteria was suspected as a pollutant in Sage Creek and Wildhorse Creek. Even though fecal coliform is identified as the pollutant for these creeks in Category 5 of the 2008 Integrated Report, the streams were monitored for *E. coli*. The bacterial indicator in Idaho's surface water standards was changed from fecal coliform to *E. coli* in 2006, so listings for fecal coliform are outdated and should be changed in the Integrated Report. DEQ collected 5 samples during baseflow conditions for Sage Creek and Wildhorse Creek and had them analyzed for *E. coli* content. Copies of the laboratory analyses are presented in Appendix E. Bacteria samples collected during baseflow ensures conservative results for bacteria since they are more concentrated at lower streamflows. Sage Creek violated both the single sample and the geomean sample (i.e., geometric mean of 5 samples) criteria and a load allocation is needed. Wildhorse Creek meets criteria for secondary contact recreation and will be moved to Category 2 of the next Integrated Report for "Waters of the State Meeting Some (Most) Standards."

A summary of the data analysis and conclusions for AUs included in Category 5 of the 2008 Integrated Report for impaired waters follows:

ID17040218SK002_06—Big Lost River, Spring Creek to Big Lost River sinks

- Listed for sediment, temperature, and cause unknown (suspected nutrient impairment).
- Investigation and literature show the channel is dry except for sporadic flow. Currently listed in Category 4c for other flow regime alterations. Stream is dewatered from irrigation withdrawals, ground water pumping, and unique hydrology.
- Delist from Category 5, "Impaired Waters," and leave in Category 4c, "Waters Impaired by Non-Pollutants," for low flow alterations.

ID17040218SK009_02—Pass Creek, source to mouth

- Listed for combined biota/habitat bioassessments.
- Data show that no nuisance algae were present and sediment target is met in Bear Creek, which is the only perennial stream in this AU.

- Delist from Category 5, "Impaired Waters," and list in Category 2, "Waters of the State Attaining Some (Most) Standards."

ID17040218SK013_05—Big Lost River, Jones Creek to Mackay Reservoir, and ID17040218SK015_05—Big Lost River, Thousand Springs Creek to Jones Creek

- Listed for sediment and cause unknown (suspected nutrient impairment).
- Data show that sediment target is exceeded and a load allocation is set in section 5.1 of this document. No nuisance algal growth or elevated in-stream nutrient content was observed, but progress toward sediment target will improve nutrient levels. Cause unknown determined to be temperature and a potential natural vegetation (PNV) TMDL was developed.
- Delist from Category 5, "Impaired Waters," and list in Category 4a, "TMDL Completed," for sediment and temperature, and delist nutrients as a suspected pollutant. Change cause unknown to temperature.

ID17040218SK016_02—Thousand Springs Creek, source to mouth

- Listed for temperature.
- Investigation of spring-fed wetlands of Thousand Springs Creek watershed using PNV shows temperature impairment of this AU. PNV temperature TMDL completed.
- Keep AU in Category 4a, "TMDL Completed," for sediment and list temperature as an additional pollutant.

ID17040218SK020_03—Willow Creek, source to mouth

- Listed for combined biota/habitat bioassessments.
- No water in the channel for two of three Beneficial Use Reconnaissance Program (BURP) sites and no condition rating in Assessment Database for any of the sites for lack of data. A July 21, 2009, investigation also showed very little water and an indistinct channel. Willow Creek enters the alluvial fan of the valley and appears to be intermittent even in years when water does flow.
- Delist from Category 5, "Impaired Waters," and list in Category 4c, "Waters Impaired by Non-Pollutants," for low flow alterations. Stream is dewatered from irrigation withdrawals, ground water pumping, and unique hydrology.

ID17040218SK022_02—Sage Creek, source to mouth

- Listed for fecal coliform.
- Samples for *E. coli* (rather than fecal coliform, in accordance with more recent water quality standard) during base flow conditions show exceedance of both single and geomean criteria for secondary contact recreation. Bacteria load allocation is set in section 5.2 of this document.
- Delist from Category 5, "Impaired Waters," and list in Category 4a, "TMDL Completed," for *E. coli*.

ID17040218SK024_02—Big Lost River, Burnt Creek to Thousand Springs Creek

- Listed for combined biota/habitat bioassessments.
- Streambank erosion inventory performed on Pinto Creek as representative of other first-order streams in AU for extrapolation of data and to inventory previous BURP

site. Data show that Pinto Creek is meeting sediment target and exhibits no evidence of other impairment.
- Delist from Category 5, "Impaired Waters," and list in Category 2, "Waters of the State Attaining Some (Most) Standards."

ID17040218SK024_03—Big Lost River, Burnt Creek to Thousand Springs Creek
- Listed for combined biota/habitat bioassessments.
- Streambank erosion inventory was performed on Grant Creek, the only water body in this AU. Data show that Grant Creek is meeting sediment target and exhibits no evidence of other impairment.
- Delist from Category 5, "Impaired Waters," and list in Category 2, "Waters of the State Attaining Some (Most) Standards."

ID17040218SK024_05—Big Lost River, Burnt Creek to Thousand Springs Creek
- Listed for sediment/siltation.
- Streambank erosion inventory was performed on Big Lost River. Data show that sediment target is exceeded and a load allocation is set in section 5.1 of this document.
- Delist from Category 5, "Impaired Waters," and list in Category 4a, "TMDL Completed."

ID17040218SK025_02—Big Lost River, Summit Creek to and including Burnt Creek
- Listed for combined biota/habitat bioassessments.
- Streambank erosion inventory was performed on Garden Creek as representative of other first-order streams in AU for extrapolation of data and to inventory previous BURP site. Data show that Garden Creek is meeting sediment target and exhibits no evidence of other impairment.
- Delist from Category 5, "Impaired Waters," and list in Category 2, "Waters of the State Attaining Some (Most) Standards."

ID17040218SK026_02—Bridge Creek, source to mouth
- Listed for cause unknown (nutrients suspected impairment).
- Investigation and monitoring was performed on Twin Bridges Creek as lowest-order stream in this AU (2^{nd} order) and at previous BURP sites. Sediment TMDL already approved by the U.S. Environmental Protection Agency (EPA) in 2004 for this segment, and data show no evidence of nutrient or other impairment.
- Keep AU in Category 4a, "TMDL Completed," for sediment and delist nutrients as a suspected pollutant.

ID17040218SK030_04—Wildhorse Creek, Fall Creek to mouth
- Listed for fecal coliform.
- Samples for *E. coli* (rather than fecal coliform, in accordance with more recent water quality standard) show no exceedance of either single or geomean criteria during baseflow conditions for secondary contact recreation. Sediment and temperature TMDLs were approved by EPA in 2004, and the Assessment Database describes BURP scores above the threshold for full support in 2003.

- Keep AU in Category 4a, "TMDL Completed," for sediment and temperature and delist fecal coliform as a pollutant.

2.4.3. Biological and Other Data

A detailed discussion of the assessments based on data collected through the Beneficial Use Reconnaissance Program is provided in the *Big Lost River Watershed Subbasin Assessment and TMDL* (DEQ 2004).

3. Subbasin Assessment—Pollutant Source Inventory

Pollution within the Big Lost River subbasin is related to land use and is primarily from excess sediment from streambank erosion. Sedimentation occurs naturally as a geologic process. Streams move sediment from source areas of high gradient and friable soil material through intermediate elevations and gradients to depositional reaches where sediment is incorporated into the floodplain or transported to larger waters and ultimately to the ocean. Land management practices have the potential to accelerate erosion or to alter depositional processes. Sediment in excess of a stream's ability to transport it becomes pollution. Excess sediment interferes with natural processes that aquatic life depend on and can result in increased instability of natural stream channels, further accelerating erosion.

3.1. Sources of Pollutants of Concern

The primary source of excess sediment, bacteria, and temperature in the Big Lost River subbasin is streambank erosion. The more bare and unstable streambanks become, the higher the volume of direct sediment delivery to the stream. Excess sediment in the substrate of a stream decreases natural hydrologic functioning and restricts habitat for aquatic wildlife. Unstable, eroding streambanks become denuded of vegetation. Higher vegetative cover holds streambanks together with root masses. But as streambanks erode and vegetative cover is lost, erosion is accelerated. Loss of vegetative cover increases solar radiation to the water surface. Without vegetative shading on the streambanks, the temperature of the stream increases and aquatic wildlife must seek out cooler refuges upstream or in alternate locations, which decreases available habitat. In areas with regular grazing, eroding streambanks can also deliver an excess bacteria load from domestic cattle.

The land use in the Sage Creek watershed is primarily grazing on U.S. Bureau of Land Management (BLM) land, so this may be the primary source of contamination. No confined animal feeding operations or failing human septic systems are known in the Sage Creek watershed.

3.1.1. Point Sources

Point sources are sources of pollutants from known discharge locations. A detailed discussion of the point sources in the Big Lost River subbasin is provided in section 5.3 of this document, included in the temperature TMDL analysis. Point sources are regulated through the National Pollutant Discharge Elimination System (NPDES) and permitted by EPA. The facilities operating under an NPDES permit in this subbasin include the following:

- Lost River Trout Hatchery, permit IDG130073, discharging to Warm Springs Creek
- Idaho Fish and Game Mackay Fish Hatchery, permit IDG130030, discharging ultimately to Warm Springs Creek
- City of Mackay Wastewater Treatment Plant (WWTP), permit ID023027, discharging to Swauger Slough near the Big Lost River

An inactive discharge permit for the INL has expired and the facilities are no longer operating or discharging. The hatcheries do not discharge to any impaired water bodies and the discharge from the city of Mackay is too small to provide any measurable pollutant load to the Big Lost River. Therefore, the point source discharges will not be included in a wasteload allocation for this TMDL. No potential impact on beneficial uses has been identified in any listed waters. This analysis supersedes any wasteload allocations assigned in the *Big Lost River Watershed Subbasin Assessment and TMDL* (DEQ 2004).

3.1.2. Nonpoint Sources

A detailed discussion of nonpoint sources is provided in the 2004 subbasin assessment and TMDL. In summary, nonpoint sources of pollution accumulate over a wide area and cannot be pin-pointed to any one source but are primarily driven by land use. Grazing in riparian areas is the most common source of instream eroaion and excess temperature in the Big Lost River watershed. Where grazing has been concentrated historically, streambanks have become more degraded. Recreational activities are also nonpoint sources of pollution where streambanks are becoming degraded by access and high use in some more-frequented areas of the Big Lost River.

3.1.3. Pollutant Transport

Sediment transport is a function of particle size and characteristics of the stream channel, such as morphological type, gradient, and width/depth ratio. Higher in the watershed, gradients are steeper and streamflow is more rapid, scouring out the fine sediments. Smaller particles transport farther in the channel before coming to rest in depositional areas of the stream. In the Big Lost River subbasin, alluvial deposits are extensive in the lower valleys of the tributaries. These alluvial sediments are fine-grained and loosely consolidated, creating a positive hydraulic gradient to the ground water. As streambanks become impacted further upstream of this natural depositional area and erosion rates increase, the tributaries become more full of fine sediments at the lower reaches and sink into the alluvium higher upstream than they would have in the past.

In the Big Lost River subbasin, bacteria is more of a regional concern than sediment, as it is limited to localized impacts of overgrazing.

Surface water temperatures are affected most strongly by channel morphology and streamside vegetation, which provide shade. The PNV method determines the relationship between existing shade and measured shade and how these factors are affected by stream width. This method is described in full in section 5.3 where in-stream water quality targets are determined for temperature TMDLs in this watershed.

4. Status of Water Quality Improvements

Many watershed improvement projects with diverse funding sources are ongoing or coming under contract in the Big Lost River subbasin. The following East Fork Big Lost River riparian habitat and stream function restoration projects have been funded in part by §319 grants:

- 750 willows planted along 3 miles of streambank in the upper watershed where grazing is being withheld for 3 years. Monitoring in fall 2008 and fall 2009 demonstrated 100% survival of plantings.
- In the lower watershed, 1.75 miles of streambank were fenced to exclude livestock access, and grazing is being withheld for 10 years.
- In fall 2010, a total of 137 failed drop structures were pulled from the upper part of the watershed to allow stream function restoration.

Fish passage is being restored for diversions in the Big Lost River and Antelope Creek. Fish passage structures have been installed with not only §319 funds, but also private match, Idaho Department of Fish and Game (IDFG), Trout Unlimited, U.S. Forest Service (USFS), Natural Resources Conservation Service (NRCS), BLM, and applicable irrigation districts financing.

Three extensive habitat restoration and improvement projects are happening along Warm Springs Creek that are privately funded. Width/depth ratios, natural sinuosity, and streambank angles are being restored over approximately 3.75 stream miles.

Further projects administered by the NRCS demonstrate tremendous progress toward watershed remediation. Of the privately-owned acreage in the Big Lost River subbasin, most of the known agricultural operations and every known animal feeding operation are enrolled in a conservation program, including the following NRCS programs:

- 58 farms in the Conservation Security Program
- 50 farms under Environmental Quality Incentives Program contracts
- 30 farms with Conservation Reserve Program acreage

Additionally, many of these farms are also enrolled in EPA's Integrated Pest Management Program. All of these voluntary programs provide technical and financial assistance to conserve, protect, and improve natural resources while promoting agricultural production and environmental quality as compatible goals. Sensitive riparian areas are especially targeted for implementing best management practices (BMPs) under these programs.

5. Total Maximum Daily Load(s)

A TMDL prescribes an upper limit (or *load capacity*) on discharge of a pollutant from all sources to ensure water quality standards are met. This load capacity can be represented by the following equation:

LC = MOS + NB + LA + WLA

Where:

LC = load capacity

MOS = margin of safety. Because of uncertainties regarding quantification of loads and the relation of specific loads to attainment of water quality standards, 40 CFR Part 130 requires a MOS, which is effectively a reduction in the load that is available for allocation to pollutant sources.

NB = natural background. When present, NB may be considered part of load allocation (LA), but it is often broken out separately because it represents a part of the load not subject to control. NB is also effectively a reduction in the load capacity available for allocation to human-made pollutant sources.

LA = the load allocation for all nonpoint sources

WLA = the wasteload allocation for all point sources

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

5.1. Sediment TMDLs

In order to restore full support of beneficial uses that may have been impaired by excess sediment, TMDL load allocations were determined using the best available data and field verification. The Salmon-Challis National Forest collected data in the Big Lost River subbasin, including subsurface fine sediment and streambank stability data, from 1995 through 2009. These data are provided in Appendix D. Also, DEQ collected additional subsurface fine sediment and streambank stability data in 2009. Maps, photographs, and field notes documenting this work are provided in Appendix C.

5.1.1. In-stream Water Quality Targets

Sediment load capacities necessary to meet the narrative criterion for sediment and to fully support beneficial uses are determined by streambank erosion rates. The DEQ has determined that excess erosion is more significant in this subbasin from unstable streambanks than from upland erosion.

5.1.1.1. Design Conditions

A detailed discussion of design conditions for the Big Lost River subbasin is provided in the 2004 subbasin assessment and TMDL (DEQ 2004). In summary, excess streambank erosion generally occurs during spring runoff when bankfull flow occurs. Therefore, the stability characteristics of streambanks are measured at bankfull widths to determine rate of excess erosion above natural background during peak flows.

5.1.1.2. Target Selection

In the original Big Lost River TMDL approved by EPA in 2004, in-stream sediment targets were established at 80% streambank stability and for subsurface fine sediment (particles <6.35 mm) to be less than 28% of the total streambed particle volume (DEQ 2004). Methods for determining streambank stability from field observations are based on modified NRCS methods, Rosgen stream classification systems, and other applicable literature (Rosgen 1996; Lohrey 1989; Pfankuch 1975). The 28% subsurface fine sediment target is based on research of salmonid spawning success as it relates to particle size of spawning bed materials (Hall 1986; McNeil and Ahnell 1964; Reiser and White 1988). The methods DEQ uses for determining bank stability are thoroughly documented in Appendix G of the 2004 Big Lost River subbasin assessment and TMDL and summarized in this document in Appendix F.

5.1.1.3. Monitoring Points

Idaho DEQ monitors streambank stability by conducting streambank erosion inventories. When bioassessments indicate impairment and sediment is suspected as a pollutant, DEQ staff identify homogenous reaches of AUs to monitor for streambank stability by examining existing data and aerial photos. In the field, DEQ staff measure the length of the streambanks that are completely stable and the length, bank height, and condition of streambanks that are eroding. Recession rates (feet per year) of the eroding streambanks are determined in the field according to their condition. The percentage of stable/eroding streambanks are extrapolated to similar stream types in the AU. The bank erosion volume is then calculated using the following equation:

$$E = [A_E \times R_{LR} \times \_{}_{B}]/2{,}000 \text{ (lb/ton)}$$

where:

E = bank erosion over sampled stream reach (tons/year/sample reach)
A_E = eroding area (square feet)
R_{LR} = lateral recession rate (feet per year)
$\_{}_{B}$ = bulk density of bank material (pounds per cubic feet)

This calculation for both the eroding and stable streambanks determines the load capacity at 80% streambank stability and the current load of the eroding areas. The load capacity is the natural, minimally erosive state one would expect of a covered, stable streambank. The current load is the tons of sediment per year calculated for the eroding streambanks at their current condition. The difference between the current load and the load capacity is the load allocation. The load allocation is the amount of sediment that needs to be reduced to go from the current condition to the natural background load capacity of the stream.

The DEQ conducted streambank erosion inventories at the locations indicated in Figure 4 based on AUs that were listed in Category 5 of the 2008 Integrated Report for sediment. The locations in Bear Creek, Pinto Creek, Grant Creek, and Garden Creek were found to be meeting their sediment water quality targets.

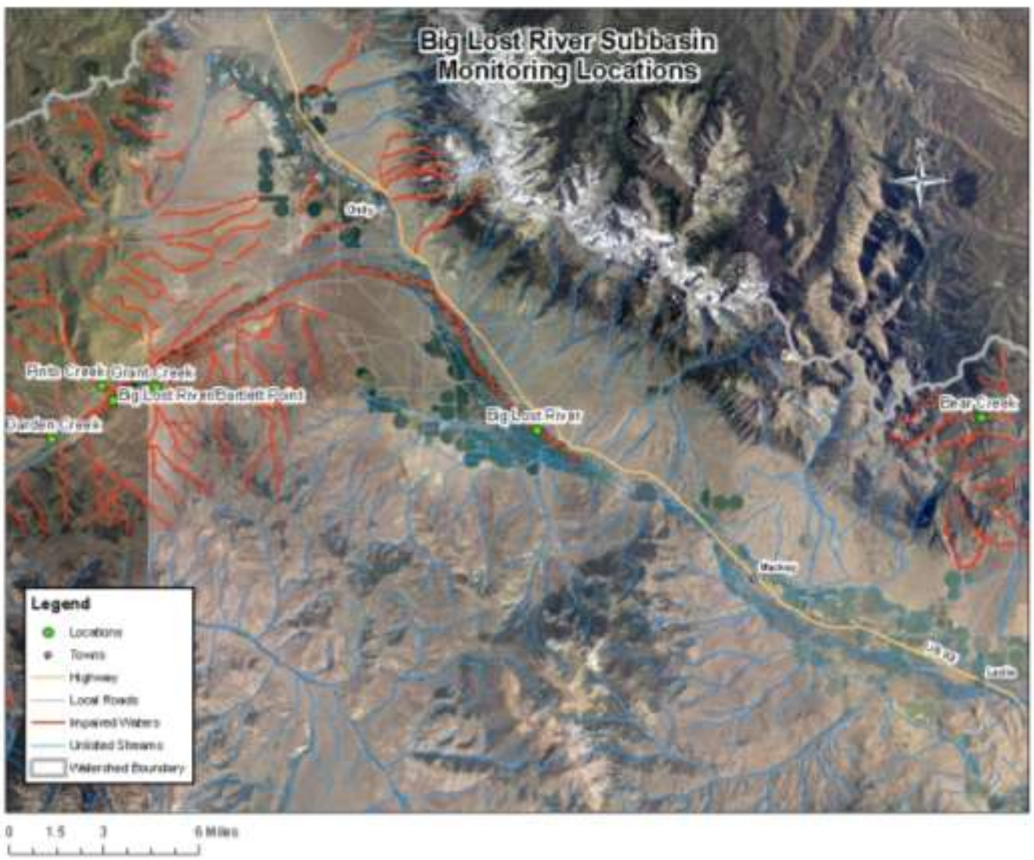

Figure 4. Locations monitored for sediment impairment in the Big Lost River subbasin

The two locations on the Big Lost River showed impairment from sediment according to calculations from the field measurements. The streambank erosion inventory data analyzed in spreadsheets are shown at the end of Appendix F. The locations listed in Table 8 should be monitored as watershed improvement projects proceed to determine if streambanks are becoming more stable and salmonid spawning habitat is improving.

Table 8. Locations to monitor for sediment trends in Big Lost River

Assessment Unit	Streambank Erosion Inventory Location	Location
ID17040218SK024_05	Big Lost River above Bartlett Point Road Bridge	N 43.99678º W.-114.02176º
ID17040218SK013_05 and ID17040218SK015_05	Big Lost River above Mackay Reservoir—also McNeil core location	N 43.98299º W.-113.75166º

5.1.2. Load Capacity

In summary of the complete discussion of sediment load capacity provided in the Big Lost River subbasin assessment and TMDL (DEQ 2004), the sediment load capacity is the sediment loading rate at which beneficial uses are supported. The assumption is that this rate will be achieved at 80% streambank stability, but monitoring will determine the individual load capacity for each impaired reach. Progress toward the load capacity will be made by maintenance of trails and roads, land management, and improvement of riparian vegetative cover and stream channel condition. The load capacity is that level of sediment delivered that will not impair beneficial uses.

Although the load capacity is calculated in this TMDL in terms of the surrogate sediment target of 80% streambank stability, the proportion of subsurface fine sediment is another indicator of meeting the sediment load capacity. Appendix F provides literature references for the subsurface fine sediment target of 28% for supporting salmonid spawning. Field methods for measuring subsurface fine sediment and the sampling results are also given in Appendix F. DEQ measured 35% fine sediment in the river substrate in the lower Big Lost River AU (ID17040218SK013_05).

The calculated target load capacity for the two Big Lost River reaches, which is the natural background erosion rate, equals 4 tons per year in the reach upstream of Bartlett Point and 6 tons per year in the reach just upstream of Mackay Reservoir. These calculations are provided in Appendix F. The load capacity is the sediment delivery rate that would be expected when the streambanks no longer exhibit excess erosion rates and become stable.

5.1.3. Estimates of Existing Pollutant Loads

Federal 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(g)). The volume of eroding streambank at bankfull condition was calculated by measuring eroding bank height and length and evaluating the bank condition to estimate lateral recession rate during periods of high streamflow, taking erodibility of the soil type into consideration. These results are shown in Appendix F. As a result of these survey results and calculations, the current loads estimated for Big Lost River are shown in Table 9.

Table 9. Current sediment loads from nonpoint sources in Big Lost River

Load Type	Location	Current Load	Estimation Method
Annual sediment loading rate	Big Lost River above Bartlett Point Road Bridge (ID17040218SK024_05)	9 tons per year	Observed erosion rate calculated on target of 80% streambank stability
Annual sediment loading rate	Big Lost River above Mackay Reservoir (ID17040218SK013_05 and ID17040218SK015_05)	206 tons per year	Observed erosion rate calculated on target of 80% streambank stability

Dividing the existing pollutant load into these two reaches is appropriate since the reach between Bartlett Road and Big Lost River Valley is essentially dewatered by irrigation withdrawals for most of the growing season, giving no hydrologic connection to these two reaches.

5.1.4. Load Allocations

Sediment load allocations are estimated targets in the process of improving water quality until beneficial uses of cold water aquatic life and salmonid spawning are fully supported. Table 10 shows the difference between the current sediment load and the load capacity of the impaired AUs. This difference equals the load allocation.

Table 10. Sediment load allocations for the Big Lost River

Location/Assessment Unit	Current Load	Load Capacity	Load Allocation	Percent Reduction Necessary
Big Lost River above Bartlett Point Road Bridge/ID17040218SK024_05 (Upper Big Lost River)	9 tons per year	4 tons per year	5 tons per year	56%
Big Lost River above Mackay Reservoir/ID17040218SK013_05 and ID17040218SK015_05 (Lower Big Lost River)	206 tons per year	6 tons per year	200 tons per year	97%

The load capacity is the natural, minimally erosive state one would expect of a covered, stable streambank. The load capacity is the natural background condition, currently targeted to be 80% stable streambanks. The current load is the tons of sediment per year calculated for the eroding streambanks at their current condition based on field measurements. The difference between the current load and the load capacity is the load allocation. The load allocation is the amount of sediment that needs to be reduced to move from the current condition to the natural background load capacity of the stream. The above load allocations show that the upper reach of Big Lost River requires a 56% sediment reduction and the lower reaches require a 97% sediment reduction to achieve the load capacity of the river.

Peak streamflows of the two sediment-impaired reaches occur in spring during snowmelt. The largest proportion of sediment is eroded from the streambanks during spring high flow. The daily sediment load is allocated based on flow. Flow duration intervals summarize the cumulative frequency of historic flow data over the period of record for which streamflow data have been recorded. At the upper Big Lost River reach, there is a real-time USGS stream gage (USGS 13120500) with 90 years of daily streamflow data. The EPA describes an approach for using load duration curves in the development of TMDLs and specifies calculating the cumulative frequency distribution using streamflow records (EPA 2007). Following this guidance, the zero to 10th percentile streamflows are designated as high flows, 10th to 40th percentiles as moist conditions, 40th to 60th as mid-range flows, 60th to 90th percentiles as dry conditions, and 90th to 100th percentile streamflows represent low flows. This approach places the midpoints of the moist, mid-range, and dry zones at the 25th, 50th, and 75th quartiles, respectively (Figure 5).

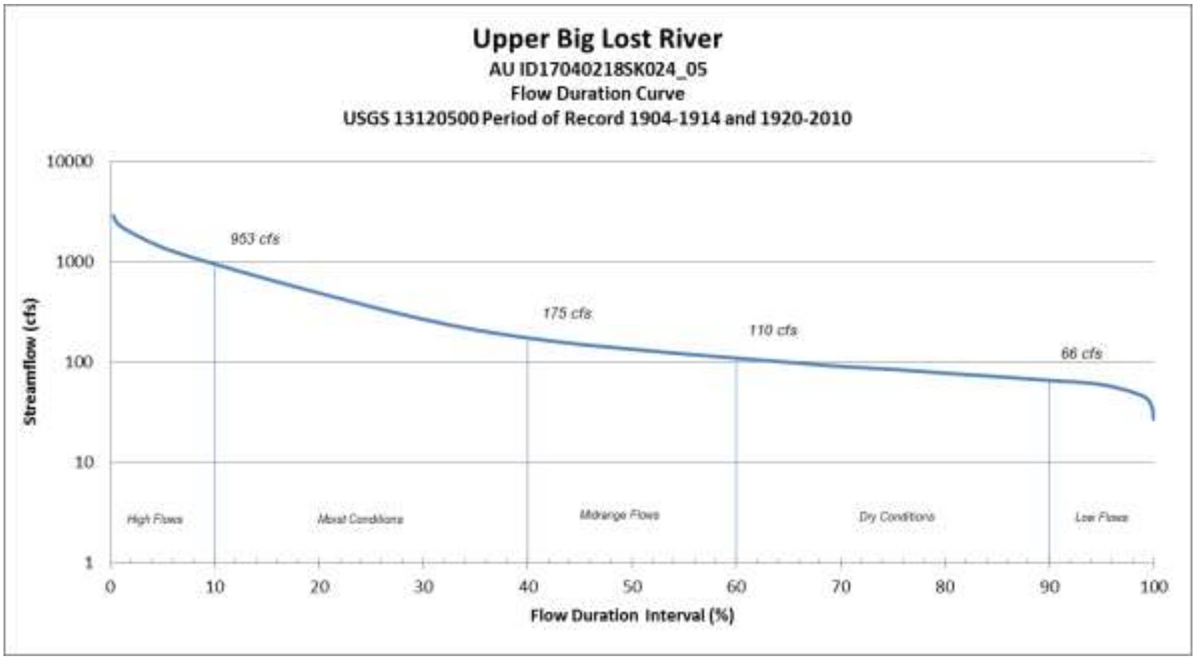

Figure 5. Flow duration curve for the upper Big Lost River at USGS 13120500

The flow duration intervals of all of the daily streamflow data of the period of record occur as follows:

- High flows (0 to 10th percentile) occur at 953 to 4340 cfs.
- Moist conditions (10th to 40th percentile) occur at 175 to 952 cfs.
- Mid-range flows (40th to 60th percentile) occur at 110 to 174 cfs.
- Dry conditions (60th to 90th percentile) occur at 66 to 109 cfs.
- Low flows (90th to 100th percentile) occur at 0.061 to 65 cfs.

To find the average yearly dates those flows exist in the subbasin, one can examine the USGS daily water statistics that show the mean of daily mean values over the period of record of data collection. For USGS gage 13120500, the daily water statistics are shown in Table 11.

Table 11. Mean of daily mean streamflows for the upper Big Lost River at USGS gage 13120500

USGS Daily Water Statistics, 13120500, AU ID17040218SK024_05												
Day of	Mean of daily mean values for each day for period of record in cfs (Calculation Period 1903-10-01 -> 2010-09-30)											
month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	83	77	74	90	340	1,160	933	312	150	127	117	92
2	84	75	74	91	358	1,170	919	299	148	129	116	91
3	84	77	74	94	385	1,200	893	291	145	131	115	91
4	83	76	74	97	416	1,230	868	284	143	130	114	88
5	83	76	75	101	435	1,290	830	273	144	130	113	87
6	81	75	76	106	460	1,310	805	259	153	129	112	88
7	82	76	76	110	490	1,320	781	248	155	129	113	88
8	82	75	76	114	510	1,320	754	240	152	130	114	86
9	82	76	76	120	532	1,290	732	233	152	128	111	86
10	83	76	75	125	558	1,270	717	231	151	129	110	88
11	83	76	75	130	578	1,260	684	223	149	129	109	88
12	81	77	76	138	607	1,280	649	224	150	129	112	87
13	81	77	78	145	636	1,280	623	218	146	127	110	87
14	82	77	78	156	667	1,280	599	212	145	126	107	87
15	82	77	77	161	716	1,280	569	205	145	127	105	86
16	84	77	78	167	752	1,260	533	200	140	127	108	85
17	84	77	80	180	802	1,230	509	194	139	125	106	84
18	83	76	81	191	840	1,200	488	190	141	123	105	84
19	82	76	80	201	883	1,190	467	189	139	122	104	84
20	82	76	82	215	921	1,180	454	191	140	122	102	85
21	81	75	83	226	945	1,190	437	186	139	122	99	84
22	80	76	83	244	951	1,180	425	184	136	121	97	84
23	80	76	84	255	980	1,140	411	182	134	120	96	91
24	80	76	84	263	1,040	1,100	403	181	132	120	97	87
25	80	76	87	264	1,080	1,080	393	175	130	119	97	86
26	79	75	89	269	1,110	1,080	376	171	130	120	95	85
27	79	75	90	275	1,140	1,060	358	166	129	119	94	84
28	78	75	87	289	1,160	1,020	350	160	128	118	93	84
29	77	79	88	302	1,180	978	349	157	129	119	92	83
30	78		90	317	1,180	951	333	155	128	118	92	84
31	77		92		1,160		317	154		117		83
Monthly Average	81	76	80	181	768	1193	579	212	141	125	105	86

High Flows 0 to 10%	953 cfs to 4340	High flows are from May 23rd through June 29th
Moist Conditions 10 to 40%	175 cfs to 952 cfs	Moist Conditions are from June 30th through August 25th and from April 17th through May 22
Mid-range flows 40 to 60%	110 to 174 cfs	Mid-range flows are from August 26th through November 13th and April 7th through April 16th
Dry conditions 60 to 90%	66 cfs to 109 cfs	Dry conditions are from November 14th through April 6th
Low Flows 90 to 100%	0.061 to 65 cfs	Low Flows do not occur in an average year

For the flows indicated in the flow duration curve, DEQ highlighted the daily water statistics for each level of flow for easier readability. Bankfull flows in the upper Big Lost River (AU ID17040218SK024_05) occur only during high flows. Therefore, 80% of the sediment load delivery occurs during high flows, 15% occurs during moist conditions, and 5% occurs during flow regimes that the EPA 2007 guidance designated as mid-range, dry, and low flows. The annual load allocation for this AU is 5 tons per year. Table 12 shows the flow-weighted daily load allocations with proportionality assumptions based on flow season.

Therefore, for a typical year, the following are the daily sediment load allocations for the upper Big Lost River:

- 210.5 pounds per day May 23–June 29
- 16.3 pounds per day April 17–May 22 and June 30–August 25
- 2.1 pounds per day August 26–April 16

Table 12. Daily sediment load allocation for the upper Big Lost River, assessment unit ID17040218SK024_05

Upper Big Lost River, AU ID17040218SK024_05					
Total annual load allocation is 5 tons per year Flow-weighted Daily Load Allocations With Proportionality Assumptions Based on Flow Season					
	80% Load delivery	15% Load delivery	5% Load delivery		
Seasonal streamflow	High Flows	Moist Conditions	Mid-range Flows	Dry Conditions	Low Flows
Seasonal load allocation	4 ton/year reduction	0.75 ton/year reduction	0.25 ton/year reduction		
Average dates from USGS Daily Water Statistics	5/23 through 6/29	6/30 through 8/25 4/17 through 5/22	8/26 through 11/13 4/7 through 4/16	11/14 through 4/6	Does not occur on average
Days in flow season	38 days	92 days	235 days		
Daily load allocation	210.5 lbs/day reduction	16.3 lbs/day reduction	2.1 lbs/day reduction		

The lower Big Lost River reach with a sediment load allocation does not have a real-time stream gage, but USGS gage 13123500 recorded daily streamflow from 1919 to 1960. The flow duration curve for the lower Big Lost River is shown in Figure 6.

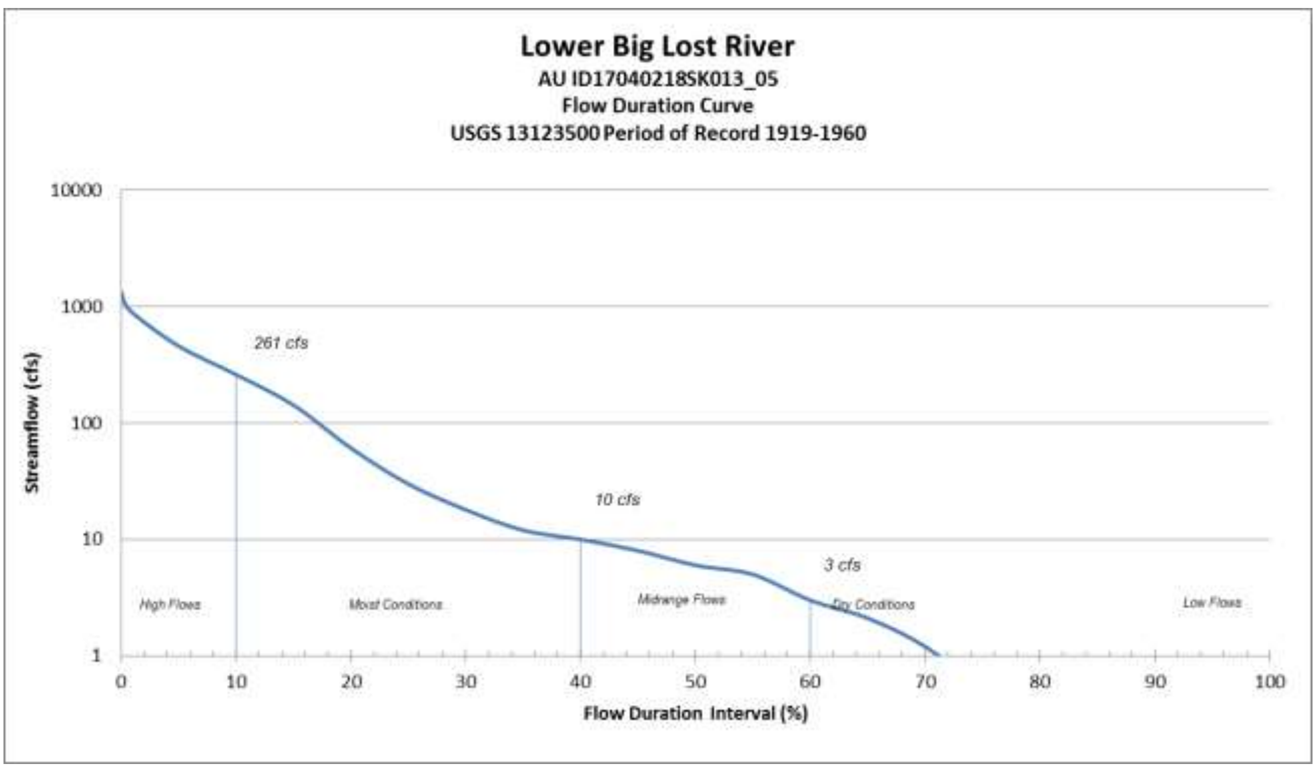

Figure 6. Flow duration curve for lower Big Lost River at USGS gage 13123500

The following are the flow duration intervals of all of the daily streamflow data of the period of record:

- High flows (0 to 10th percentile) occur at 261 to 1340 cfs.

- Moist conditions (10th to 40th percentile) occur at 10 to 260 cfs.
- Mid-range flows (40th to 60th percentile) occur at 3 to 9 cfs.
- Dry conditions (60th to 90th percentile) occur at 0 to 2 cfs.
- Low flows (90th to 100th percentile) do not occur.

To find the average yearly dates those flows exist in the subbasin, one can examine the USGS daily water statistics that show the mean of daily mean values over the period of record of data collection. For USGS gage 13123500, the daily water statistics are shown in Table 13.

Table 13. Mean of daily mean streamflows for the lower Big Lost River at USGS gage 13123500

USGS Daily Water Statistics, 13123500, AU ID17040218SK013_05												
Day of month	Mean of daily mean values for each day for 39 - 40 years of record in cfs (Calculation Period 1918-10-01 -> 1960-09-30)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1	3.5	2.6	2.5	2.4	33	376	340	75	17	9.9	10	6.2
2	3.4	2.6	2.5	2.4	36	363	326	72	16	9.7	10	6.1
3	3.5	2.6	2.5	2.4	42	364	320	67	16	9.6	10	6.2
4	3.4	2.7	2.4	2.4	57	369	308	65	15	9.9	9.9	6.1
5	3.4	2.7	2.4	2.4	65	377	289	61	15	9.9	9.7	5.9
6	3.3	2.6	2.4	2.3	67	399	276	55	14	10	9.6	5.9
7	3.3	2.6	2.4	2.4	74	431	263	52	14	10	9.5	5.6
8	3.3	2.5	2.3	2.4	83	448	249	49	13	10	9.5	5.5
9	3.2	2.6	2.3	2.4	86	456	239	47	13	10	9.5	5.4
10	3.2	2.6	2.4	2.5	89	446	229	45	12	10	9.4	5.4
11	3.2	2.6	2.3	3.1	95	441	224	43	12	10	9.1	5.3
12	3.2	2.5	2.3	4.2	106	445	215	40	12	10	8.8	5.2
13	3.1	2.5	2.4	6.5	115	453	202	38	12	10	8.6	5.1
14	3.1	2.5	2.4	8.6	124	456	191	35	11	10	8.4	5.1
15	3.1	2.5	2.4	7.9	134	454	182	34	11	10	8.2	5
16	3	2.5	2.4	7.2	144	446	174	32	12	10	8	4.7
17	2.9	2.4	2.4	8.4	158	431	164	30	11	10	7.9	4.7
18	2.9	2.4	2.4	11	178	421	153	28	11	10	7.9	4.7
19	2.9	2.4	2.4	13	196	414	146	26	11	10	7.6	4.6
20	2.9	2.4	2.4	14	215	417	142	25	11	10	7.5	4.6
21	2.8	2.3	2.3	17	230	413	136	25	11	10	7.3	4.6
22	2.8	2.4	2.3	19	244	422	131	24	10	10	7.1	4.5
23	2.8	2.4	2.4	20	258	419	126	23	10	10	6.9	4.5
24	2.8	2.4	2.4	20	276	401	118	23	10	10	6.8	4.3
25	2.8	2.4	2.4	21	302	395	113	22	10	10	6.7	4.2
26	2.8	2.4	2.6	24	334	388	109	22	10	10	6.6	4.2
27	2.7	2.4	2.5	28	358	389	99	21	10	10	6.5	4.1
28	2.7	2.5	2.4	30	374	362	93	20	9.8	10	6.5	4.1
29	2.7	2.6	2.4	32	390	344	89	19	9.9	10	6.3	4.1
30	2.7		2.5	32	389	343	83	18	9.8	10	6.3	4.1
31	2.6		2.5		383		79	18		10		4

High Flows 0 to 10%	261 cfs to 1340	High flows are from May 24th through July 7th
Moist Conditions 10 to 40%	10 cfs to 261 cfs	Moist Conditions are from April 18th through May 23rd and from July 8th through September 21st
Mid-range flows 40 to 60%	3 to 10 cfs	Mid-range flows are from September 22nd through January 16th and April 11th through April 17th
Dry conditions 60 to 90%	0 to 3 cfs	Dry conditions are from January 17th through April 10th
Low Flows 90 to 100%	0	

For the flows indicated in the flow duration curve, DEQ highlighted the daily water statistics for each flow level for easier readability. Bankfull flows in the lower Big Lost River (AU ID17040218SK013_05) occur only during high flows. Therefore, 80% of the sediment load delivery occurs during high flows, 15% occurs during moist conditions, and 5% occurs during flow regimes designated as mid-range and dry (EPA 2007). The annual load allocation for this AU is 200 tons per year. Table 14 shows the flow-weighted daily load allocations with proportionality assumptions based on flow season.

Therefore, for a typical year, the daily sediment load allocations for the lower Big Lost River are as follows:

- 3.6 tons per day May 24–July 7

- 536 pounds per day April 18–May 23 and July 8–September 21
- 96 pounds per day September 22–April 17

Table 14. Daily sediment load allocation for lower Big Lost River, assessment unit ID17040218SK013_05

Lower Big Lost River, AU ID17040218SK013_05					
Total annual load allocation is 200 tons per year Flow-weighted Daily Load Allocations With Proportionality Assumptions Based on Flow Season					
	80% Load delivery	15% Load delivery	5% Load delivery		
Seasonal streamflow averages	High Flows 261 to 1340 cfs	Moist Conditions 10 to 261 cfs	Mid-range Flows 3 to 10 cfs	Dry Conditions 0 to 3cfs	Low Flows 0
Seasonal load allocation	160 ton/year reduction	30 ton/year reduction	10 ton/year reduction		
Average dates from USGS Daily Water Statistics	5/24 through 7/7	4/18 through 5/23 7/8 through 9/21	9/22 through 1/16 4/11 through 4/17	1/7 through 4/10	
Days in flow season	45 days	112 days	208 days		
Daily load allocation	3.6 tons/day reduction	536 lbs/day reduction	96 lbs/day reduction		

Although the sediment load allocations are expressed in terms of daily reductions, progress toward meeting the natural background load capacity is measured through the surrogate targets of 80% streambank stability and 28% subsurface fine sediment.

5.1.4.1. Wasteload Allocation

The facilities operating under an NPDES permit in this subbasin do not discharge effluent to any listed portion of the Big Lost River. The effluent from the City of Mackay discharges to Swauger Slough near the Big Lost River with no measureable pollutant load to the Big Lost River. Therefore, the point source discharges will not be included in a wasteload allocation for this TMDL. No potential impact on beneficial uses has been identified in any listed waters. This analysis supersedes any wasteload allocations assigned in the *Big Lost River Watershed Subbasin Assessment and TMDL* (DEQ 2004).

5.1.4.2. Margin of Safety

Conservative assumptions used to develop existing sediment loads ensure a margin of safety. These conservative assumptions include the following:

- Evaluating desired bank erosion rates as natural background conditions
- Using a target of subsurface fine particles based on literature values that support fry survival providing for a stable salmonid population

5.1.4.3. Seasonal Variation

The field method for determining in-stream sediment impairment by measuring streambank erosion takes seasonal variation into account by deriving sediment load capacity from bankfull conditions. Erosion rates are based on runoff events and peak and base streamflow conditions. Therefore, bank condition at bankfull condition is measured and evaluated in the field to calculate current rates of erosion and sediment delivery. In addition, the daily sediment load allocations are flow-weighted values based on flow season.

5.1.4.4. Reasonable Assurance

After TMDL acceptance by DEQ, EPA, and stakeholders, the next step of the Idaho water body management process is implementation. Idaho's water quality standards identify designated agencies that are responsible for evaluating and modifying BMPs to protect impaired water bodies. Idaho DEQ is committed to developing implementation plans within 18 months of EPA approval of a TMDL document. The applicable watershed advisory group (WAG), DEQ, and applicable agencies will develop implementation plans and DEQ will incorporate them into the state's water quality management plan.

Ongoing assessment of the support status of the water bodies with TMDLs will be reported in a 5-year review of the TMDL. If full support status has not been obtained, further implementation will be necessary and further reassessment performed until full support status is reached. If full support status is reached, then the requirements of the TMDL will be considered complete.

5.1.4.5. Natural Background

As described in the 2004 Big Lost River TMDL, natural background loading rates are assumed to be the natural sediment load capacity of 80% or greater streambank stability and 28% or less subsurface fine sediment. Therefore, natural background is accounted for in the load capacity calculations (DEQ 2004).

5.2. Bacteria TMDL

Two AUs, Sage Creek and Wildhorse Creek, are listed in Category 5 of the Integrated Report for fecal coliform impairment. However, Idaho's current water quality standards list criteria for *Escherichia coliform* bacteria (*E. coli*). Historically, Idaho monitored for fecal coliform, but the standard changed in 2006 to *E. coli*, a common intestinal bacteria found in warm-blooded animals and therefore considered more directly pathogenic to humans. The Idaho water quality standards have numeric criteria for *E. coli* for both primary and secondary contact recreation. Sage Creek and Wildhorse Creek are undesignated water bodies; so they are afforded protection for cold water aquatic life and primary or secondary contact recreation according to IDAPA 58.01.02.101.01.a.

After a review of the listed streams, DEQ has determined that likely recreational activities consist of secondary contact recreation. As a result, the water quality bacteria targets will be those water quality criteria for secondary contact recreation. Thus, the number of colonies of *E. coli* shall not exceed either the single instantaneous measure of 576 colonies/100 milliliter (mL) or the geometric mean of 126 colonies/100 mL for 5 samples collected in a 30-day period every 3 to 7 days. After sampling, DEQ determined that Sage Creek's geometric mean measurement of 720 colonies/100 mL exceeded this target, and Wildhorse Creek's measurement of 12 colonies/100 mL meets the target. Therefore, a bacteria TMDL was developed for Sage Creek, but Wildhorse Creek should be moved to Category 2 of the Integrated Report. Copies of the laboratory analyses are provided in Appendix E.

An essential assumption in this method of load calculations is that the water quality standard is the load capacity of a system. By using a percentage of the target or "load capacity," the calculations become unitless percentages, which overcome the inherent problem of calculating loads from a parameter that does not lend itself to load calculations. Allocations can then be made from this percentage of the load according to land use in the watershed during critical time periods (May–October). Grazing accounts for 80% of the load allocation. The remaining 20% will be distributed between the margin of safety (MOS) (10%) and the wildlife (natural background) component (10%).

5.2.1. In-stream Water Quality Targets

In-stream water quality targets for the Sage Creek AU were set from the Idaho water quality standards. The water quality standards relate beneficial use impairment to a numeric standard (e.g., "...Waters designated for recreation are not to contain E. coli bacteria…" IDAPA 58.01.02.251.01). The target developed for bacteria impairment is the *E. coli* water quality standard.

5.2.1.1. Design Conditions

Bacteria impact the creek throughout the summer months into the fall. The critical period for the recreation beneficial use is May to October. The highest concentrations of bacteria typically occur later in the season due to lower water flow. With no known sources of human-caused bacteria loading, it is assumed that the observed *E. coli* levels (Table 7) are caused by a combination of wildlife, waterfowl, and livestock. To be protective of the beneficial use, the design conditions should fall within the critical period when the bacteria contamination is most likely to occur. In Sage Creek, this period could be anytime during the grazing season, depending on grazing rotation patterns.

5.2.1.2. Target Selection

The State of Idaho water quality standards prescribe *E. coli* criteria for both primary and secondary contact recreation. After a review of Sage Creek, DEQ has determined that likely public uses would fall under secondary contact recreation, if any. In order to support the beneficial use of secondary contact recreation, the number of colonies of *E. coli* may not exceed either a single instantaneous sample of 576 colonies/100 mL or a geometric mean of 126 colonies/100 mL for 5 samples collected in a 30-day period every 3 to 7 days.

5.2.1.3. Monitoring Points

Sage Creek should be monitored for *E. coli* bacteria near the road crossing of Walker Road over Sage Creek at approximately N 44.082338, W -114.029398. See Figure 8 and Photo 22 in Appendix E for a map and photo of the area DEQ sampled in 2009 to determine compliance with secondary contact recreation criteria. Because the major exceedances generally occur during the grazing season (April through September), monitoring should occur during the grazing season, although year-round monitoring may be developed so that comparisons between the grazed and non-grazed seasons can be assessed.

5.2.2. Load Capacity

The CWA requires that a TMDL be developed from a load capacity. A load capacity is the greatest amount of load that a water body can carry without violating water quality standards. In this case, the numeric water quality standards for secondary contact recreation will be used. Table 15 shows the load capacity, which is the water quality criterion.

Table 15. Load capacities and critical periods

Stream	Parameter	Critical Period	Load Capacity
Sage Creek	Bacteria (*E. coli*)	June through September	126 colonies/100 milliliters

5.2.3. Estimates of Existing Pollutant Loads

Natural background bacteria levels will be estimated from average bacteria counts collected during the noncritical period (months April through May and October through November). The nonpoint source load will be estimated from the difference in the previous number and average bacteria counts collected during the critical period (months June through September).

5.2.4. Load Allocations

The monitoring location should be low in the watershed to account for upland drainage bacterial influence. The point DEQ sampled below the bridge should be monitored as watershed improvement projects proceed. The land use in the area is primarily grazing on BLM land, so this may be the primary source of contamination. No confined animal feeding operations or failing human septic systems are known in the Sage Creek watershed. The load allocation is presented in Table 16.

Table 16. Bacteria load allocation for Sage Creek
(geometric mean of number of colonies per 100 milliliter sample)

Stream/ Assessment Unit	Load Capacity	Natural Background	Margin of Safety	Load Allocation	Total Load	Load Reduction	Percent Reduction
Sage Creek ID17040218SK022_02	126	13	13	100	720	620	86%

Bacterial concentrations vary from one sample to the next due to the short life span of bacteria and unpredictable source discharge. Therefore, ongoing monitoring should be performed to determine if beneficial uses are supported at an 86% reduction of *E. coli*.

In order to support the beneficial use of secondary contact recreation, the number of *E. coli* colonies must not exceed either a single instantaneous sample of 576 colonies/100 mL or a geometric mean of 126 colonies/100 mL for 5 samples collected in a 30-day period 3 to 7 days apart. Since this target is not seasonal, it is applied as a daily load allocation.

5.2.4.1. Margin of Safety

For the Sage Creek bacteria TMDL, an explicit MOS is set at 10%, and an additional 10% is allocated to the natural background bacterial population contributed by wildlife. In addition, any conservative approaches used in the various calculations required by a TMDL will be included as an implicit component of the MOS.

5.2.4.2. Seasonal Variation

In Sage Creek, the summer growing season is when concentrations of bacteria are the highest. This season is also when water flow is lowest. With lower water flow, bacteria increase due to a combination of agricultural diversion and return flow. Seasonal variation as it relates to development of this TMDL is addressed by ensuring that loads are reduced during the critical period (when beneficial uses are impaired and loads are controllable). Thus, the effects of seasonal variation are built into the load allocations.

5.2.4.3. Wasteload Allocation

There are no point sources within the Sage Creek watershed, so no wasteload allocation is established.

5.2.4.4. Reasonable Assurance

After TMDL acceptance by DEQ, EPA, and stakeholders, the next step of the Idaho water body management process is implementation. Idaho’s water quality standards identify designated agencies that are responsible for evaluating and modifying BMPs to protect impaired water bodies. Idaho DEQ is committed to developing implementation plans within 18 months of EPA approval of a TMDL document. The applicable WAG, DEQ, and applicable agencies will develop implementation plans, and DEQ will incorporated them into the state’s water quality management plan.

Ongoing assessment of the support status of the water bodies with TMDLs will be reported in a 5-year review of the TMDL. If full support status has not been achieved, further implementation will be necessary and further reassessment performed until full support status is reached. Monitoring will be done at least every 5 years. If full support status is reached, the requirements of the TMDL will be considered complete.

5.3. Temperature TMDLs

5.3.1. In-stream Water Quality Targets

For the water bodies in the Big Lost River subbasin temperature TMDLs, DEQ utilized a PNV approach. The Idaho water quality standards include a provision (IDAPA 58.01.02.200.09) establishing 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 goal, and the natural level of shade and channel width become the TMDL targets. The in-stream temperature that results from attaining these conditions is consistent with the water quality standards, even though it may exceed numeric temperature criteria.

The PNV approach is described briefly below. Additionally, the procedures and methodologies to develop PNV target shade levels and to estimate existing shade levels are described in Shumar and de Varona (2009). For a more complete discussion of shade and its effects on stream water temperature, see the *South Fork Clearwater River Subbasin Assessment and Total Maximum Daily Loads* (DEQ and EPA 2003) and *The Potential Natural Vegetation (PNV) Temperature Total Maximum Daily Load (TMDL) Procedures Manual* (Shumar and de Varona 2009), available at http://www.deq.idaho.gov/media/528731-pnv_temp_tmdl_manual_revised_1009.pdf.

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 the amount of solar radiation hitting a stream throughout its length are shade and stream morphology. Shade is provided by the surrounding vegetation and other physical features such as hillsides, canyon walls, terraces, and high banks. Stream morphology affects how closely riparian vegetation grows together and water storage in the alluvial aquifer. Streamside vegetation and channel morphology are the factors influencing shade that are most likely to have been influenced by anthropogenic activities and be corrected and addressed by a TMDL. Depending on how much vertical elevation surrounds the stream, vegetation further away from the riparian corridor can also provide shade. However, riparian vegetation provides a substantial amount of shade on a stream by virtue of its proximity.

We can measure the amount of shade that a stream receives in a number of ways. Effective shade (i.e., that shade provided by all objects that intercept the sun as it makes its way across the sky) can be measured in a given spot with a Solar Pathfinder or with other optical equipment similar to a fish-eye lens on a camera. Effective shade can also be modeled using detailed information about riparian plants and their communities, topography, and the stream's aspect or estimated using aerial photographs. In addition to shade, canopy cover is a similar parameter that affects solar radiation. Canopy cover is the vegetation that hangs directly over the stream and can be measured using a densiometer or estimated visually either on site or using aerial photography. All of these methods provide information about how much of the stream is exposed to direct solar radiation.

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

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

Existing shade was estimated for Antelope Creek, Big Lost River, East Fork Big Lost River, Leadbelt Creek, Spring Creek, and Thousand Springs Creek from visual interpretations of aerial photos. These estimates were field verified at 20 sites by measuring shade with a Solar Pathfinder at systematically located points along the streams (see below for methodology). PNV targets were determined from an analysis of probable vegetation at the streams and comparing that to shade curves developed for similar vegetation communities. A shade curve shows the relationship between effective shade and stream width. As a stream gets wider, the shade decreases as the vegetation has less ability to shade the center of wide streams. As the vegetation gets taller, the more shade the plant community is able to provide at any given channel width.

Existing and potential shade was converted to solar loads from data collected on flat-plate collectors at the nearest National Renewable Energy Laboratory (NREL) weather stations collecting these data. In this case, we used the station in Pocatello, Idaho. 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. PNV shade and the associated target solar 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 thereby considered to be consistent with the Idaho water quality standards, even though they may exceed numeric criteria by more than 0.3°C.

<u>Pathfinder Methodology</u>

The Solar Pathfinder is a device that allows field crews 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 where the tracing is made. To adequately characterize the effective shade on a stream reach, 10 traces were taken at systematic or random intervals along the length of the stream in question.

At each sampling location, the Solar Pathfinder was placed in the middle of the stream at about the bankfull water level following the manufacturer’s instructions for taking traces.

Systematic sampling was used because it is easiest to accomplish and does not bias the location of sampling. For each sampled reach, the sampler started at a unique location (such as 50 or 100 meters from a bridge or fence line) and then proceeded upstream or downstream stopping to take additional traces at fixed intervals (e.g., every 50 meters, every 50 paces, etc.). One can also randomly locate points of measurement by generating random numbers to be used as interval distances.

When possible, the sampler also measured bankfull widths, photographed the landscape, and took notes while taking Solar Pathfinder traces. This documentation helps show changes in riparian plant communities and what kinds of plant species (the large, dominant, shade-producing ones) are present. Additionally, or as a substitution, convex and/or concave densiometer readings can be taken at the same location as Solar Pathfinder traces. These readings provide the potential to develop relationships between canopy cover (measured with a densiometer) and effective shade for a given stream.

<u>Aerial Photo Interpretation</u>

Estimates of shade based on plant type and natural breaks in vegetation were marked out on a 1:100,000 or 1:250,000 hydrography. Each interval is assigned a single value representing the bottom of a 10% shade class (adapted from the Cumulative Watershed Effects process, IDL 2000). For example, if we estimate that existing shade for a particular stretch of stream is somewhere between 50% and 59%, we assign the shade class value of 50% to that section of stream. The estimate is based on a general intuitive observation about the kind of vegetation present, its density, and the width of the stream. Streams where the banks and water are clearly visible are usually in low shade classes (10, 20, or 30%). Streams with dense forest or heavy brush where no portion of the stream is visible are usually in high shade classes (70, 80, or 90%). More open canopies where portions of the stream may be visible usually fall into moderate shade class intervals (40, 50, or 60%).

It is important to note that visual shade estimates made from the aerial photos are strongly influenced by canopy cover. 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 canopy cover measurements are remarkably similar (OWEB 2001), reinforcing the idea that riparian vegetation and objects proximal to the stream provide the most shade. The visual estimates of shade in this TMDL were field verified with a Solar Pathfinder. The Pathfinder measures effective shade and takes into consideration other physical features that block the sun from hitting the stream surface (e.g., hillsides, canyon walls, terraces, and man-made structures).

<u>Stream Morphology</u>

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

This width factor (i.e., NSDZ or bankfull width) may not be discernible from the aerial photo work described previously. Accordingly, this parameter must be estimated from available information. DEQ uses regional curves for the major basins in Idaho—developed from data compiled by Diane Hopster of the Idaho Department of Lands (Figure7)—to estimate natural bankfull width.

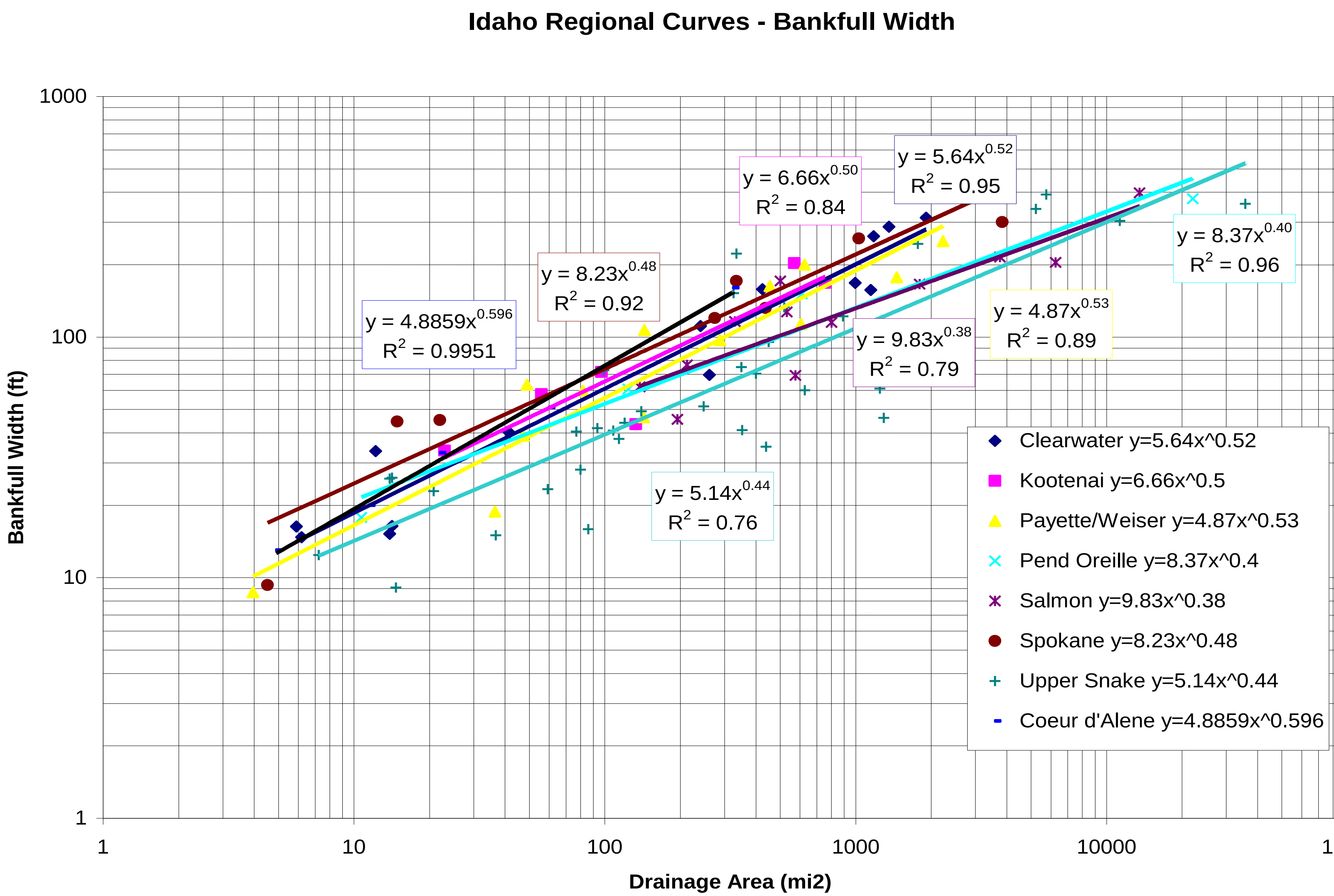

Figure 7. Bankfull width as a function of drainage area

For each stream evaluated in the load analysis, natural bankfull width was estimated based on the drainage area of the Upper Snake Basin curve (Figure 7). Although estimates from other curves were examined (e.g., Salmon Basin), the Upper Snake Basin curve was ultimately chosen because of the basin's proximity to the Big Lost River watershed and its comparable climate and geology. Additionally, existing width data should be evaluated and compared to these curve estimates if such data are available. However, for the Big Lost River watershed only a few BURP and Pathfinder sites exist, and bankfull width data from those sites represent only spot data (i.e., three measured widths in a reach only several hundred meters long) that are not always representative of the stream as a whole.

In general, we found BURP/Pathfinder bankfull width data to agree with bankfull width estimates from the Upper Snake Basin curve and chose not to make natural widths any smaller than these Upper Snake Basin estimates (Table 17). However, there are stream-specific complications to channel widths that need to be kept in mind. They are described below.

- Leadbelt Creek is a small drainage in the upper Antelope Creek watershed. The hydrology of Leadbelt Creek is complicated by two natural phenomena: 1) the stream drains into the alluvium at its lower end and generally does not have continuous surface flow to Antelope Creek, and 2) beaver ponds are extensive in the upper watershed. These two factors tend to make widths wider than predicted in the upper portion and smaller than predicted at the lower portion.
- Antelope Creek has predictable bankfull widths in the upper portion of the watershed but not in the lower portion where diversions and alluvial loses and gains complicate the hydrology.
- Thousand Springs Creek originates as a large spring at the base of Anderson Peak. Hydrologically, the stream's width is unpredictable based on drainage area because of the large spring source. Thousand Springs Creek begins large and becomes pond-like at the upper end, then loses much of that flow to the alluvium, only to regain it again as more springs and irrigation return flow join it at its lower end.
- The East Fork Big Lost River has width dimensions that are relatively predictable based on drainage area with the possible exception of slightly smaller widths in the headwaters area.
- Natural widths for the Big Lost River have been complicated by diversion. The river's origins at the confluence of the East Fork and the North Fork have widths that are consistent with drainage area predictions; however, downstream, below the Bartlett Point Diversion where the river runs dry during most of the irrigation season, bankfull width has not been determined.

Natural bankfull width estimates for each stream in each subwatershed are presented in tables in section 5.3.3. These load analysis tables will contain a natural bankfull width and an existing bankfull width for every stream segment in the analysis based on the bankfull width results presented in here. In general, most streams have a natural and an existing bankfull width equivalent to the drainage area prediction in Table 17.

Table 17. Bankfull width estimates from drainage area regional curves for Upper Snake (US) and Salmon basins and existing measurements

Location	area (sq mi)	US (m)	Salmon (m)	existing (m)
Leadbelt Cr bl Camp Cr	10.3	4	7	
Leadbelt Cr bl Deer Cr	8.7	4	7	2
Leadbelt Cr ab Deer Cr	6.7	4	6	3.75
Leadbelt Cr @ 7000 ft	2.5	2	4	4.2
Leadbelt Cr headwaters	0.58	1	2	
Antelope Cr @ diversion	232	17	24	
Antelope Cr bl Cherry Cr	213	17	23	13.9
Antelope Cr bl Bear Cr	85	11	16	15
Antelope Cr bl Iron Bog	42.3	8	12	8.55
Antelope Cr ab Iron Bog	18.8	6	9	5.25
Antelope Cr bl Timber Cr	9.9	4	7	
Antelope Cr ab Trail Cr	0.88	1	3	
Thousand Springs Cr @ Trail Cr Rd	144	14	20	12
Thousand Springs Cr @ Chilly Rd	132	13	19	6
EF Big Lost River @ mouth	273	18	25	
EF Big Lost River ab Wildhorse Cr	211	17	23	16.1(09) 16.5(03)
EF Big Lost bl Star Hope Cr	147	14	20	13.5
EF Big Lost ab Star Hope Cr	71	10	15	
EF Big Lost bl Cabin Cr	43.5	8	13	6.1
EF Big Lost bl Charcoal/Coal Cr	31.3	7	11	
EF Big Lost bl Anderson Canyon	12.2	5	8	2.9
EF Big Lost ab Anderson Canyon	4.6	3	5	
Big Lost River bl NF/EF confluence	388	22	29	
Big Lost River bl Bady Cr	440	23	30	23.7(09) 17.8(03)
Big Lost River ab 1000 Springs Cr	477	24	31	
Big Lost River bl 1000 Springs Cr	627	27	35	
Big Lost River ab Mackay Res	665	27	35	
Big Lost River bl Mackay Res	797	30	38	
Big Lost River ab Antelope Cr	986	33	41	
Big Lost River @ Moore Diversion	1325	37	46	
Spring Cr @ mouth	25	6	10	
Twin Bridges Creek @ mouth	20.1	6	9	
Twin Bridges Creek @ 7150ft	15.6	5	9	
Twin Bridges Creek @ 7210ft	9.6	4	7	
Twin Bridges Creek @ 7560ft	4.83	3	5	
Twin Bridges Creek @ 8290ft	1.89	2	4	
1st tributary to Twin Bridges Cr	1.44	2	3	
2nd tributary to Twin Bridges Cr	1.45	2	3	
3rd tributary to Twin Bridges Cr	2.57	2	4	
3rd tributary @ 7920ft	1.38	2	3	
4th tributary to Twin Bridges Cr	2.96	3	5	
4th tributary ab 1st tributary	1.53	2	4	
1st tributary to 4th tributary	0.59	1	2	
2nd tributary to 4th tributary	0.49	1	2	
5th tributary to Twin Bridges Cr	1.88	2	4	
NF of 5th tributary	0.68	1	3	
SF of 5th tributary	0.92	2	3	

5.3.1.1. Design Conditions

The Big Lost River subbasin is located within the Middle Rockies level III Ecoregion (McGrath et al. 2001). The majority of the Big Lost River below Bartlett Point, Thousand Springs Creek, and Spring Creek is in the Dry Intermontane Sagebrush Valleys level IV Ecoregion, known for low precipitation due to high mountain rain-shadow and deep valley fill, both resulting in little surface drainage of water. Most of the East Fork Big Lost River, Twin Bridges Creek, Antelope Creek, and Leadbelt Creek are in the Dry Gneissic-Schistose-Volcanic Hills level IV Ecoregion underlain by quaternary and tertiary volcanic rock. This area is slightly wetter than the Dry Intermontane region below it. Headwaters of Leadbelt Creek and Twin Bridges Creek are likely in the Barren Hills level IV Ecoregion with open Douglas-fir/lodgepole/subalpine fir forests and aspen groves in narrow elevation bands predominantly on north-facing slopes. The headwaters of Antelope Creek and East Fork Big Lost River, as well as a portion of the East Fork near the North Fork confluence, are in the Dry Partly Wooded Mountains level IV Ecoregion of the Idaho Batholith level III Ecoregion. This area is known for its mosaic of shrubland, open Douglas-fir, and aspen forests.

Determining appropriate PNV for riparian areas along streams is often difficult given past histories and changing environments. For forested areas in upper Leadbelt Creek, Twin Bridges Creek, and Antelope Creek, we relied upon potential vegetation descriptions provided by the Salmon-Challis National Forest. These headwater areas are primarily in dry Douglas-fir areas without ponderosa pine and occasionally in aspen groves and Douglas-fir/lodgepole pine areas in steep terrain. Antelope Creek has high-elevation shrub meadows that we have placed in the Drummond willow/sedge vegetation type. Antelope Creek, Leadbelt Creek, and Twin Bridges Creek below the forested zone have been placed in a Geyer's willow/sedge vegetation type. Lower Leadbelt Creek transitions to yellow willow and sandbar willow types at lower elevations. The sandbar willow along lower Leadbelt Creek below Deer Creek may be a rare form of *Salix exigua* known as subspecies *melanopsis* variety *tenerrima*. Antelope Creek below Iron Bog Creek transitions to a narrowleaf cottonwood vegetation type due to the larger, wider floodplain. Lower Antelope Creek has a broad alluvial plain with highly anastomosed channels that may lack the ability to maintain cottonwood forest.

We have placed the majority of East Fork Big Lost River into a Geyer's willow/sedge vegetation type with the exception of the last 1,800 meters, which appear to be dominated by alders. In the Big Lost River in the narrow canyon below the East Fork/North Fork confluence, we have retained the alder vegetation type for a short distance until the valley broadens sufficiently for the narrowleaf cottonwood vegetation type to begin. The riparian vegetation along the upper Big Lost River is complicated by a periodic narrowing of the valley such that only a strip of trees can occupy the zone adjacent to the water's edge. In these areas, it would be unreasonable to apply the full narrowleaf cottonwood community shade target, so we have chosen to use half the normal target value. The Big Lost River below the Bartlett Point Diversion is often a dewatered channel during the irrigation season. As noted by Rood et al. (2003), the dewatering of the braided Big Lost River channel has led to mortality of the narrowleaf cottonwood and sandbar willow communities within the last 5 years.

Spring Creek is a small spring-fed area in the floodplain of the Big Lost River. It is unknown what its original riparian vegetation might have been. Because of its low elevation and highly anastomosed meadow, we have chosen to place it into a yellow willow riparian vegetation type. Thousand Springs Creek is a similar spring-fed system; however, it is a broad, higher-elevation marsh that is completely dominated by grass and grass-like (graminoid) species. Such grass meadows also exist in places in the headwaters of Twin Bridges Creek. Drier headwater sections of Twin Bridges Creek where ephemeral water runs after snow-melt have been placed into a sagebrush/grass community.

Thousand Springs Creek proper (AU# ID17040218SK016_03) is not listed for temperature. However, a tributary unit (AU# ID17040218SK016_02) was listed for temperature. These tributaries are small springs adjacent to the creek and ephemeral washes that drain the mountains to the east. The ephemeral washes are primarily dry channels on alluvial fans and rock/barren areas above the tree line. However, between these two non-vegetated areas are bands of sagebrush/grass and dry Douglas-fir. The smaller springs adjacent to Thousand Springs Creek are in grass meadow habitat. The load analysis table for AU# ID17040218SK016_02 includes an accounting of total length of channel in each habitat type.

5.3.1.2. Target Selection

To determine PNV shade targets for the streams in the Big Lost River subbasin, effective shade curves from Shumar and de Varona (2009) were examined. These curves were produced using vegetation community modeling of Idaho plant communities. Effective shade curves include percent shade on the vertical axis and stream width on the horizontal axis. As a stream becomes wider, a given vegetation type loses its ability to shade the stream. For this subbasin, curves with the most similar vegetation type to what is expected in the Big Lost River subbasin were selected for shade target determinations. These curves include the "Dry Douglas-Fir without Ponderosa Pine" and the "Douglas-fir/Lodgepole – Steep" curves developed for these vegetation types in the Salmon-Challis National Forest. The following curves developed for non-forest riparian vegetation were also employed: Drummond willow (*Salix drummondiana*)/sedge, Geyer's willow (*S. geyeriana*)/sedge, quaking aspen (*Populus tremuloides*), narrowleaf cottonwood (*P. angustifolia*), yellow willow (*S. lutea*), sandbar willow (*S. exigua*), and mountain alder (*Alnus incana*). Additionally, the graminoid (grass meadow) and sagebrush/grass shade curves were developed by DEQ (Shumar and de Varona 2009) for use in these unique meadow and ephemeral systems.

5.3.1.3. Monitoring Points

The accuracy of the aerial photo interpretations were field verified with a Solar Pathfinder at 20 sites (Table 18). In general, the original aerial photo interpretations over-estimated shade by an average of 10% ± 3.2% (average ± 95% confidence interval). When individual streams were examined, this relationship remained true for the East Fork Big Lost River sites (10% ± 3.3%). However, the Antelope Creek sites showed a greater shade over-estimation (18% ± 4.9%), while the Leadbelt Creek sites showed less over-estimation (6% ± 7.8%). The results of the field verification were used to correct the original aerial photo interpretation and to recalibrate our estimations when examining non-verified locations. Existing shade data presented in this document represent those corrected values.

Table 18. Solar Pathfinder field verification results

aerial class	pathfinder actual	pathfinder class	delta	sites
40	28.9	20	20	Antelope 1
30	18	10	20	Antelope 2
40	31.7	30	10	Antelope 3
50	31.7	30	20	Antelope 4
10	14.4	10	0	Leadbelt 1
30	22.2	20	10	Leadbelt 3
40	42.6	40	0	Leadbelt 4
50	52.7	50	0	Leadbelt 5
60	47.5	40	20	Leadbelt 6
20	16.5	10	10	EF 1
10	1.9	0	10	EF 2
10	0.9	0	10	EF 2a
0	0.45	0	0	EF 3
20	12.9	10	10	EF 4
40	20	20	20	EF 5
10	0.9	0	10	EF 6
10	2	0	10	EF 7
10	3.9	0	10	EF 8
20	12.7	10	10	Big Lost 1
10	17.2	10	0	Big Lost 2
			10	average
			7.25	std dev
			3.18	95%CI

Effective shade monitoring can take place on any reach throughout the Big Lost River subbasin and be compared to estimates of existing shade seen on Figures 8, 11, 14, 17, 20, and 23 and described in Tables 19–27. Those areas with the largest disparity between existing shade estimates and target shade levels 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 existing shade estimates vary in length depending on land use or landscape that have 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 shade levels during future monitoring.

5.3.2. Load Capacity

The load capacity for a stream under PNV conditions is essentially the solar load allowed under the shade targets specified for the reaches within that stream. These loads are determined by multiplying the solar load received by a flat-plate collector (under full sun) for a given period of time by the fraction of solar radiation not blocked by shade (i.e., the percent open or 100% minus percent shade). In other words, if a shade target is 60% (or 0.6), 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 from flat-plate collectors at the NREL weather station in Pocatello, Idaho. The solar loads used in this TMDL are spring/summer averages; thus, we used an average load for the 6-month period from April through September. These months coincide with the time of year when stream temperatures are increasing and deciduous vegetation is in leaf and extend into early fall spawning time. Tables 19–27 (and Figures 9, 12, 15, 18, 21, 24, and 26) show the PNV shade targets (identified as target or potential shade) and their corresponding potential summer loads (in kilowatt-hours per square meter per day [kWh/m^2/day] and kilowatt-hours per day [kWh/day]) that serve as the load capacities for the streams.

The effective shade calculations are based on the 6-month period from April through September. This time period coincides with the critical months when temperatures affect beneficial uses such as spring and fall salmonid spawning and when cold water aquatic life criteria may be exceeded. Late July and early August typically represent the period of highest stream temperatures. However, solar gains can begin early in the spring and affect not only the highest temperatures reached later in the summer but also salmonid spawning temperatures in spring and fall. Thus, solar loading in these streams is evaluated from spring (April) to early fall (September).

The lower segment of the Big Lost River (below Mackay Reservoir) has the highest load capacity (i.e., potential summer load) at about 6.6 million kWh/day (Table 23). Twin Bridges Creek tributaries have the lowest load capacity at 48,867 kWh/day (Table 25).

5.3.3. Estimates of Existing Pollutant Loads

Regulations allow that loadings "...may range from reasonably accurate estimates to gross allotments, depending on the availability of data and appropriate techniques for predicting the loading" (Water quality planning and management, 40 CFR § 130.2(g)). 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 and partially field verified using a Solar Pathfinder. 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 station. Existing shade data are presented in Tables 19–27 and Figures 8, 11, 14, 17, 20, and 23. Like load capacities (potential loads), existing loads in Tables 19–27 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 load analysis 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, which is discussed in the load allocation section and becomes the basis for calculating lack of shade (Figures 10, 13, 16, 19, 22, and 25).

Consistent with load capacity, the highest existing load (8.5 million kWh/day) is in the lower segment of the Big Lost River below Mackay Reservoir (to the Moore Diversion) (Table 23). The lowest existing load is in the Twin Bridges Creek tributaries (86,075 kWh/day) (Table 25).

Table 19. Existing and potential solar loads for Antelope Creek

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Antelope Creek**
AU# ID17040218SK057_02														
180	0.9	0.615	1	0	-0.62	1	1	180	110.7	180	0	-110.7	-10	aspen
220	0.9	0.615	0.87	0.7995	0.1845	1	1	220	135.3	220	175.89	40.59	0	Drummond willow
140	0.9	0.615	0.94	0.369	-0.246	1	1	140	86.1	140	51.66	-34.44	-4	Dry DF w/o Ppine
120	0.7	1.845	0.94	0.369	-1.476	1	1	120	221.4	120	44.28	-177.12	-24	
1100	0.9	0.615	0.98	0.123	-0.492	1	1	1100	676.5	1100	135.3	-541.2	-8	DF/lodgepole-steep
570	0.8	1.23	0.76	1.476	0.246	2	2	1140	1402.2	1140	1682.64	280.44	0	Drummond willow
2140	0.9	0.615	0.94	0.369	-0.246	2	2	4280	2632.2	4280	1579.32	-1052.88	-4	Dry DF w/o Ppine
360	0.7	1.845	0.56	2.706	0.861	3	3	1080	1992.6	1080	2922.48	929.88	0	Drummond willow
210	0.9	0.615	0.92	0.492	-0.123	3	3	630	387.45	630	309.96	-77.49	-2	Dry DF w/o Ppine
AU# ID17040218SK057_03														
80	0.9	0.615	0.92	0.492	-0.123	3	3	240	147.6	240	118.08	-29.52	-2	
530	0.8	1.23	0.92	0.492	-0.738	3	3	1590	1955.7	1590	782.28	-1173.42	-12	
980	0.9	0.615	0.84	0.984	0.369	4	4	3920	2410.8	3920	3857.28	1446.48	0	
90	0.8	1.23	0.84	0.984	-0.246	4	4	360	442.8	360	354.24	-88.56	0	
150	0.6	2.46	0.45	3.3825	0.9225	4	4	600	1476	600	2029.5	553.5	0	Drummond willow
910	0.8	1.23	0.76	1.476	0.246	5	5	4550	5596.5	4550	6715.8	1119.3	0	Dry DF w/o Ppine
1050	0.7	1.845	0.76	1.476	-0.369	5	5	5250	9686.25	5250	7749	-1937.25	-6	
350	0.3	4.305	0.39	3.7515	-0.5535	6	6	2100	9040.5	2100	7878.15	-1162.35	-9	Geyers willow
270	0.5	3.075	0.69	1.9065	-1.1685	6	6	1620	4981.5	1620	3088.53	-1892.97	-19	Dry DF w/o Ppine
350	0.4	3.69	0.39	3.7515	0.0615	6	6	2100	7749	2100	7878.15	129.15	0	Geyers willow/
850	0.3	4.305	0.39	3.7515	-0.5535	6	6	5100	21955.5	5100	19132.65	-2822.85	-9	sedge
AU# ID17040218SK052_04														
280	0.3	4.305	0.32	4.182	-0.123	8	8	2240	9643.2	2240	9367.68	-275.52	-2	
230	0.3	4.305	0.32	4.182	-0.123	8	8	1840	7921.2	1840	7694.88	-226.32	-2	
490	0.2	4.92	0.32	4.182	-0.738	8	8	3920	19286.4	3920	16393.44	-2892.96	-12	
180	0.3	4.305	0.75	1.5375	-2.7675	8	8	1440	6199.2	1440	2214	-3985.2	-45	narrowleaf
150	0.4	3.69	0.75	1.5375	-2.1525	8	8	1200	4428	1200	1845	-2583	-35	cottonwood
400	0.3	4.305	0.75	1.5375	-2.7675	8	8	3200	13776	3200	4920	-8856	-45	
210	0.1	5.535	0.75	1.5375	-3.9975	8	8	1680	9298.8	1680	2583	-6715.8	-65	
400	0.2	4.92	0.7	1.845	-3.075	9	9	3600	17712	3600	6642	-11070	-50	
570	0.1	5.535	0.7	1.845	-3.69	9	9	5130	28394.55	5130	9464.85	-18929.7	-60	
670	0.3	4.305	0.7	1.845	-2.46	9	9	6030	25959.15	6030	11125.35	-14833.8	-40	
510	0.2	4.92	0.7	1.845	-3.075	9	9	4590	22582.8	4590	8468.55	-14114.25	-50	
260	0.1	5.535	0.65	2.1525	-3.3825	10	10	2600	14391	2600	5596.5	-8794.5	-55	
90	0.2	4.92	0.65	2.1525	-2.7675	10	10	900	4428	900	1937.25	-2490.75	-45	
1430	0.1	5.535	0.65	2.1525	-3.3825	10	10	14300	79150.5	14300	30780.75	-48369.75	-55	
160	0	6.15	0.65	2.1525	-3.9975	10	10	1600	9840	1600	3444	-6396	-65	
640	0.2	4.92	0.65	2.1525	-2.7675	10	10	6400	31488	6400	13776	-17712	-45	
660	0.1	5.535	0.61	2.3985	-3.1365	11	11	7260	40184.1	7260	17413.11	-22770.99	-51	
170	0	6.15	0.61	2.3985	-3.7515	11	11	1870	11500.5	1870	4485.195	-7015.305	-61	
840	0.1	5.535	0.61	2.3985	-3.1365	11	11	9240	51143.4	9240	22162.14	-28981.26	-51	
630	0.2	4.92	0.61	2.3985	-2.5215	11	11	6930	34095.6	6930	16621.605	-17473.995	-41	
260	0.3	4.305	0.57	2.6445	-1.6605	12	12	3120	13431.6	3120	8250.84	-5180.76	-27	
860	0.2	4.92	0.57	2.6445	-2.2755	12	12	10320	50774.4	10320	27291.24	-23483.16	-37	
830	0.5	3.075	0.57	2.6445	-0.4305	12	12	9960	30627	9960	26339.22	-4287.78	-7	
920	0.4	3.69	0.53	2.8905	-0.7995	13	13	11960	44132.4	11960	34570.38	-9562.02	-13	
100	0	6.15	0.53	2.8905	-3.2595	13	13	1300	7995	1300	3757.65	-4237.35	-53	
210	0.5	3.075	0.53	2.8905	-0.1845	13	13	2730	8394.75	2730	7891.065	-503.685	-3	
980	0.3	4.305	0.53	2.8905	-1.4145	13	13	12740	54845.7	12740	36824.97	-18020.73	-23	

Table 19 (cont.). Existing and potential solar loads for Antelope Creek

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Antelope Creek**
810	0.2	4.92	0.17	5.1045	0.1845	14	14	11340	55792.8	11340	57885.03	2092.23	0	yellow willow
460	0	6.15	0.17	5.1045	-1.0455	14	14	6440	39606	6440	32872.98	-6733.02	-17	
440	0.1	5.535	0.17	5.1045	-0.4305	14	14	6160	34095.6	6160	31443.72	-2651.88	-7	
1200	0	6.15	0.15	5.2275	-0.9225	15	15	18000	110700	18000	94095	-16605	-15	
AU# ID17040218SK047_04														
1500	0	6.15	0.15	5.2275	-0.9225	16	16	24000	147600	24000	125460	-22140	-15	
AU# ID17040218SK049_04														
770	0	6.15	0.15	5.2275	-0.9225	16	16	12320	75768	12320	64402.8	-11365.2	-15	
340	0.1	5.535	0.15	5.2275	-0.3075	16	16	5440	30110.4	5440	28437.6	-1672.8	-5	
680	0	6.15	0.15	5.2275	-0.9225	16	16	10880	66912	10880	56875.2	-10036.8	-15	
190	0.1	5.535	0.15	5.2275	-0.3075	16	16	3040	16826.4	3040	15891.6	-934.8	-5	
860	0	6.15	0.14	5.289	-0.861	17	17	14620	89913	14620	77325.18	-12587.82	-14	
AU# ID17040218SK049_05														
1050	0	6.15	0.14	5.289	-0.861	17	17	17850	109777.5	17850	94408.65	-15368.85	-14	
AU# ID17040218SK047_05														
410	0	6.15	0.14	5.289	-0.861	17	17	6970	42865.5	6970	36864.33	-6001.17	-14	
AU# ID17040218SK046_05														
1680	0	6.15	0.14	5.289	-0.861	17	17	28560	175644	28560	151053.84	-24590.16	-14	
390	0.3	4.305	0.43	3.5055	-0.7995	17	17	6630	28542.15	6630	23241.465	-5300.685	-13	narrowleaf
540	0	6.15	0.43	3.5055	-2.6445	17	17	9180	56457	9180	32180.49	-24276.51	-43	cottonwood
460	0.1	5.535	0.43	3.5055	-2.0295	17	17	7820	43283.7	7820	27413.01	-15870.69	-33	
220	0.3	4.305	0.43	3.5055	-0.7995	17	17	3740	16100.7	3740	13110.57	-2990.13	-13	
1580	0.1	5.535	0.43	3.5055	-2.0295	17	17	26860	148670.1	26860	94157.73	-54512.37	-33	
350	0.2	4.92	0.43	3.5055	-1.4145	17	17	5950	29274	5950	20857.725	-8416.275	-23	
280	0.4	3.69	0.43	3.5055	-0.1845	17	17	4760	17564.4	4760	16686.18	-878.22	-3	
170	0	6.15	0.43	3.5055	-2.6445	17	17	2890	17773.5	2890	10130.895	-7642.605	-43	
330	0.1	5.535	0.43	3.5055	-2.0295	17	17	5610	31051.35	5610	19665.855	-11385.495	-33	
330	0	6.15	0.43	3.5055	-2.6445	17	17	5610	34501.5	5610	19665.855	-14835.645	-43	
5080	dry													
1100	0.1	5.535	0.43	3.5055	-2.0295	17	17	18700	103504.5	18700	65552.85	-37951.65	-33	
510	0.3	4.305	0.43	3.5055	-0.7995	17	17	8670	37324.35	8670	30392.685	-6931.665	-13	
1800	0.1	5.535	0.43	3.5055	-2.0295	17	17	30600	169371	30600	107268.3	-62102.7	-33	
							Total	**477,060**	**2,453,739**	**477,060**	**1,755,685**	**-698,054**	**-23**	

Table 20. Existing and potential solar loads for Leadbelt Creek

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Leadbelt Creek**
AU# ID17040218SK058_02														
350	0.9	0.615	0.98	0.123	-0.49	1	1	350	215.25	350	43.05	-172.2	-8	DF/lodgepole-steep
500	0.8	1.23	0.94	0.369	-0.861	1	1	500	615	500	184.5	-430.5	-14	Dry DF w/o Ppine
120	0.3	4.305	0.93	0.4305	-3.8745	1	1	120	516.6	120	51.66	-464.94	-63	Geyers willow/sedge
110	0.9	0.615	0.94	0.369	-0.246	1	1	110	67.65	110	40.59	-27.06	-4	Dry DF w/o Ppine
80	0.7	1.845	0.99	0.0615	-1.7835	2	2	160	295.2	160	9.84	-285.36	-29	aspen
150	0.3	4.305	0.82	1.107	-3.198	2	2	300	1291.5	300	332.1	-959.4	-52	Geyers willow/sedge
60	0	6.15	0.82	1.107	-5.043	16	2	960	5904	120	132.84	-5771.16	-82	beaver pond
130	0.4	3.69	0.82	1.107	-2.583	2	2	260	959.4	260	287.82	-671.58	-42	
40	0	6.15	0.82	1.107	-5.043	30	2	1200	7380	80	88.56	-7291.44	-82	beaver pond
480	0.6	2.46	0.82	1.107	-1.353	2	2	960	2361.6	960	1062.72	-1298.88	-22	
120	0.3	4.305	0.82	1.107	-3.198	2	2	240	1033.2	240	265.68	-767.52	-52	
140	0.5	3.075	0.64	2.214	-0.861	3	3	420	1291.5	420	929.88	-361.62	-14	
810	0.4	3.69	0.64	2.214	-1.476	3	3	2430	8966.7	2430	5380.02	-3586.68	-24	
260	0.3	4.305	0.64	2.214	-2.091	3	3	780	3357.9	780	1726.92	-1630.98	-34	
1070	0.5	3.075	0.46	3.321	0.246	4	4	4280	13161	4280	14213.88	1052.88	0	yellow willow
1230	0.4	3.69	0.46	3.321	-0.369	4	4	4920	18154.8	4920	16339.32	-1815.48	-6	
90	0.1	5.535	0.46	3.321	-2.214	4	4	360	1992.6	360	1195.56	-797.04	-36	
350	0.3	4.305	0.46	3.321	-0.984	4	4	1400	6027	1400	4649.4	-1377.6	-16	
500	0.2	4.92	0.46	3.321	-1.599	4	4	2000	9840	2000	6642	-3198	-26	
360	0.1	5.535	0.58	2.583	-2.952	4	4	1440	7970.4	1440	3719.52	-4250.88	-48	sandbar willow
700	dry													
450	0.4	3.69	0.58	2.583	-1.107	4	4	1800	6642	1800	4649.4	-1992.6	-18	
700	0.1	5.535	0.58	2.583	-2.952	4	4	2800	15498	2800	7232.4	-8265.6	-48	
490	0.4	3.69	0.58	2.583	-1.107	4	4	1960	7232.4	1960	5062.68	-2169.72	-18	
140	0	6.15	0.58	2.583	-3.567	4	4	560	3444	560	1446.48	-1997.52	-58	
150	0.3	4.305	0.58	2.583	-1.722	4	4	600	2583	600	1549.8	-1033.2	-28	
240	0	6.15	0.58	2.583	-3.567	4	4	960	5904	960	2479.68	-3424.32	-58	
160	0.4	3.69	0.46	3.321	-0.369	4	4	640	2361.6	640	2125.44	-236.16	-6	yellow willow
90	0	6.15	0.46	3.321	-2.829	4	4	360	2214	360	1195.56	-1018.44	-46	
190	0.4	3.69	0.46	3.321	-0.369	4	4	760	2804.4	760	2523.96	-280.44	-6	
							Total	**33,630**	**140,085**	**31,670**	**85,561**	**-54,523**	**-32**	

Table 21. Existing and potential solar loads for East Fork Big Lost River

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**East Fork Big Lost River**
AU# ID17040218SK039_02														
190	0.4	3.69	0.64	2.214	-1.48	3	3	570	2103.3	570	1261.98	-841.32	-24	Geyers
1350	0	6.15	0.64	2.214	-3.936	3	3	4050	24907.5	4050	8966.7	-15940.8	-64	willow/
AU# ID17040218SK039_03														sedge
730	0	6.15	0.64	2.214	-3.936	3	3	2190	13468.5	2190	4848.66	-8619.84	-64	
1680	0.1	5.535	0.45	3.3825	-2.1525	5	5	8400	46494	8400	28413	-18081	-35	
220	0.2	4.92	0.45	3.3825	-1.5375	5	5	1100	5412	1100	3720.75	-1691.25	-25	
240	0.1	5.535	0.45	3.3825	-2.1525	5	5	1200	6642	1200	4059	-2583	-35	
450	0	6.15	0.39	3.7515	-2.3985	6	6	2700	16605	2700	10129.05	-6475.95	-39	
1730	0	6.15	0.53	2.8905	-3.2595	4	4	6920	42558	6920	20002.26	-22555.74	-53	
1480	0	6.15	0.64	2.214	-3.936	3	3	4440	27306	4440	9830.16	-17475.84	-64	
1320	0	6.15	0.35	3.9975	-2.1525	7	7	9240	56826	9240	36936.9	-19889.1	-35	
AU# ID17040218SK033_03														
860	0	6.15	0.32	4.182	-1.968	8	8	6880	42312	6880	28772.16	-13539.84	-32	
1960	0.1	5.535	0.32	4.182	-1.353	8	8	15680	86788.8	15680	65573.76	-21215.04	-22	
240	0.2	4.92	0.32	4.182	-0.738	8	8	1920	9446.4	1920	8029.44	-1416.96	-12	
AU# ID17040218SK033_04														
1800	0.2	4.92	0.28	4.428	-0.492	9	9	16200	79704	16200	71733.6	-7970.4	-8	
140	0	6.15	0.26	4.551	-1.599	10	10	1400	8610	1400	6371.4	-2238.6	-26	
340	0.3	4.305	0.26	4.551	0.246	10	10	3400	14637	3400	15473.4	836.4	0	
230	0.3	4.305	0.26	4.551	0.246	10	10	2300	9901.5	2300	10467.3	565.8	0	
230	0.1	5.535	0.26	4.551	-0.984	10	10	2300	12730.5	2300	10467.3	-2263.2	-16	
370	0.2	4.92	0.26	4.551	-0.369	10	10	3700	18204	3700	16838.7	-1365.3	-6	
130	0.1	5.535	0.26	4.551	-0.984	10	10	1300	7195.5	1300	5916.3	-1279.2	-16	
460	0.2	4.92	0.26	4.551	-0.369	10	10	4600	22632	4600	20934.6	-1697.4	-6	
1920	0	6.15	0.19	4.9815	-1.1685	14	14	26880	165312	26880	133902.72	-31409.28	-19	
650	0.1	5.535	0.18	5.043	-0.492	15	15	9750	53966.25	9750	49169.25	-4797	-8	
430	0	6.15	0.18	5.043	-1.107	15	15	6450	39667.5	6450	32527.35	-7140.15	-18	
260	0.1	5.535	0.18	5.043	-0.492	15	15	3900	21586.5	3900	19667.7	-1918.8	-8	
750	0	6.15	0.18	5.043	-1.107	15	15	11250	69187.5	11250	56733.75	-12453.75	-18	
16820	0	6.15	0.16	5.166	-0.984	17	17	285940	1758531	285940	1477166.04	-281364.96	-16	
2600	0	6.15	0.15	5.2275	-0.9225	18	18	46800	287820	46800	244647	-43173	-15	
1800	0.1	5.535	0.16	5.166	-0.369	18	18	32400	179334	32400	167378.4	-11955.6	-6	mtn alder
							Total	**523,860**	**3,129,889**	**523,860**	**2,569,939**	**-559,950**	**-24**	

Table 22. Existing and potential solar loads for Big Lost River above Mackay Reservoir

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Big Lost River, above Mackay Reservoir**
AU# ID17040218SK025_05														
2840	0	6.15	0.13	5.3505	-0.80	22	22	62480	384252	62480	334299.24	-49952.76	-13	mtn alder
530	0	6.15	0.13	5.3505	-0.7995	22	22	11660	71709	11660	62386.83	-9322.17	-13	
2810	0.1	5.535	0.17	5.1045	-0.4305	22	22	61820	342173.7	61820	315560.19	-26613.51	-7	narrowleaf
910	0.1	5.535	0.34	4.059	-1.476	22	22	20020	110810.7	20020	81261.18	-29549.52	-24	cottonwood
200	0	6.15	0.17	5.1045	-1.0455	22	22	4400	27060	4400	22459.8	-4600.2	-17	
220	0.1	5.535	0.17	5.1045	-0.4305	22	22	4840	26789.4	4840	24705.78	-2083.62	-7	half target
790	0.1	5.535	0.17	5.1045	-0.4305	22	22	17380	96198.3	17380	88716.21	-7482.09	-7	
AU# ID17040218SK024_05														
250	0.1	5.535	0.34	4.059	-1.476	22	22	5500	30442.5	5500	22324.5	-8118	-24	
1130	0.1	5.535	0.34	4.059	-1.476	22	22	24860	137600.1	24860	100906.74	-36693.36	-24	
660	0.1	5.535	0.33	4.1205	-1.4145	23	23	15180	84021.3	15180	62549.19	-21472.11	-23	
1560	0.1	5.535	0.17	5.1045	-0.4305	23	23	35880	198595.8	35880	183149.46	-15446.34	-7	half target
420	0.2	4.92	0.33	4.1205	-0.7995	23	23	9660	47527.2	9660	39804.03	-7723.17	-13	
160	0	6.15	0.33	4.1205	-2.0295	23	23	3680	22632	3680	15163.44	-7468.56	-33	
1440	0.1	5.535	0.33	4.1205	-1.4145	23	23	33120	183319.2	33120	136470.96	-46848.24	-23	
390	0	6.15	0.33	4.1205	-2.0295	23	23	8970	55165.5	8970	36960.885	-18204.615	-33	
260	0.1	5.535	0.33	4.1205	-1.4145	23	23	5980	33099.3	5980	24640.59	-8458.71	-23	
610	0	6.15	0.33	4.1205	-2.0295	23	23	14030	86284.5	14030	57810.615	-28473.885	-33	
430	0	6.15	0.33	4.1205	-2.0295	23	23	9890	60823.5	9890	40751.745	-20071.755	-33	
2300	0.1	5.535	0.33	4.1205	-1.4145	23	23	52900	292801.5	52900	217974.45	-74827.05	-23	
1240	0	6.15	0.33	4.1205	-2.0295	23	23	28520	175398	28520	117516.66	-57881.34	-33	
410	0.1	5.535	0.33	4.1205	-1.4145	23	23	9430	52195.05	9430	38856.315	-13338.735	-23	
290	0	6.15	0.33	4.1205	-2.0295	23	23	6670	41020.5	6670	27483.735	-13536.765	-33	
140	0.1	5.535	0.33	4.1205	-1.4145	23	23	3220	17822.7	3220	13268.01	-4554.69	-23	
3600	0	6.15	0.32	4.182	-1.968	24	24	86400	531360	86400	361324.8	-170035.2	-32	
700	0.1	5.535	0.32	4.182	-1.353	24	24	16800	92988	16800	70257.6	-22730.4	-22	
580	0	6.15	0.16	5.166	-0.984	24	24	13920	85608	13920	71910.72	-13697.28	-16	half target
1000	0.1	5.535	0.16	5.166	-0.369	24	24	24000	132840	24000	123984	-8856	-6	
2150	0	6.15	0.32	4.182	-1.968	24	24	51600	317340	51600	215791.2	-101548.8	-32	
360	0.1	5.535	0.16	5.166	-0.369	24	24	8640	47822.4	8640	44634.24	-3188.16	-6	half target
5260	0	6.15	0.32	4.182	-1.968	24	24	126240	776376	126240	527935.68	-248440.32	-32	
AU# ID17040218SK015_05														
130	0	6.15	0.28	4.428	-1.722	27	27	3510	21586.5	3510	15542.28	-6044.22	-28	
230	0.1	5.535	0.28	4.428	-1.107	27	27	6210	34372.35	6210	27497.88	-6874.47	-18	
320	0	6.15	0.28	4.428	-1.722	27	27	8640	53136	8640	38257.92	-14878.08	-28	
760	0.1	5.535	0.14	5.289	-0.246	27	27	20520	113578.2	20520	108530.28	-5047.92	-4	half target
6240	0	6.15	0.28	4.428	-1.722	27	27	168480	1036152	168480	746029.44	-290122.56	-28	
AU# ID17040218SK013_05														
7330	0	6.15	0.28	4.428	-1.722	27	27	197910	1217146.5	197910	876345.48	-340801.02	-28	
							Total	**1,182,960**	**7,038,048**	**1,182,960**	**5,293,062**	**-1,744,986**	**-21**	

Table 23. Existing and potential solar loads for Big Lost River below Mackay Reservoir

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Big Lost River, below Mackay Reservoir**
AU# ID17040218SK011_05														
1300	0.4	3.69	0.26	4.551	0.86	30	30	39000	143910	39000	177489	33579	14	narrowleaf
1700	0.2	4.92	0.26	4.551	-0.369	30	30	51000	250920	51000	232101	-18819	-6	cottonwood
670	0.1	5.535	0.26	4.551	-0.984	30	30	20100	111253.5	20100	91475.1	-19778.4	-16	
630	0.2	4.92	0.26	4.551	-0.369	30	30	18900	92988	18900	86013.9	-6974.1	-6	
550	0	6.15	0.26	4.551	-1.599	30	30	16500	101475	16500	75091.5	-26383.5	-26	
560	0.1	5.535	0.26	4.551	-0.984	30	30	16800	92988	16800	76456.8	-16531.2	-16	
4380	0	6.15	0.26	4.551	-1.599	30	30	131400	808110	131400	598001.4	-210108.6	-26	
AU# ID17040218SK010_05														
11130	0	6.15	0.25	4.6125	-1.5375	31	31	345030	2121934.5	345030	1591450.875	-530483.625	-25	
280	0.1	5.535	0.24	4.674	-0.861	32	32	8960	49593.6	8960	41879.04	-7714.56	-14	
AU# ID17040218SK007_05														
5490	0	6.15	0.24	4.674	-1.476	32	32	175680	1080432	175680	821128.32	-259303.68	-24	
780	0.1	5.535	0.24	4.674	-0.861	32	32	24960	138153.6	24960	116663.04	-21490.56	-14	
140	0.1	5.535	0.24	4.674	-0.861	32	32	4480	24796.8	4480	20939.52	-3857.28	-14	
610	0	6.15	0.24	4.674	-1.476	32	32	19520	120048	19520	91236.48	-28811.52	-24	
1300	0.1	5.535	0.24	4.674	-0.861	32	32	41600	230256	41600	194438.4	-35817.6	-14	
1300	0	6.15	0.24	4.674	-1.476	33	33	42900	263835	42900	200514.6	-63320.4	-24	
1220	0.1	5.535	0.24	4.674	-0.861	33	33	40260	222839.1	40260	188175.24	-34663.86	-14	
5230	0	6.15	0.24	4.674	-1.476	33	33	172590	1061428.5	172590	806685.66	-254742.84	-24	
AU# ID17040218SK006_06														
7020	0	6.15	0.24	4.674	-1.476	37	37	259740	1597401	259740	1214024.76	-383376.24	-24	
							Total	**1,429,420**	**8,512,363**	**1,429,420**	**6,623,765**	**-1,888,598**	**-17**	

Table 24. Existing and potential solar loads for Thousand Springs Creek tributaries

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Thousand Springs Creek Tributaries**
AU# ID17040218SK016_02														
590	0.6	2.46	0.55	2.7675	0.31	1	1	590	1451.4	590	1632.825	181.425	0	grass
2530	0.5	3.075	0.55	2.7675	-0.3075	1	1	2530	7779.75	2530	7001.775	-777.975	-5	meadow
4750	0.7	1.845	0.65	2.1525	0.3075	1	1	4750	8763.75	4750	10224.375	1460.625	5	sage/grass
1230	0.6	2.46	0.65	2.1525	-0.3075	1	1	1230	3025.8	1230	2647.575	-378.225	-5	
2880	0.9	0.615	0.94	0.369	-0.246	1	1	2880	1771.2	2880	1062.72	-708.48	-4	dry DF w/o Ppine
5970	0	6.15	0	6.15	0	1	1	5970	36715.5	5970	36715.5	0	0	rock/barren
10480	0	6.15	0	6.15	0	1	1	10480	64452	10480	64452	0	0	dry channel
190	0	6.15	0	6.15	0	80	80	15200	93480	15200	93480	0	0	pond
3700	0	6.15	0	6.15	0	1	1	3700	22755	3700	22755	0	0	canal
							Total	**47,330**	**240,194**	**47,330**	**239,972**	**-223**	**-1**	

Table 25. Existing and potential solar loads for Twin Bridges Creek tributaries

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m²/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m²/day)	Potential Load minus Existing load (kWh/m²/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m²)	Existing Summer Load (kWh/day)	Natural Segment Area (m²)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Twin Bridges Creek Tributaries**	water body
AU# ID17040218SK026_02															
970	0.5	3.075	0.55	2.7675	-0.31	1	1	970	2982.75	970	2684.475	-298.275	-5	meadow	1st tributary
1000	0.8	1.23	0.82	1.107	-0.123	2	2	2000	2460	2000	2214	-246	-2	Geyer's willow/sedge	
160	0.4	3.69	0.82	1.107	-2.583	2	2	320	1180.8	320	354.24	-826.56	-42		
190	0.1	5.535	0.82	1.107	-4.428	2	2	380	2103.3	380	420.66	-1682.64	-72		
830	0.6	2.46	0.65	2.1525	-0.3075	1	1	830	2041.8	830	1786.575	-255.225	-5	sage/grass	2nd tributary
350	0.5	3.075	0.55	2.7675	-0.3075	1	1	350	1076.25	350	968.625	-107.625	-5	meadow	
170	0.8	1.23	0.55	2.7675	1.5375	1	1	170	209.1	170	470.475	261.375	25		
400	0.5	3.075	0.55	2.7675	-0.3075	1	1	400	1230	400	1107	-123	-5		
610	0.7	1.845	0.82	1.107	-0.738	2	2	1220	2250.9	1220	1350.54	-900.36	-12	Geyer's willow/sedge	
250	0.4	3.69	0.82	1.107	-2.583	2	2	500	1845	500	553.5	-1291.5	-42		
200	0.1	5.535	0.82	1.107	-4.428	2	2	400	2214	400	442.8	-1771.2	-72		
170	0.7	1.845	0.82	1.107	-0.738	2	2	340	627.3	340	376.38	-250.92	-12		
100	0.1	5.535	0.82	1.107	-4.428	2	2	200	1107	200	221.4	-885.6	-72		
1700	0.9	0.615	0.94	0.369	-0.246	1	1	1700	1045.5	1700	627.3	-418.2	-4	dry DF w/o Ppine	3rd tributary
1400	0.7	1.845	0.82	1.107	-0.738	2	2	2800	5166	2800	3099.6	-2066.4	-12	Geyer's willow/sedge	
130	0.5	3.075	0.82	1.107	-1.968	2	2	260	799.5	260	287.82	-511.68	-32		
1100	0.7	1.845	0.82	1.107	-0.738	2	2	2200	4059	2200	2435.4	-1623.6	-12		
520	0.6	2.46	0.82	1.107	-1.353	2	2	1040	2558.4	1040	1151.28	-1407.12	-22		
280	0.4	3.69	0.82	1.107	-2.583	2	2	560	2066.4	560	619.92	-1446.48	-42		
60	0	6.15	0.82	1.107	-5.043	2	2	120	738	120	132.84	-605.16	-82		
230	0.5	3.075	0.55	2.7675	-0.3075	1	1	230	707.25	230	636.525	-70.725	-5	meadow	4th tributary
170	0.9	0.615	0.94	0.369	-0.246	1	1	170	104.55	170	62.73	-41.82	-4	dry DF w/o Ppine	
420	0.3	4.305	0.55	2.7675	-1.5375	1	1	420	1808.1	420	1162.35	-645.75	-25	meadow	
880	0.9	0.615	0.94	0.369	-0.246	1	1	880	541.2	880	324.72	-216.48	-4	dry DF w/o Ppine	
390	0.6	2.46	0.82	1.107	-1.353	2	2	780	1918.8	780	863.46	-1055.34	-22	Geyer's willow/sedge	
790	0.7	1.845	0.82	1.107	-0.738	2	2	1580	2915.1	1580	1749.06	-1166.04	-12		
270	0.8	1.23	0.82	1.107	-0.123	2	2	540	664.2	540	597.78	-66.42	-2		
470	0.8	1.23	0.64	2.214	0.984	3	3	1410	1734.3	1410	3121.74	1387.44	16		
810	0.6	2.46	0.64	2.214	-0.246	3	3	2430	5977.8	2430	5380.02	-597.78	-4		
550	0.3	4.305	0.64	2.214	-2.091	3	3	1650	7103.25	1650	3653.1	-3450.15	-34		
890	0.3	4.305	0.65	2.1525	-2.1525	1	1	890	3831.45	890	1915.725	-1915.725	-35	sage/grass	1st to 4th
360	0.8	1.23	0.93	0.4305	-0.7995	1	1	360	442.8	360	154.98	-287.82	-13	Geyer's willow/sedge	
610	0.4	3.69	0.93	0.4305	-3.2595	1	1	610	2250.9	610	262.605	-1988.295	-53		
200	0.8	1.23	0.93	0.4305	-0.7995	1	1	200	246	200	86.1	-159.9	-13		
620	0.3	4.305	0.65	2.1525	-2.1525	1	1	620	2669.1	620	1334.55	-1334.55	-35	sage/grass	2nd to 4th
670	0.7	1.845	0.93	0.4305	-1.4145	1	1	670	1236.15	670	288.435	-947.715	-23	Geyer's willow/sedge	
310	0.8	1.23	0.93	0.4305	-0.7995	1	1	310	381.3	310	133.455	-247.845	-13		
150	0.4	3.69	0.93	0.4305	-3.2595	1	1	150	553.5	150	64.575	-488.925	-53		
240	0.8	1.23	0.93	0.4305	-0.7995	1	1	240	295.2	240	103.32	-191.88	-13		
800	0.5	3.075	0.55	2.7675	-0.3075	1	1	800	2460	800	2214	-246	-5	meadow	NF 5th trib
220	0.7	1.845	0.93	0.4305	-1.4145	1	1	220	405.9	220	94.71	-311.19	-23	Geyer's willow/sedge	
180	0.2	4.92	0.93	0.4305	-4.4895	1	1	180	885.6	180	77.49	-808.11	-73		
420	0.8	1.23	0.93	0.4305	-0.7995	1	1	420	516.6	420	180.81	-335.79	-13		
530	0.7	1.845	0.93	0.4305	-1.4145	1	1	530	977.85	530	228.165	-749.685	-23		
370	0.8	1.23	0.93	0.4305	-0.7995	1	1	370	455.1	370	159.285	-295.815	-13		SF 5th trib
220	0.2	4.92	0.55	2.7675	-2.1525	1	1	220	1082.4	220	608.85	-473.55	-35	meadow	
1400	0.7	1.845	0.93	0.4305	-1.4145	1	1	1400	2583	1400	602.7	-1980.3	-23	Geyer's willow/sedge	
400	0.8	1.23	0.93	0.4305	-0.7995	1	1	400	492	400	172.2	-319.8	-13		
500	0.7	1.845	0.82	1.107	-0.738	2	2	1000	1845	1000	1107	-738	-12		5th tributary
100	0	6.15	0.82	1.107	-5.043	2	2	200	1230	200	221.4	-1008.6	-82		
							Total	**36,640**	**86,075**	**36,640**	**48,867**	**-37,209**	**-24**		

Table 26. Existing and potential solar loads for Twin Bridges Creek

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Twin Bridges Creek**
AU# ID17040218SK026_02														
890	0	6.15	0	6.15	0	1	1	890	5473.5	890	5473.5	0	0	rock/barren
70	0.9	0.615	0.94	0.369	-0.246	1	1	70	43.05	70	25.83	-17.22	-4	dry DF w/o Ppine
220	0.5	3.075	0.55	2.7675	-0.3075	1	1	220	676.5	220	608.85	-67.65	-5	meadow
200	0.9	0.615	0.93	0.4305	-0.1845	1	1	200	123	200	86.1	-36.9	-3	Geyer's
470	0.7	1.845	0.93	0.4305	-1.4145	1	1	470	867.15	470	202.335	-664.815	-23	willow/sedge
140	0.8	1.23	0.82	1.107	-0.123	2	2	280	344.4	280	309.96	-34.44	-2	
70	0.6	2.46	0.82	1.107	-1.353	2	2	140	344.4	140	154.98	-189.42	-22	
590	0.8	1.23	0.82	1.107	-0.123	2	2	1180	1451.4	1180	1306.26	-145.14	-2	
1000	0.9	0.615	0.82	1.107	0.492	2	2	2000	1230	2000	2214	984	8	
970	0.6	2.46	0.64	2.214	-0.246	3	3	2910	7158.6	2910	6442.74	-715.86	-4	
320	0.8	1.23	0.64	2.214	0.984	3	3	960	1180.8	960	2125.44	944.64	16	
1230	0.5	3.075	0.64	2.214	-0.861	3	3	3690	11346.75	3690	8169.66	-3177.09	-14	
170	0.2	4.92	0.64	2.214	-2.706	3	3	510	2509.2	510	1129.14	-1380.06	-44	
170	0.5	3.075	0.64	2.214	-0.861	3	3	510	1568.25	510	1129.14	-439.11	-14	
130	0.2	4.92	0.53	2.8905	-2.0295	4	4	520	2558.4	520	1503.06	-1055.34	-33	
200	0.6	2.46	0.53	2.8905	0.4305	4	4	800	1968	800	2312.4	344.4	7	
340	0.5	3.075	0.53	2.8905	-0.1845	4	4	1360	4182	1360	3931.08	-250.92	-3	
140	0.4	3.69	0.53	2.8905	-0.7995	4	4	560	2066.4	560	1618.68	-447.72	-13	
70	0	6.15	0.53	2.8905	-3.2595	4	4	280	1722	280	809.34	-912.66	-53	
480	0.2	4.92	0.53	2.8905	-2.0295	4	4	1920	9446.4	1920	5549.76	-3896.64	-33	
200	0.5	3.075	0.53	2.8905	-0.1845	4	4	800	2460	800	2312.4	-147.6	-3	
400	0.3	4.305	0.53	2.8905	-1.4145	4	4	1600	6888	1600	4624.8	-2263.2	-23	
580	0.1	5.535	0.53	2.8905	-2.6445	4	4	2320	12841.2	2320	6705.96	-6135.24	-43	
250	0	6.15	0.53	2.8905	-3.2595	4	4	1000	6150	1000	2890.5	-3259.5	-53	
							Subtotal	25,190	84,599	25,190	61,636	-22,963	-15	
AU# ID17040218SK026_03														
440	0.1	5.535	0.45	3.3825	-2.1525	5	5	2200	12177	2200	7441.5	-4735.5	-35	
830	0	6.15	0.45	3.3825	-2.7675	5	5	4150	25522.5	4150	14037.375	-11485.125	-45	
430	0.1	5.535	0.45	3.3825	-2.1525	5	5	2150	11900.25	2150	7272.375	-4627.875	0	
520	0.3	4.305	0.45	3.3825	-0.9225	5	5	2600	11193	2600	8794.5	-2398.5	0	
270	0	6.15	0.45	3.3825	-2.7675	5	5	1350	8302.5	1350	4566.375	-3736.125	-45	
180	0.1	5.535	0.45	3.3825	-2.1525	5	5	900	4981.5	900	3044.25	-1937.25	-35	
260	0.1	5.535	0.4	3.69	-1.845	6	6	1560	8634.6	1560	5756.4	-2878.2	-30	
370	0	6.15	0.4	3.69	-2.46	6	6	2220	13653	2220	8191.8	-5461.2	-40	
290	0.1	5.535	0.4	3.69	-1.845	6	6	1740	9630.9	1740	6420.6	-3210.3	-30	
590	0	6.15	0.4	3.69	-2.46	6	6	3540	21771	3540	13062.6	-8708.4	-40	
760	0.1	5.535	0.43	3.5055	-2.0295	6	6	4560	25239.6	4560	15985.08	-9254.52	-33	mountain
70	0.9	0.615	0.43	3.5055	2.8905	6	6	420	258.3	420	1472.31	1214.01	47	alder
220	0.1	5.535	0.43	3.5055	-2.0295	6	6	1320	7306.2	1320	4627.26	-2678.94	-33	
250	0.5	3.075	0.43	3.5055	0.4305	6	6	1500	4612.5	1500	5258.25	645.75	7	
							Subtotal	30,210	165,183	30,210	105,931	-59,252	-22	
							Total	**55,400**	**249,782**	**55,400**	**167,567**	**-82,216**	**-18**	

Table 27. Existing and potential solar loads for Spring Creek

Segment Length (meters)	Existing Shade (fraction)	Existing Summer Load (kWh/m^2/day)	Potential Shade (fraction)	Potential Summer Load (kWh/m^2/day)	Potential Load minus Existing load (kWh/m^2/day)	Existing Stream Width (m)	Natural Stream Width (m)	Existing Segment Area (m^2)	Existing Summer Load (kWh/day)	Natural Segment Area (m^2)	Potential Summer Load (kWh/day)	Potential Load minus Existing Load (kWh/day)	Lack of Shade (%)	**Spring Creek**
AU# ID17040218SK007_05														
260	0.4	3.69	0.3	4.305	0.62	7	7	1820	6715.8	1820	7835.1	1119.3	0	yellow
490	0.1	5.535	0.3	4.305	-1.23	7	7	3430	18985.05	3430	14766.15	-4218.9	-20	willow
200	0	6.15	0.3	4.305	-1.845	7	7	1400	8610	1400	6027	-2583	-30	
1400	0.1	5.535	0.3	4.305	-1.23	7	7	9800	54243	9800	42189	-12054	-20	
1000	0	6.15	0.3	4.305	-1.845	7	7	7000	43050	7000	30135	-12915	-30	
1000	0.1	5.535	0.3	4.305	-1.23	7	7	7000	38745	7000	30135	-8610	-20	
							Total	**30,450**	**170,349**	**30,450**	**131,087**	**-39,262**	**-20**	

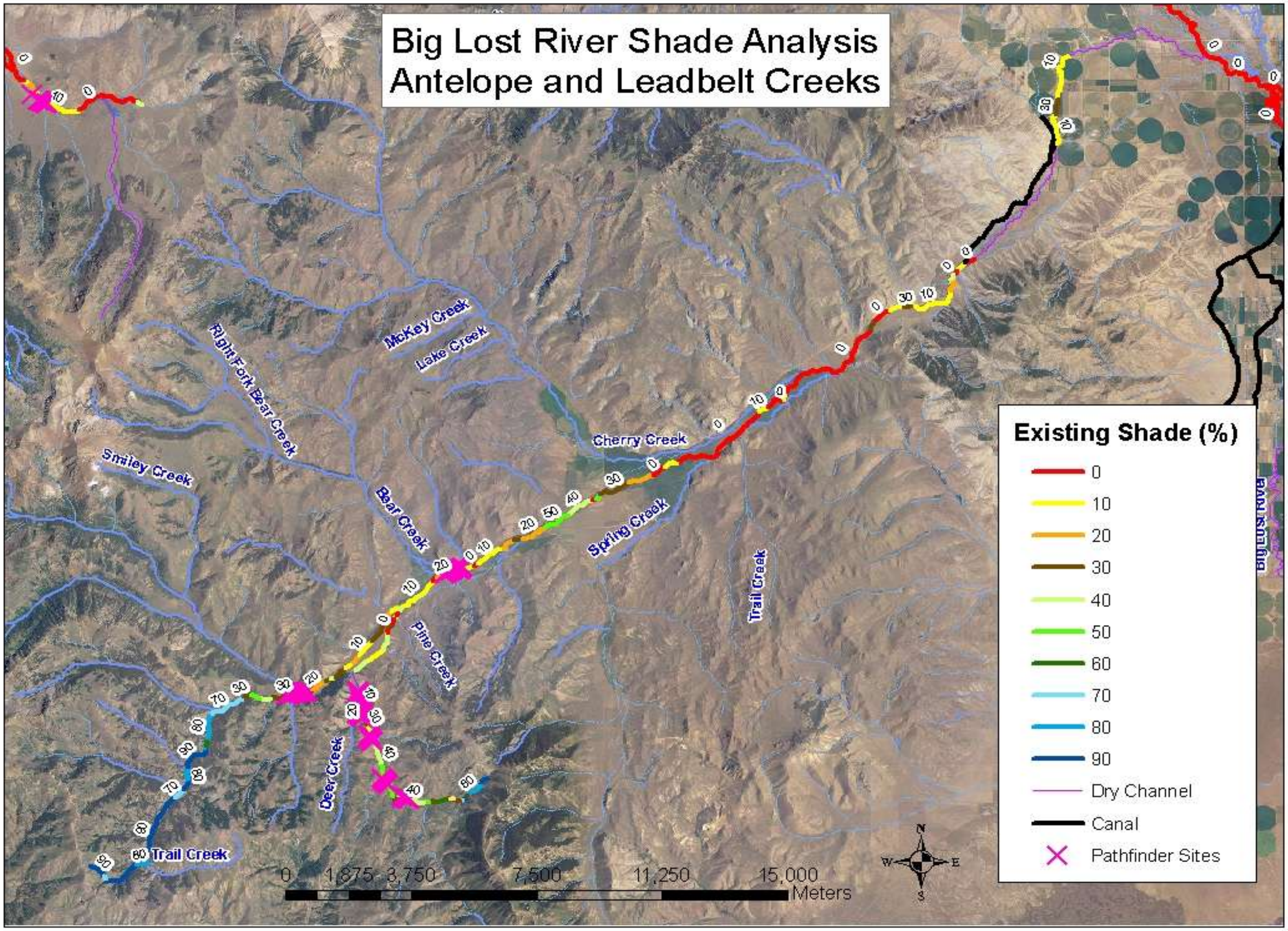

Figure 8. Existing shade estimated for Antelope and Leadbelt Creeks by aerial photo interpretation

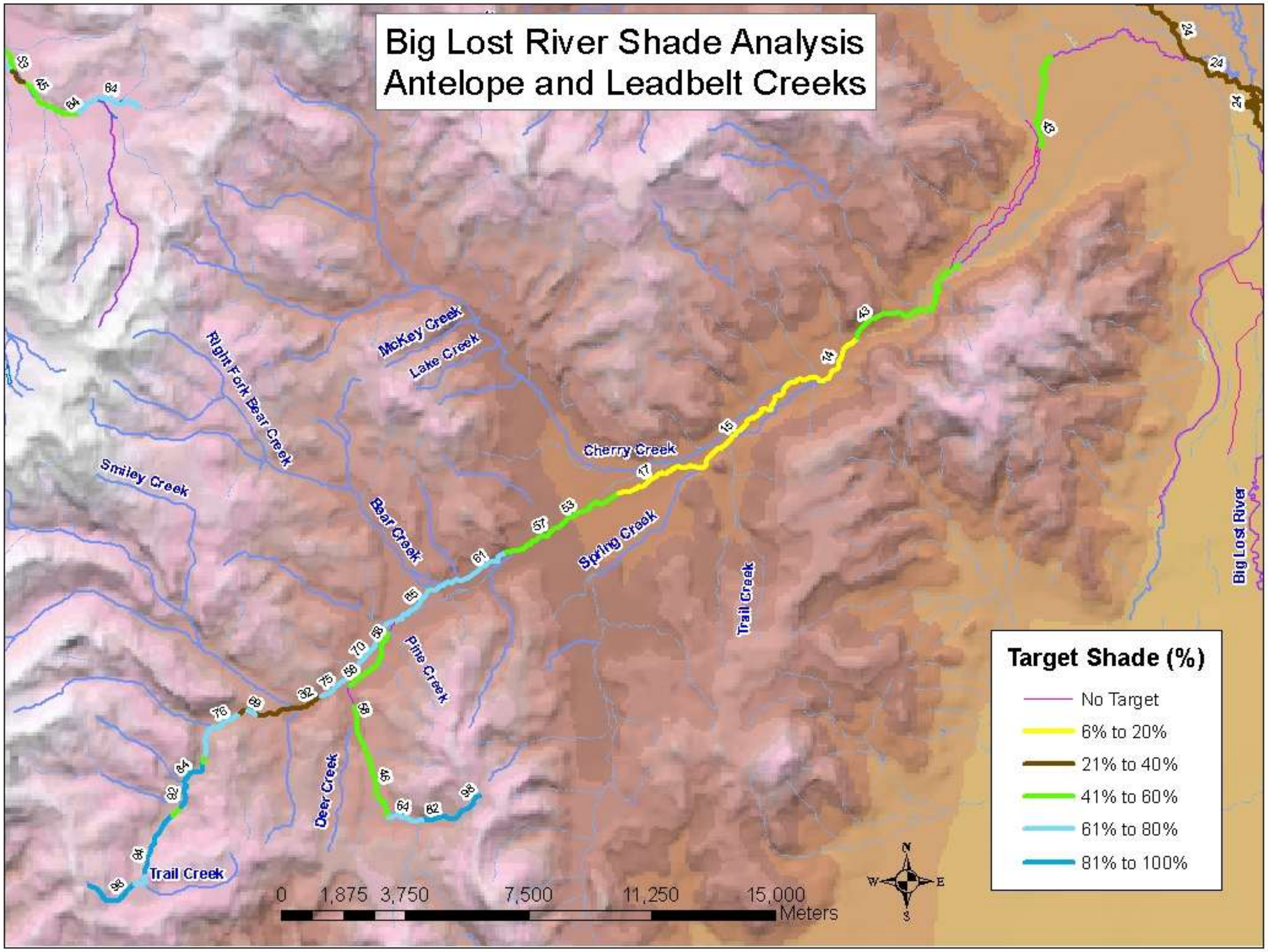

Figure 9. Target shade for Antelope and Leadbelt Creeks

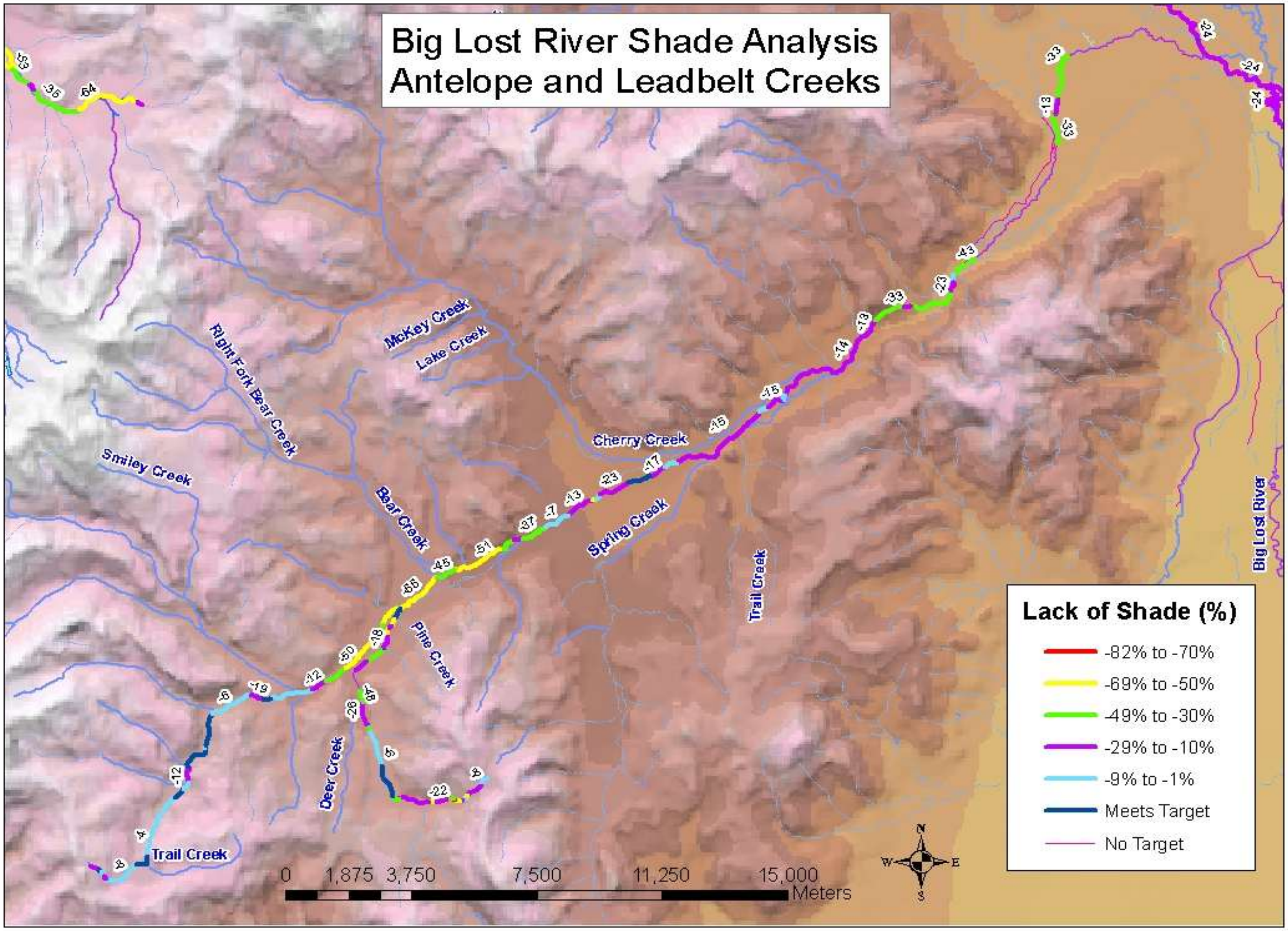

Figure 10. Lack of shade (difference between existing and target) for Antelope and Leadbelt Creeks

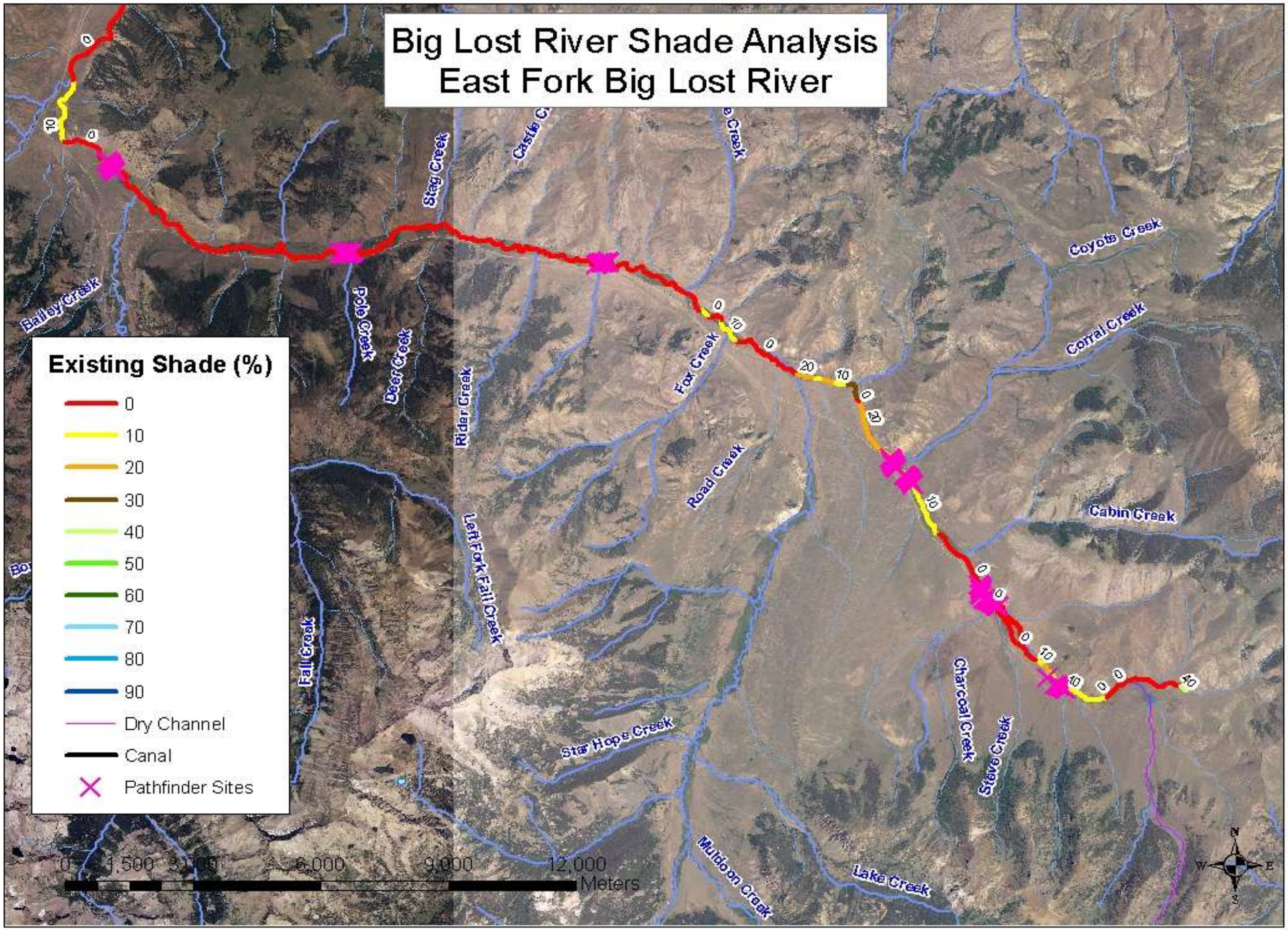

Figure 11. Existing shade estimated for East Fork Big Lost River by aerial photo interpretation

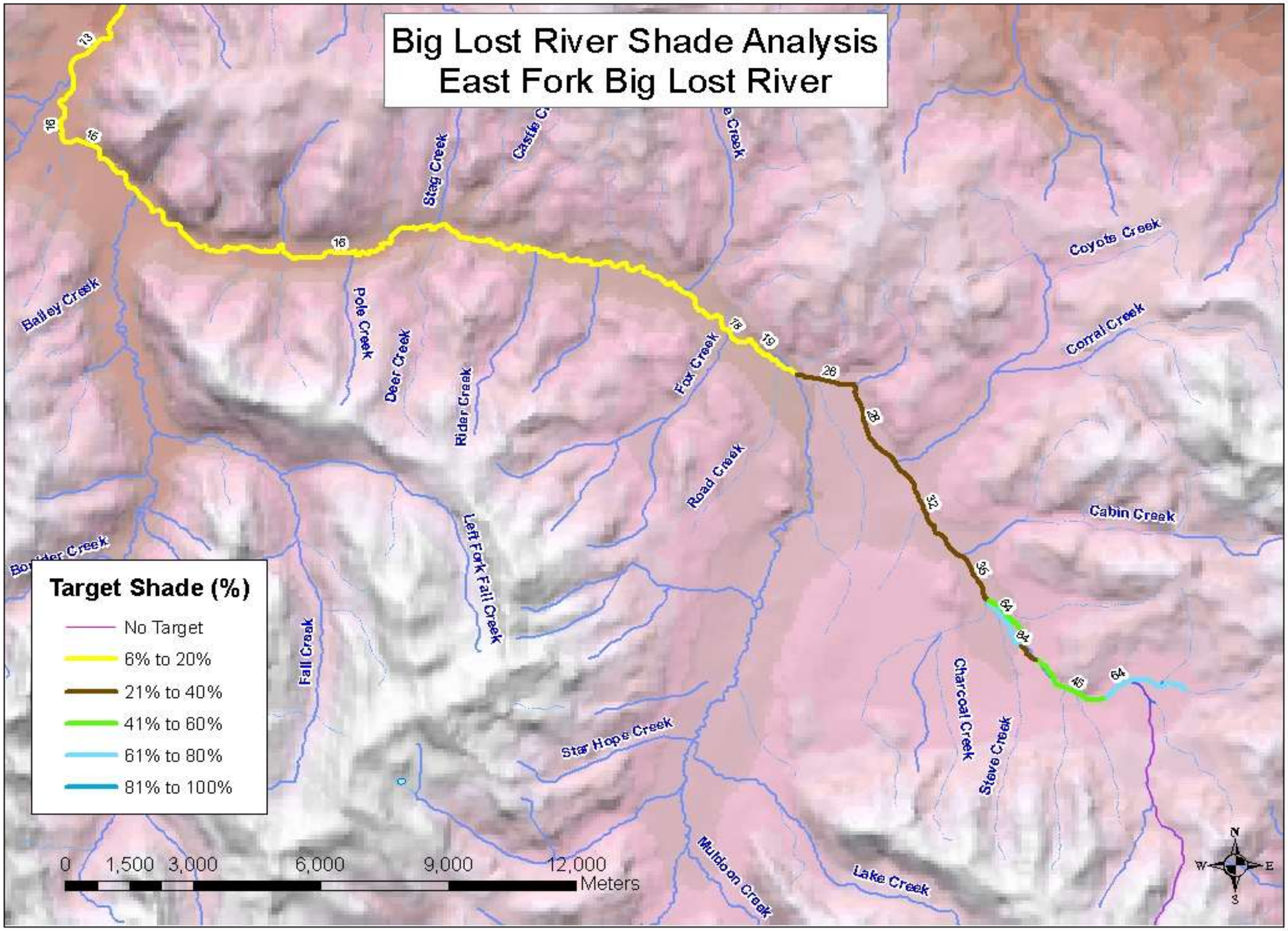

Figure 12. Target shade for East Fork Big Lost River

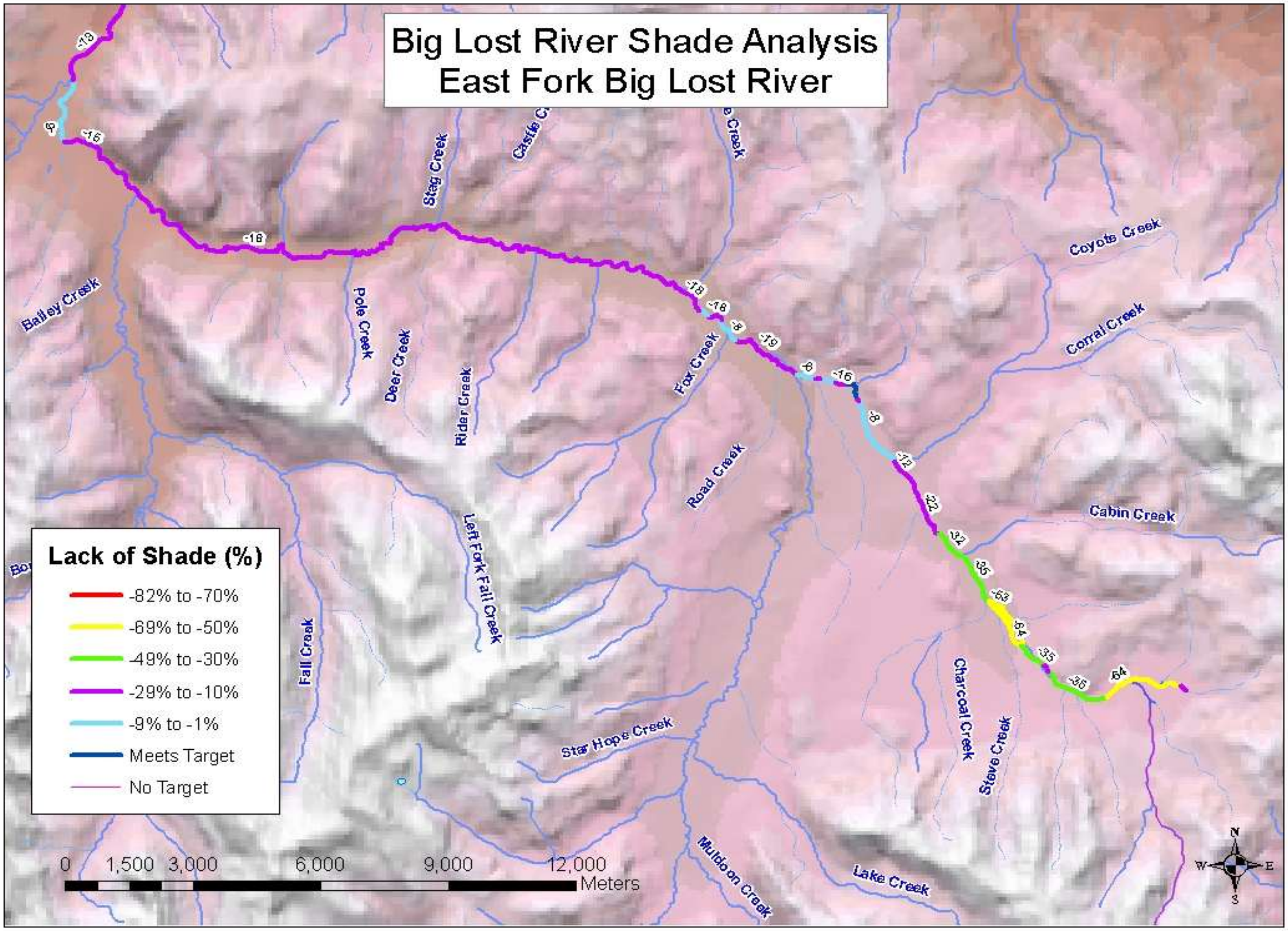

Figure 13. Lack of shade (difference between existing and target) for East Fork Big Lost River

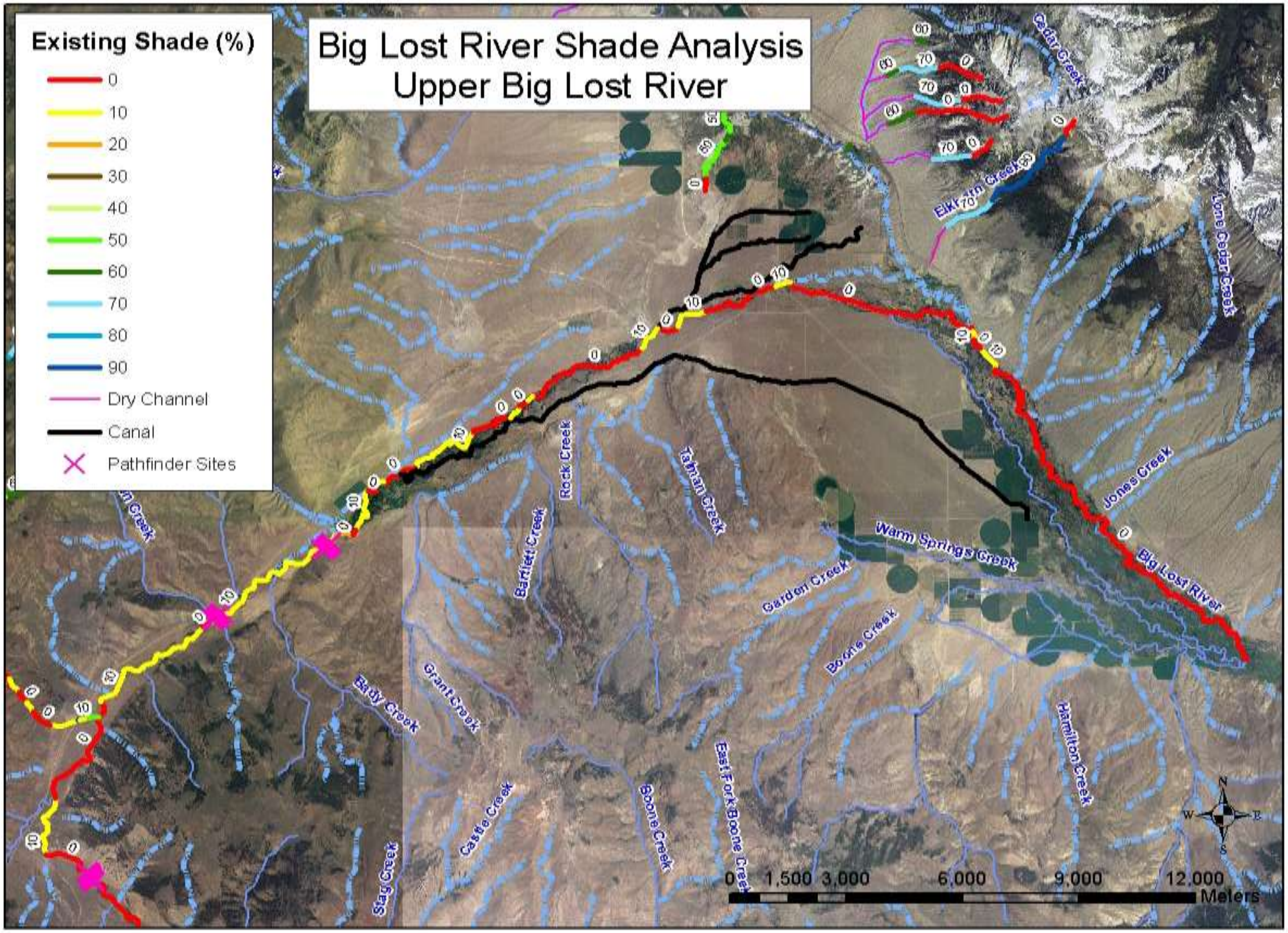

Figure 14. Existing shade estimated for upper Big Lost River by aerial photo interpretation

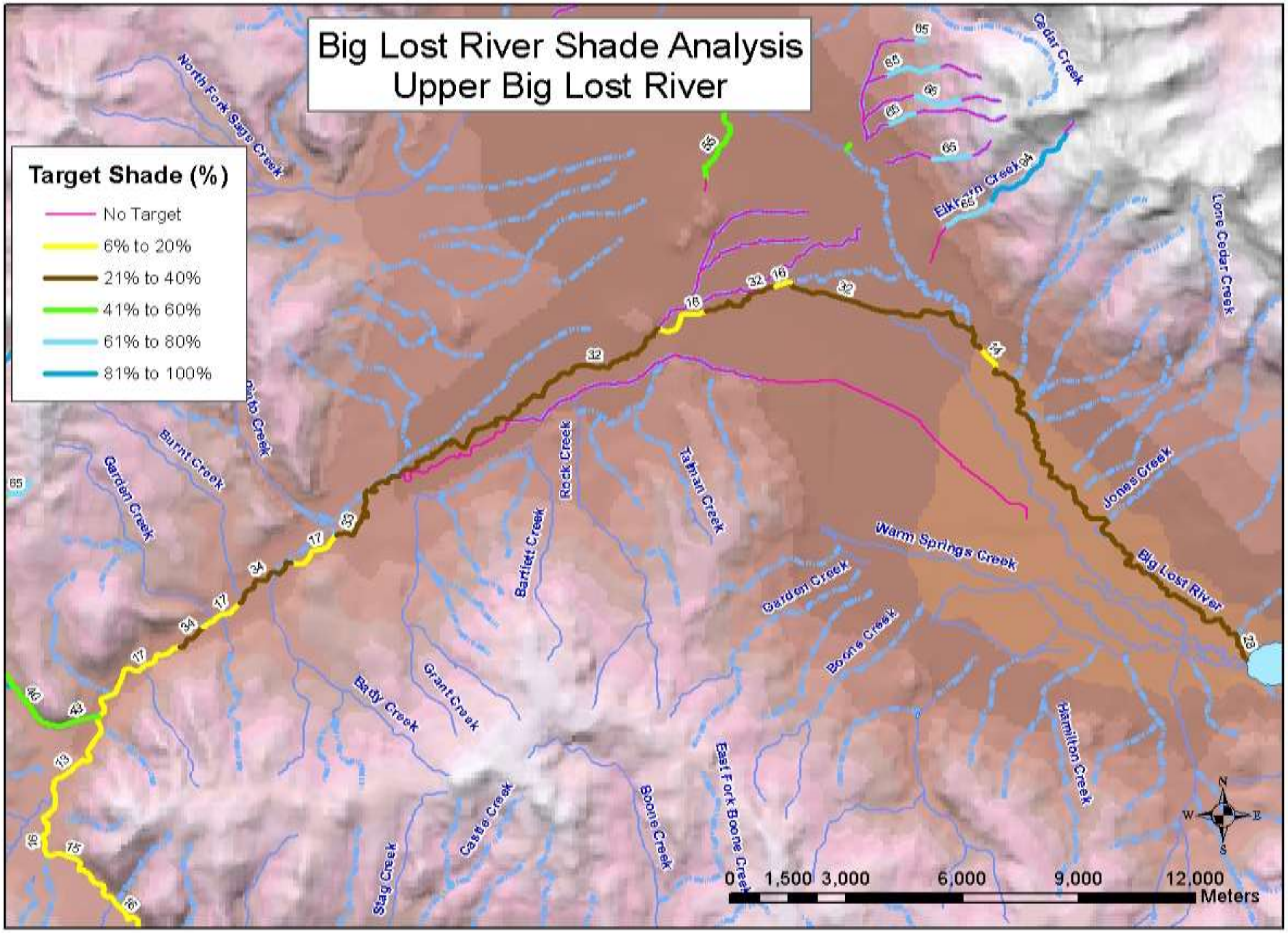

Figure 15. Target shade for upper Big Lost River

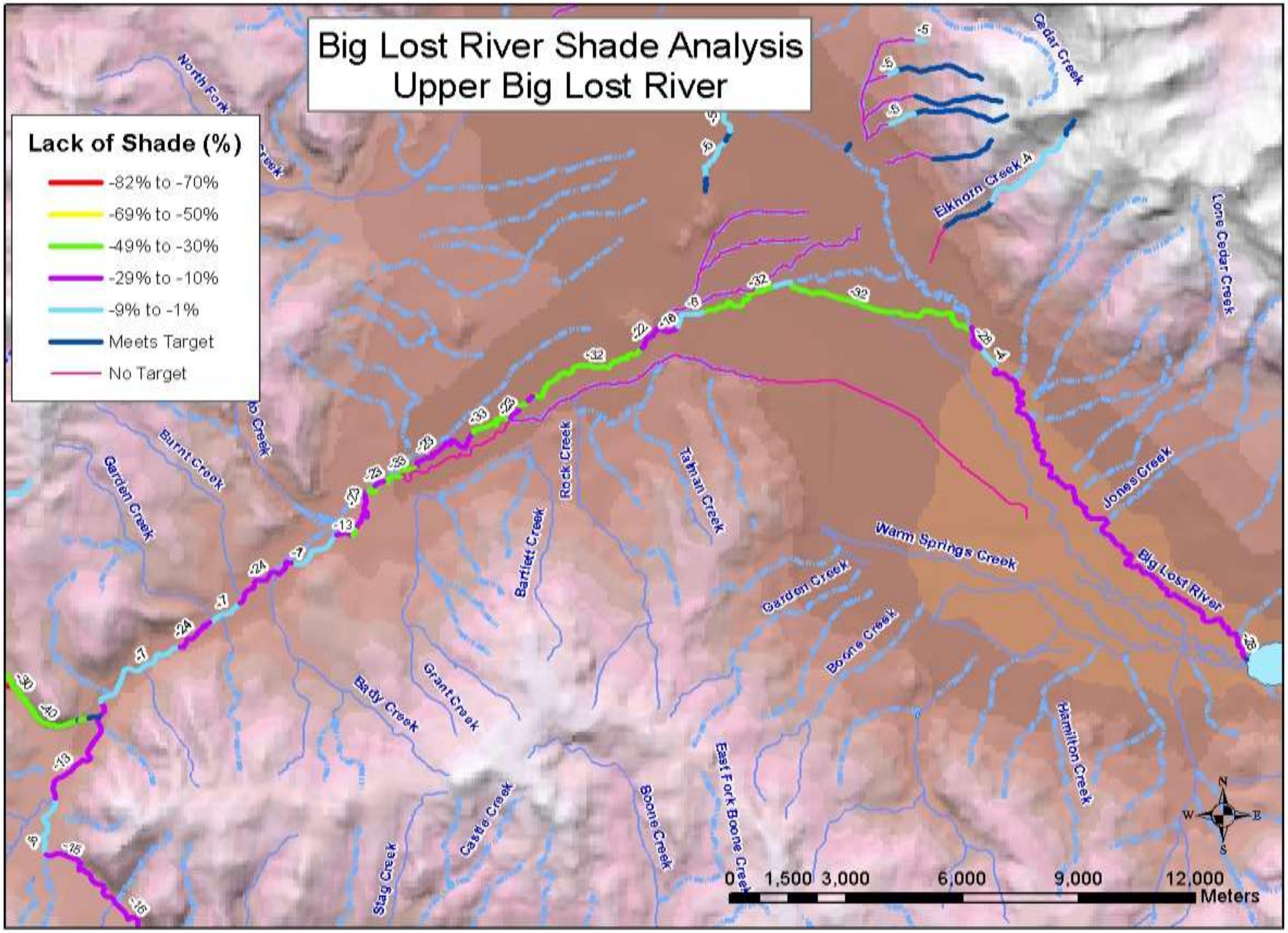

Figure 16. Lack of shade (difference between existing and target) for upper Big Lost River

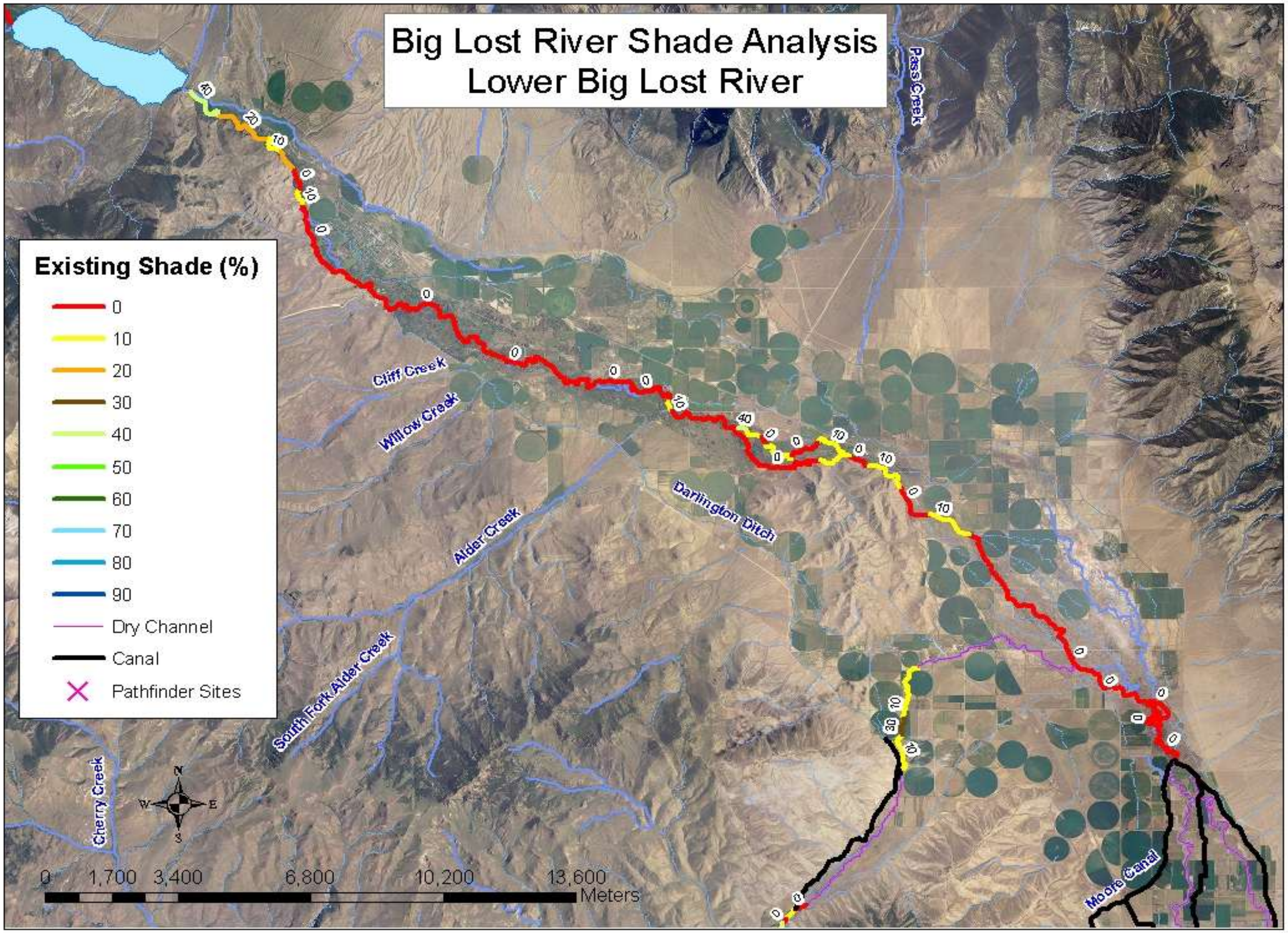

Figure 17. Existing shade estimated for lower Big Lost River by aerial photo interpretation

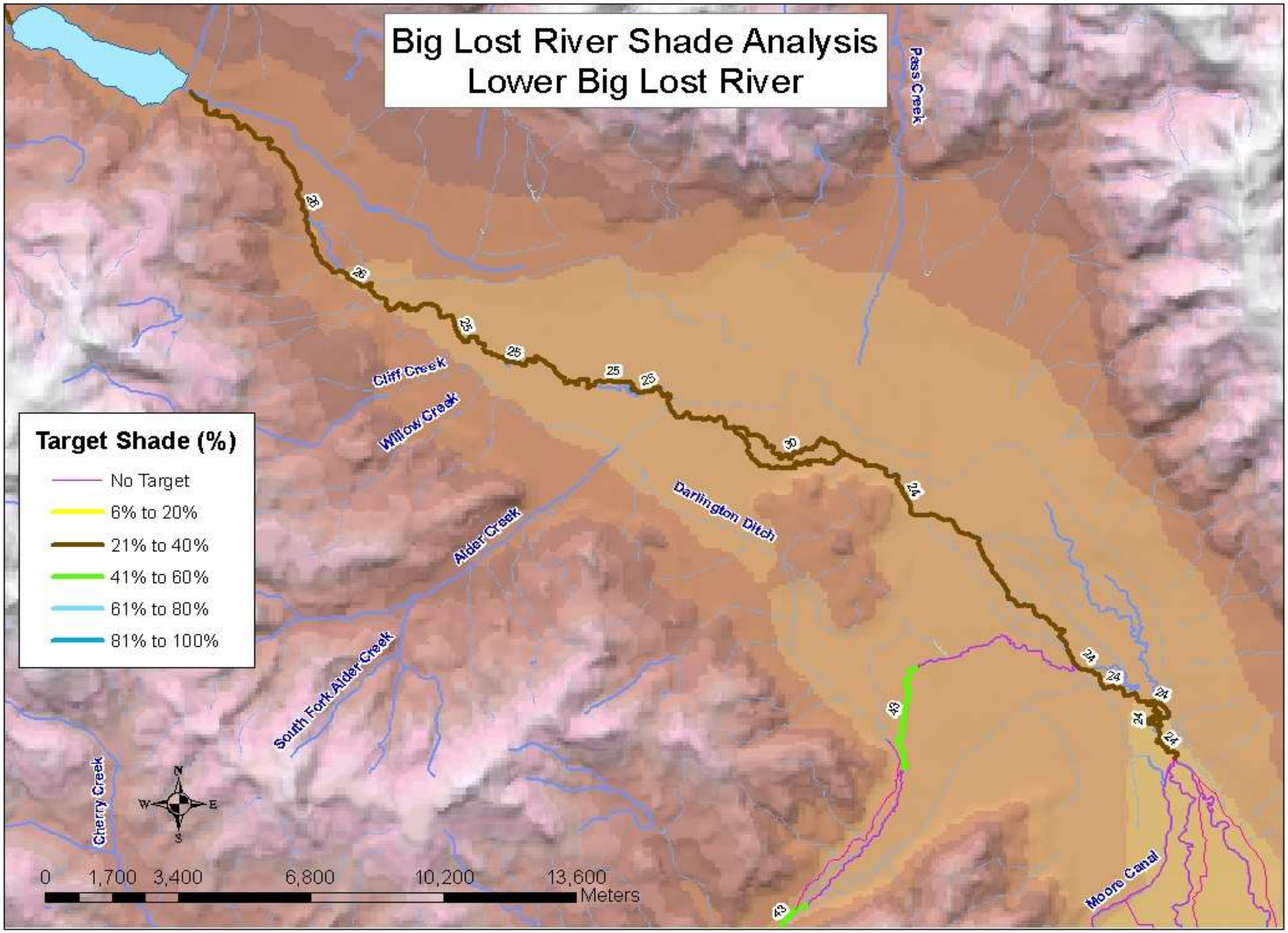

Figure 18. Target shade for lower Big Lost River

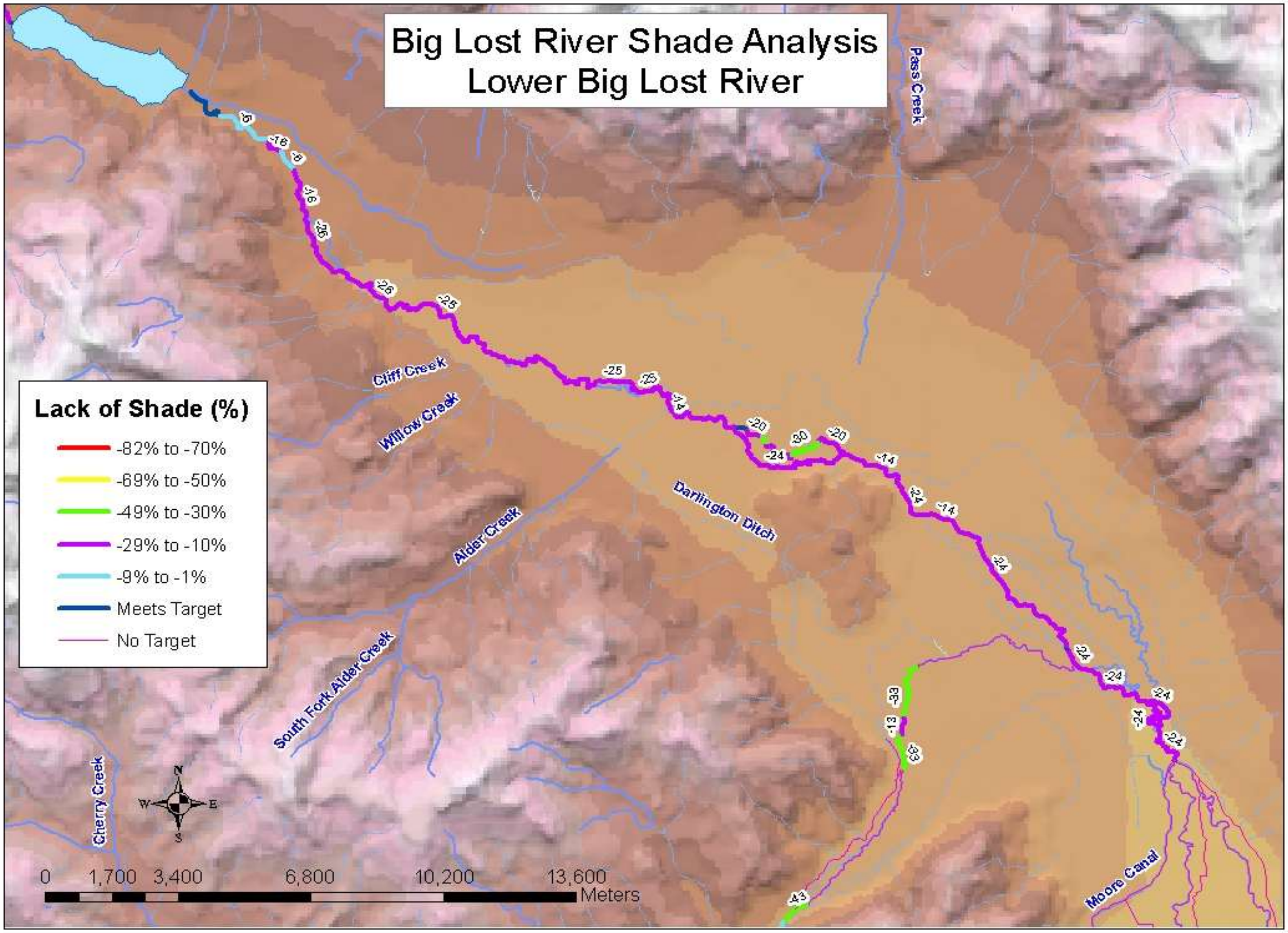

Figure 19. Lack of shade (difference between existing and target) for lower Big Lost River

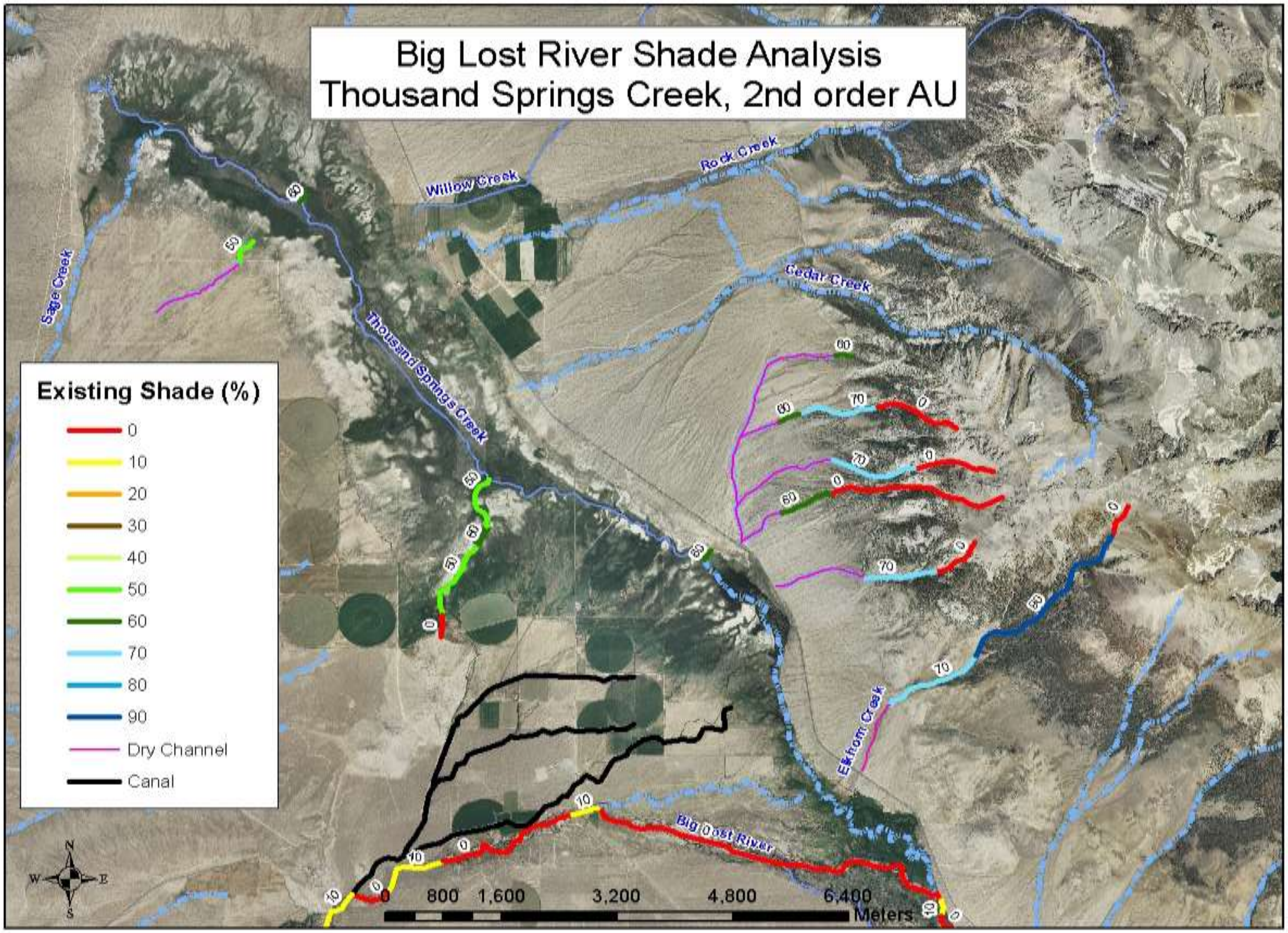

Figure 20. Existing shade estimated for Thousand Springs Creek tributaries by aerial photo interpretation

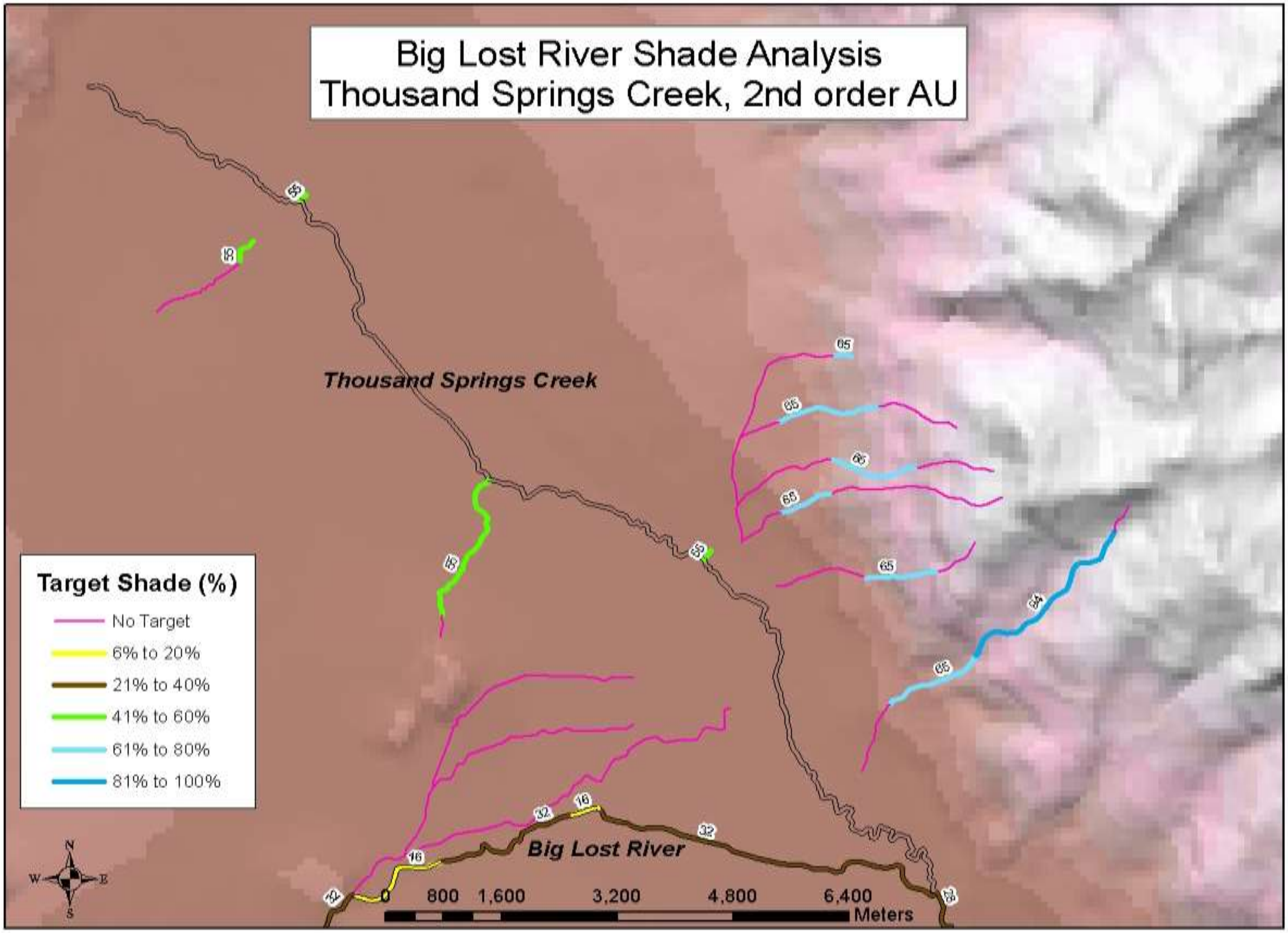

Figure 21. Target shade for Thousand Springs Creek tributaries

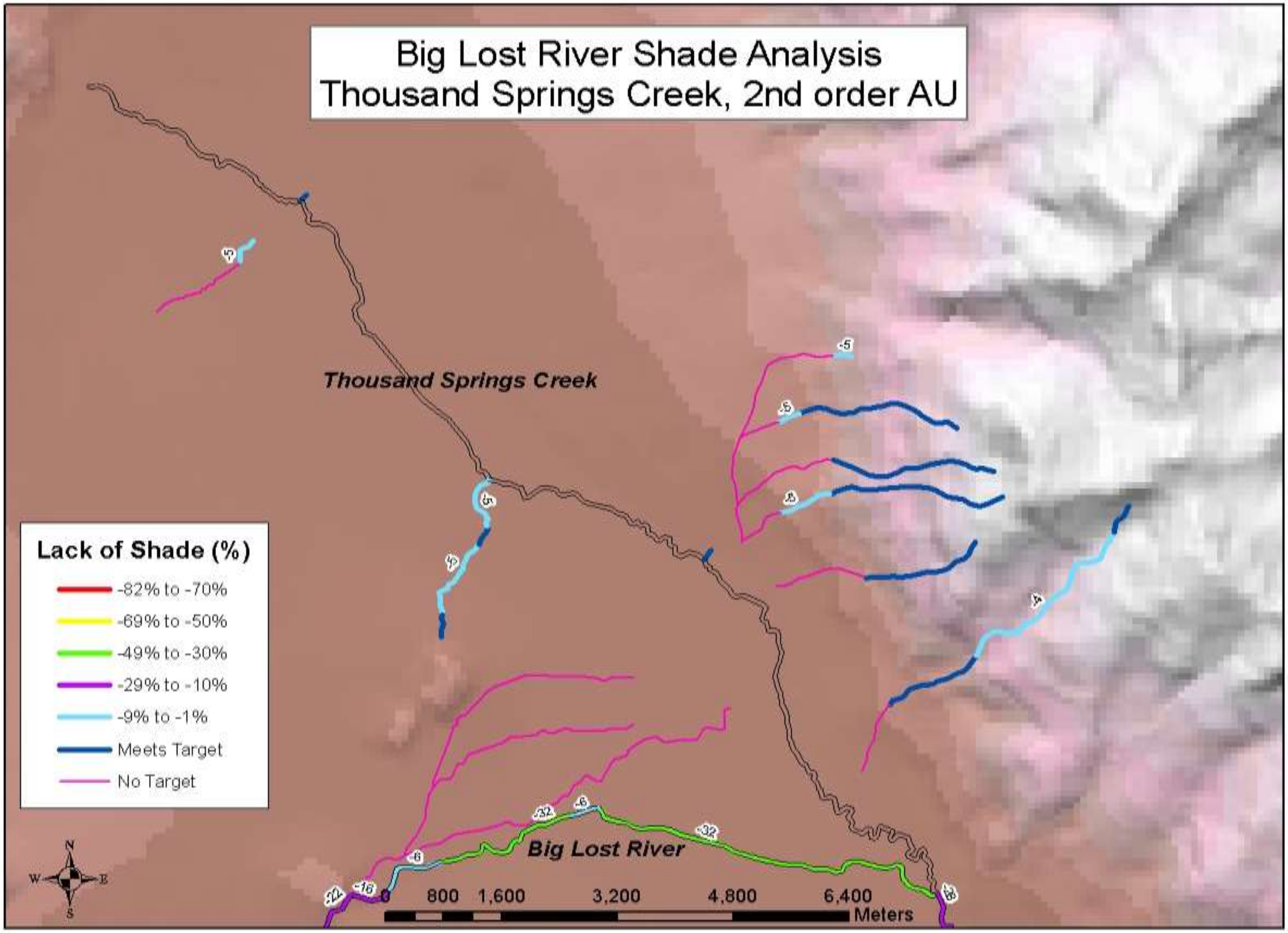

Figure 22. Lack of shade (difference between existing and target) for Thousand Springs Creek tributaries

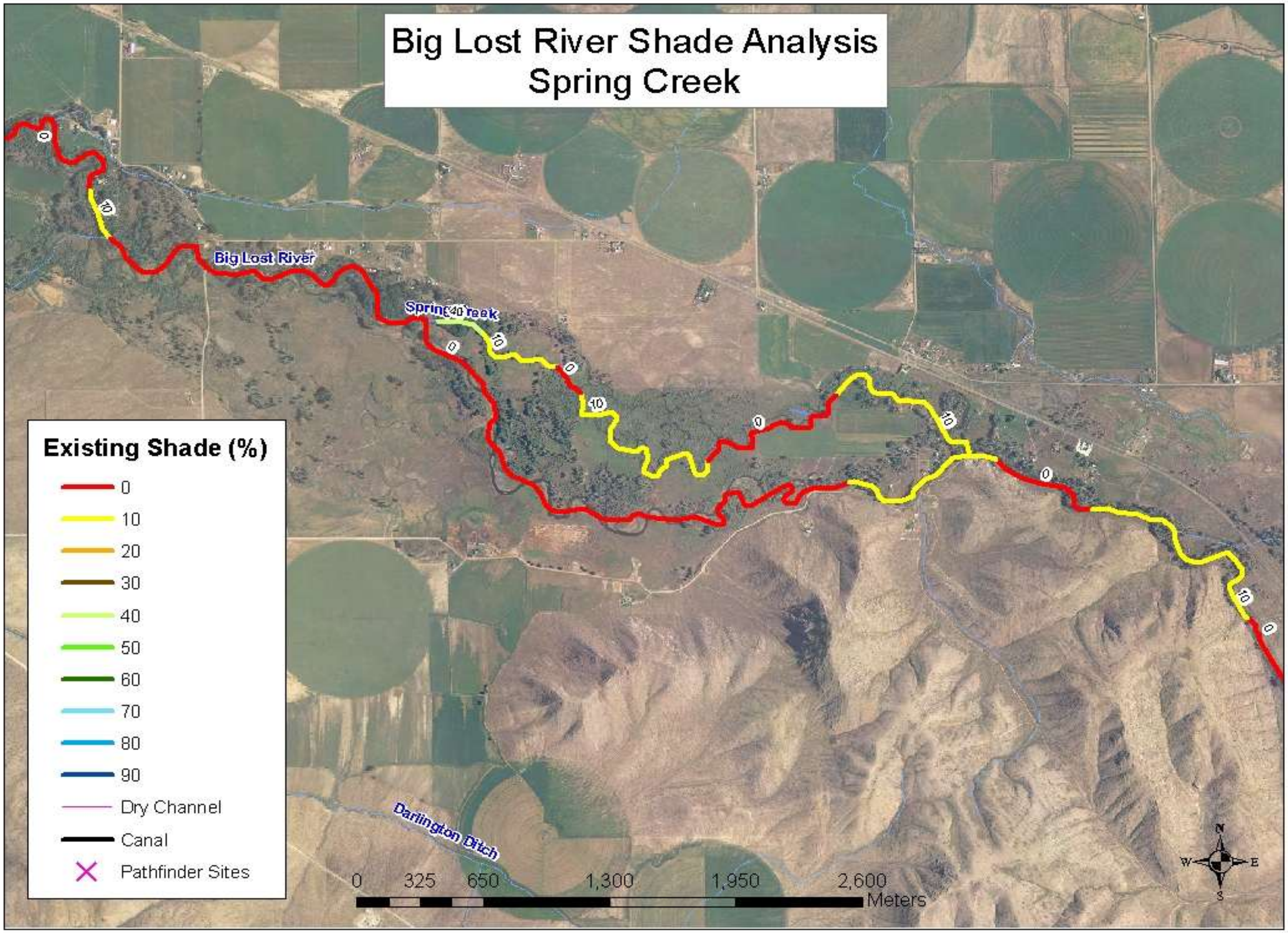

Figure 23. Existing shade estimated for Spring Creek by aerial photo interpretation

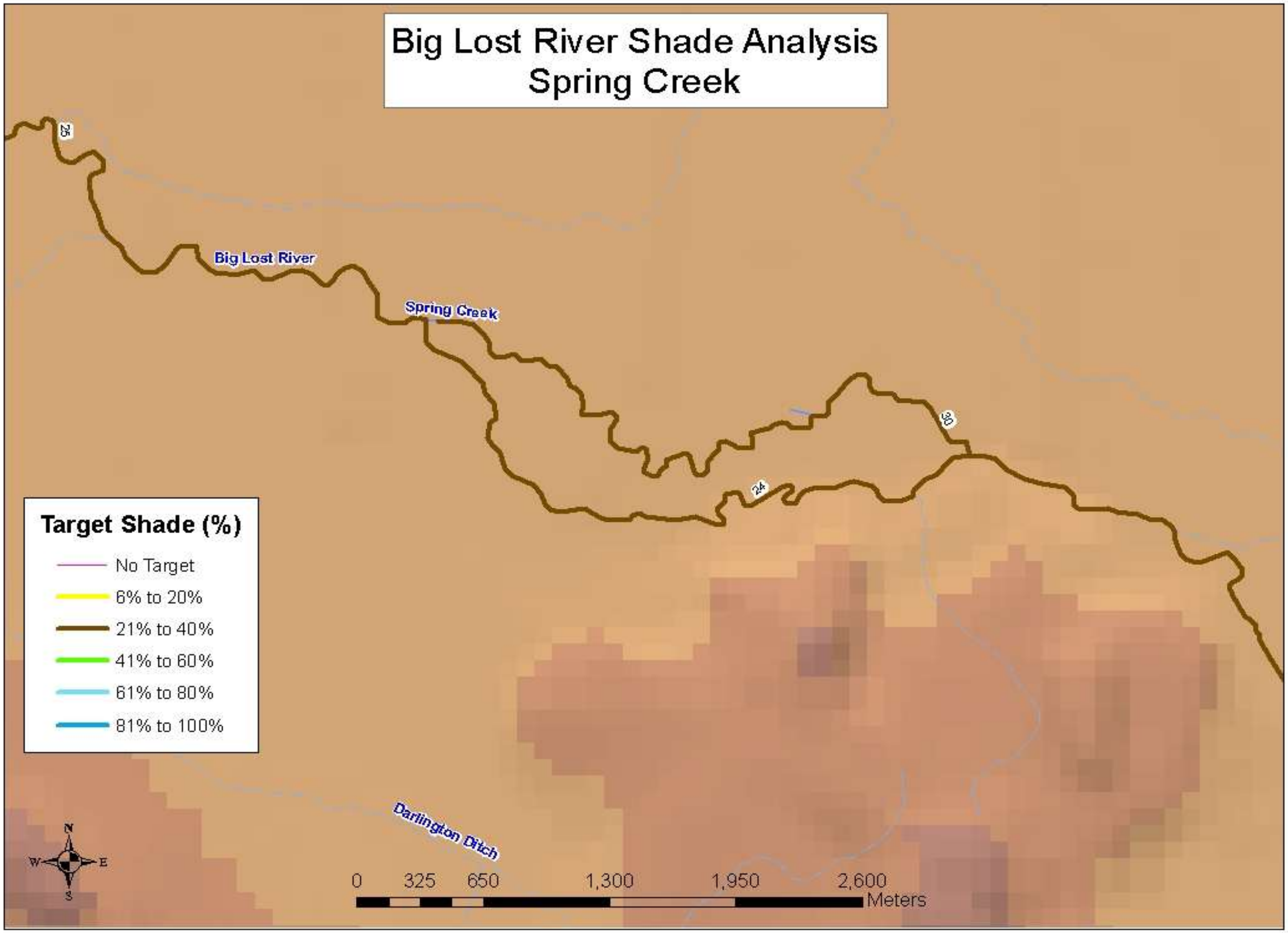

Figure 24. Target shade for Spring Creek

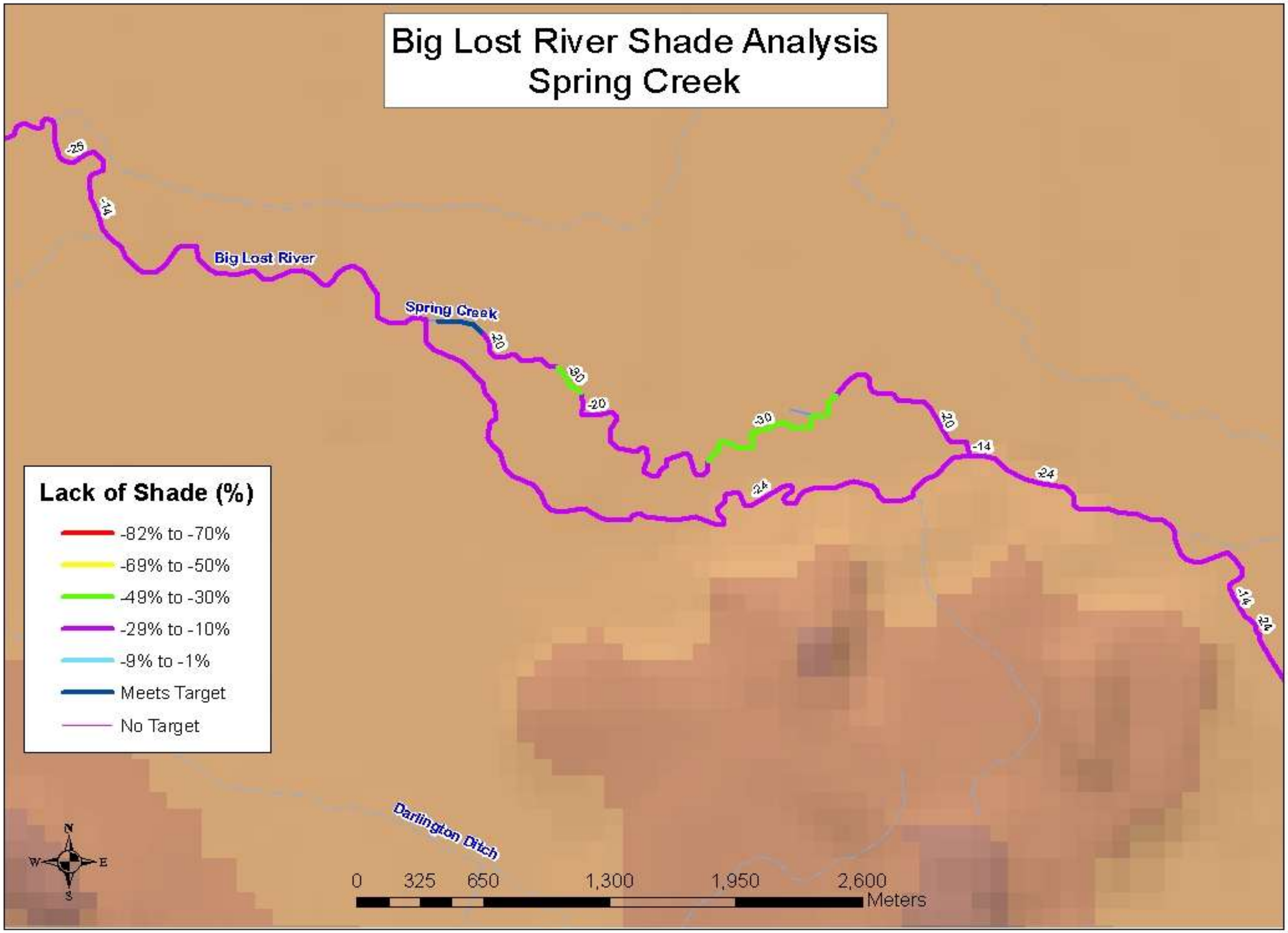

Figure 25. Lack of shade (difference between existing and target) for Spring Creek

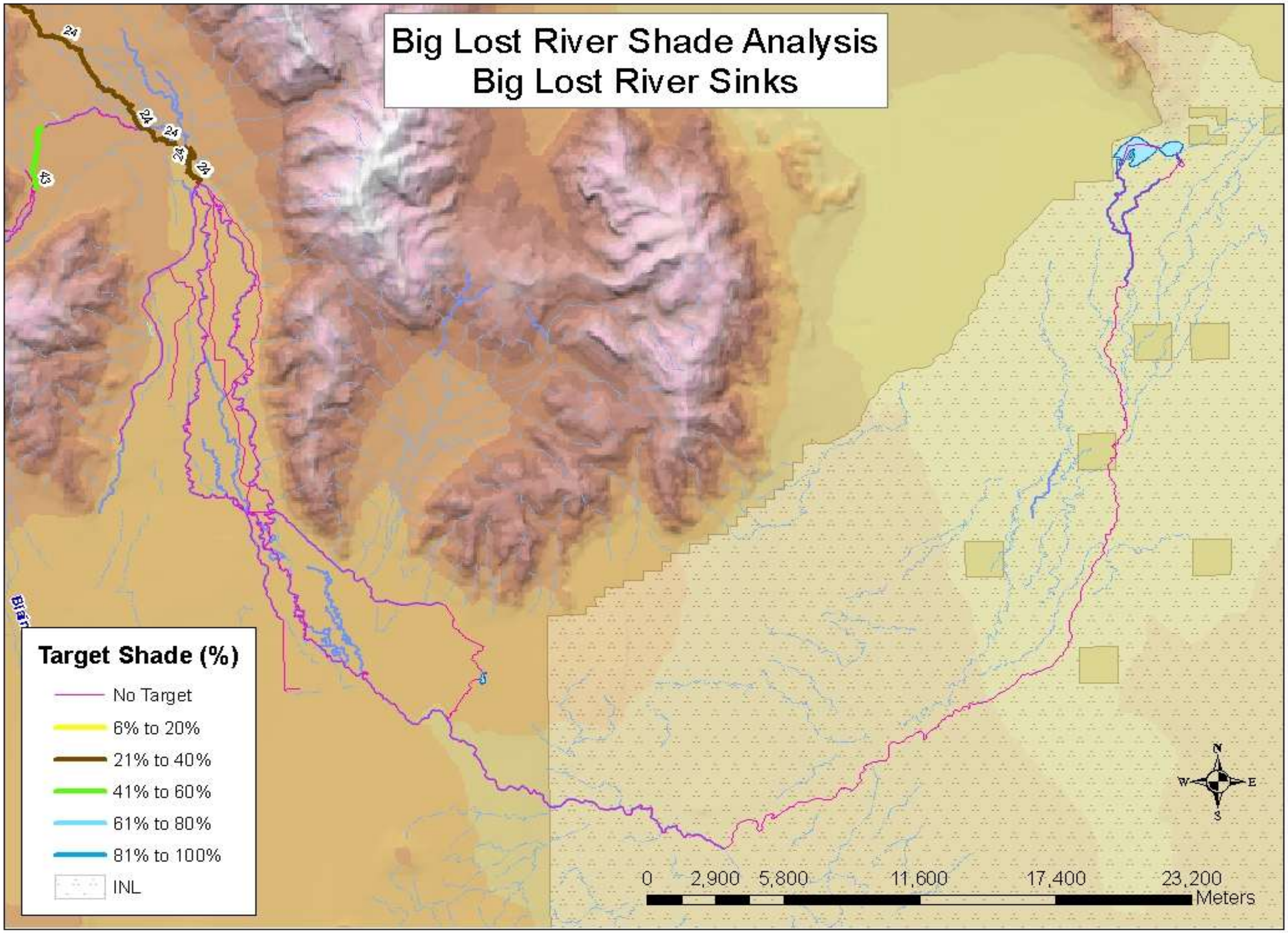

Figure 26. Target shade for Big Lost River sinks

5.3.4. Load Allocations

Because this TMDL is based on solar loads at PNV, which is equivalent to background loads, the load allocation is essentially the necessary load reduction to achieve background conditions. However, in order to reach that objective, load allocations are assigned to nonpoint source activities that have affected or may affect riparian vegetation and shade as a whole. Therefore, load allocations are reach specific and are dependent upon the target load for a given reach. Tables 19–27 show the target or potential shade, which is converted to a potential summer load by multiplying the inverse fraction (1 minus shade fraction) by the average load received by a flat-plate collector for the months of April–September. This calculation results in the load capacity of the stream necessary to achieve background conditions. At that point, there is no opportunity to further remove shade from the stream by any activity without exceeding its load capacity. Additionally, because this TMDL is dependent upon background conditions for achieving water quality standards, all tributaries to the waters examined here need to be in natural conditions to prevent excess heat loads to the system.

Table 28 shows the total existing, total target (i.e., load capacity), and total excess heat load (kWh/day); the percent of existing load that is in excess; and the average lack of shade for each water body examined. The size of a stream influences the size of the excess load. Large streams have higher existing and target loads by virtue of their larger channel widths. Table 28 lists the water bodies in order of their excess loads, from highest to lowest. Therefore, large water bodies tend to be listed first and small tributaries are listed last.

Although the following analysis emphasizes total heat loads for streams in this TMDL, differences between existing shade and target shade, as depicted in the lack-of-shade figures (Figures 10, 13, 16, 19, 22, and 25) are the key to successfully restoring these waters to conditions achieving water quality standards. Target shade levels for individual reaches should be the goal managers strive for with future implementation plans. Managers should focus on the largest differences between existing and target shade as locations to prioritize implementation efforts. Each load analysis table contains a final column that lists the lack of shade on the stream. It is derived from subtracting the target shade from the existing shade for each segment. Thus, stream segments with the largest lack of shade are in the worst condition. The average lack of shade listed at the bottom of the last column in each load analysis table is also listed in the table below and represents a general condition level for comparison among streams.

The Big Lost River itself was the largest water body examined and hence appears first in Table 28. The lower segment (i.e., below Mackay Reservoir) is slightly larger than the upper segment based on total target loads (load capacity). These segments lack shade primarily due to changes in hydrology and land use as a result of irrigated agriculture. Excess loads are about one-quarter of the total existing loads to these systems, and these segments lack 17 and 21% shade, on average. As mentioned previously, Rood et al. (2003) have described riparian conditions where dewatering from irrigation diversion has resulted in the die-off of the narrowleaf cottonwood and willow riparian communities.

Table 28. Total solar loads and average lack of shade for all waters

Water Body	Load (kWh/day)[a]	Load Capacity & Allocation (kWh/day)	Excess Load (kWh/day)	Load Reduction (%)	Average Lack of Shade (%)
Big Lost River, below Mackay Reservoir	8,512,363	6,623,765	1,888,598	22	17
Big Lost River, above Mackay Reservoir	7,038,048	5,293,062	1,744,986	25	21
Antelope Creek	2,453,739	1,755,685	698,054	28	23
East Fork Big Lost River	3,129,889	2,569,939	559,950	18	24
Twin Bridges Creek	249,782	167,567	82,216	33	18
Leadbelt Creek	140,085	85,561	54,523	39	32
Spring Creek	170,349	131,087	39,262	23	20
Twin Bridges Creek Tributaries	86,075	48,867	37,209	43	24
Thousand Springs Creek Tributaries	240,194	239,972	223	<1	1

[a] kWh/day = kilowatt hours per day

Although the East Fork Big Lost River is larger than Antelope Creek according to the load capacity, the East Fork appears to be in slightly better condition, with an 18% necessary load reduction compared to 28% for Antelope Creek. Likewise, Spring Creek appears to be larger than Leadbelt Creek; however, Leadbelt Creek has the higher proportion of excess load (39% versus 23%). Twin Bridges Creek and its tributaries appear to be the most impaired streams examined (33% and 43% necessary reduction, respectively); however, these load analyses are compounded by beaver activity and dry channels, both of which are natural phenomena that cause the stream to appear to be missing shade targets. Although segments of Twin Bridges Creek, Leadbelt Creek, and others are likely lacking shade, the implementation process should segregate out natural phenomena such as beaver ponds and intermittent segments.

The Geyer's willow community on the East Fork Big Lost River appears to be in recovery as a result of restoration activities in that drainage. Antelope Creek and Spring Creek likely have similar impacts to the narrowleaf cottonwood and willow communities as a result of irrigation diversion and subsequent die-off or removal of trees and shrubs.

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

5.3.5. Wasteload Allocation

There are three known NPDES-permitted point sources in the affected watersheds according to EPA's Permit Compliance System (PCS). Two are active fish hatcheries on Warm Springs Creek and one is a WWTP for the City of Mackay (ID023027) that discharges to wetlands adjacent to the Big Lost River. A fourth permit existed for DOE–INL tanks and tank components (IDR05A60F) with the Big Lost River listed as the receiving water. However, to our knowledge, the permit for the DOE facility has expired and the facilities are no longer discharging.

The Lost River Trout Hatchery (IDG130073) is located at the headwater springs to Warm Springs Creek on the south side of the Big Lost River above Mackay Reservoir (Figure 27). IDFG's Mackay Fish Hatchery (IDG130030) is located on a spring emerging from the side of a hill below Boone Creek. These springs drain to Warm Springs Creek approximately 3 miles below the headwater springs. Warm Springs Creek drains southeast and confluences with Parsons Creek before entering Mackay Reservoir adjacent to the Big Lost River. Warm Springs Creek, Parsons Creek, and Mackay Reservoir are not §303d-listed for temperature. Thus, these NPDES discharges have no direct effect on temperature-listed water bodies.

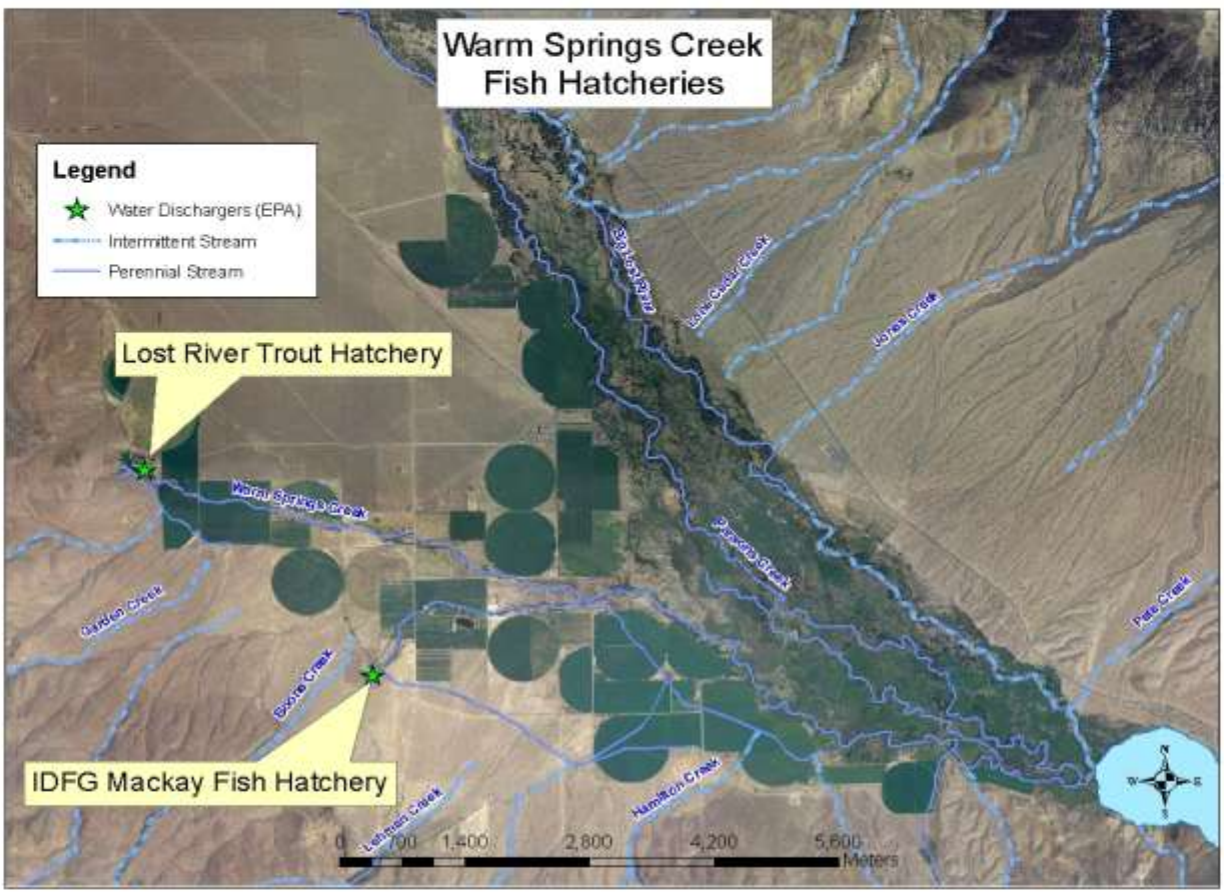

Figure 27. Big Lost River subbasin fish hatchery locations

Effluent temperatures emanating from the IDFG Mackay Fish Hatchery have been relatively constant within 2 °C (11 ºC to 12.6 ºC) for the past 24 years (Figure 28). Additionally, spring inflow temperatures into the facility have been measured at 10 ºC and 12.2 ºC, suggesting that the facility does not raise temperatures very much (probably <1 ºC). Natural springs may experience a similar level of increase from solar gain alone.

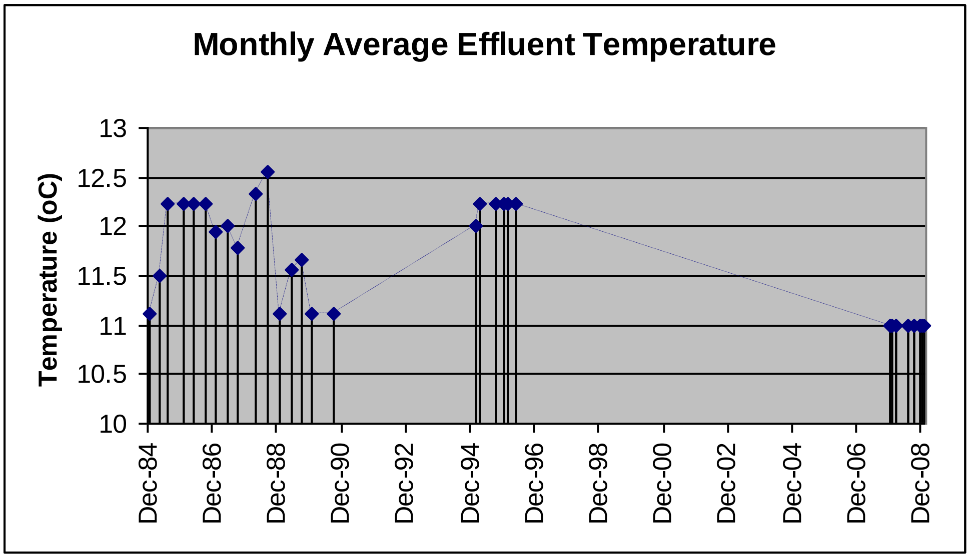

Figure 28. Monthly average effluent temperatures at Mackay Fish Hatchery

Thus, the hatcheries are not expected to have a thermal impact on water bodies within this subbasin. 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 and 58.01.02.401.01) should be involved.

The City of Mackay WWTP is a series of lagoons that ultimately discharge to wetlands adjacent to the Big Lost River below Mackay Reservoir (Figure 29). The wetland area likely mitigates any thermal load the discharge may have before it reaches the river; however, we have analyzed the potential impact from the discharge as if it were a direct discharge. Tables 29 and 30 show the maximum effluent temperature allowable that would still avoid raising the Big Lost River at various flows from 19 ºC to greater than 19.3 ºC (for cold water aquatic life criteria) (Table 29) or from 9 ºC to 9.3 ºC (for salmonid spawning criteria) (Table 30).

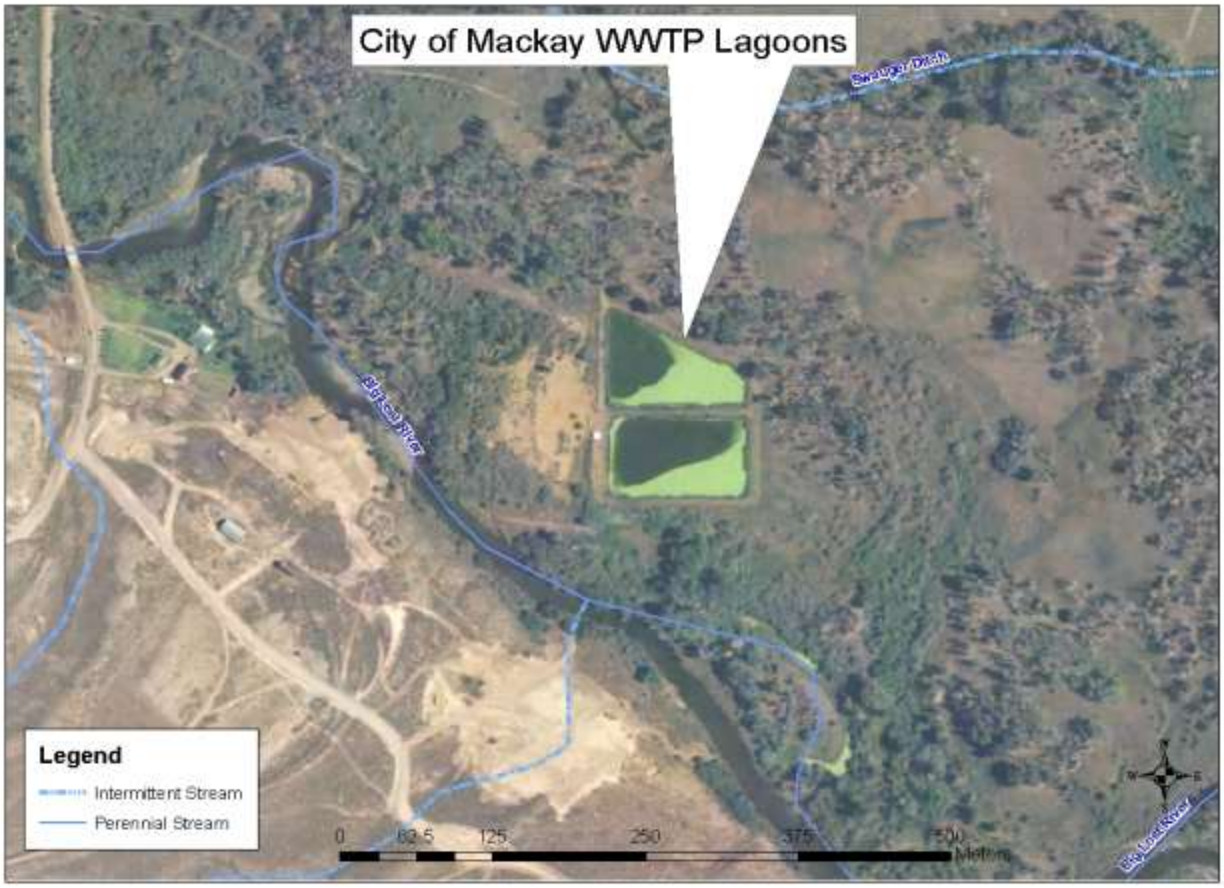

Figure 29. City of Mackay Wastewater Treatment Plant (WWTP)

Table 29. Maximum effluent temperatures (ºC) that could raise Big Lost River temperatures from 19 ºC to 19.3 ºC at various flows

Coldwater Aquatic Life Criteria

effluent T limits which would not cause >0.3C increase
when cold water criteria are applicable
assuming ambient T = 19 C

Stream Flow (cfs)	City of Mackay WWTP Facility Effluent Discharge (cfs)				
	0.1	0.15	0.2	0.25	0.3
100	94.3	69.3	56.8	49.3	44.3
200	169.3	119.3	94.3	79.3	69.3
300	244.3	169.3	131.8	109.3	94.3
400	319.3	219.3	169.3	139.3	119.3
500	394.3	269.3	206.8	169.3	144.3
600	469.3	319.3	244.3	199.3	169.3
700	544.3	369.3	281.8	229.3	194.3
800	619.3	419.3	319.3	259.3	219.3
900	694.3	469.3	356.8	289.3	244.3

facility existing effluent flow w/ infiltration = 0.07 MGD (0.108 cfs)
facility design flow = 0.108 MGD (0.17 cfs)
facility design flow with infiltration = 0.18 MGD (0.28 cfs)

Table 30. Maximum effluent temperatures (ºC) that could raise Big Lost River temperatures from 9 ºC to 9.3 ºC at various flows

Salmonid Spawning Criteria

effluent T limits which would not cause >0.3C increase
when salmonid spawning criteria are applicable
assuming ambient T = 9 C

Stream Flow (cfs)	City of Mackay WWTP Facility Effluent Discharge (cfs)				
	0.1	**0.15**	**0.2**	**0.25**	**0.3**
100	84.3	59.3	46.8	39.3	34.3
200	159.3	109.3	84.3	69.3	59.3
300	234.3	159.3	121.8	99.3	84.3
400	309.3	209.3	159.3	129.3	109.3
500	384.3	259.3	196.8	159.3	134.3
600	459.3	309.3	234.3	189.3	159.3
700	534.3	359.3	271.8	219.3	184.3
800	609.3	409.3	309.3	249.3	209.3
900	684.3	459.3	346.8	279.3	234.3

The range of streamflows is based on mean monthly flows recorded for the Big Lost River approximately 3 miles above the WWTP discharge (Table 31). Note that under the highest effluent flow discharge (0.3 cfs > design flow plus infiltration) and lowest mean monthly river flow (100 cfs), the effluent temperature could be 44.3 ºC and not raise the river temperature above 19.3 ºC (Table 29). Likewise, the effluent temperature could be 34.3 ºC and not raise the river temperature above 9.3 ºC under the highest effluent flow and lowest mean monthly river flow (Table 30). These data suggest that the effluent discharge from the City of Mackay WWTP is too small to have much thermal effect on the Big Lost River. Thus, a wasteload allocation is not necessary for the facility.

Table 31. Mean monthly flows for the Big Lost River below Mackay Reservoir, 1904–2008 (U.S. Geological Survey gage 13127000)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Mean monthly flow (cubic feet per second)	119	126	144	157	475	932	663	405	228	168	104	108

5.3.5.1. Reasonable Assurance

After TMDL acceptance by DEQ, EPA, and stakeholders, the next step of the Idaho water body management process is implementation. Idaho’s water quality standards identify designated agencies that are responsible for evaluating and modifying BMPs to protect impaired water bodies. The implementation strategies should incorporate field verification of the load analysis tables included in this TMDL.

Ongoing assessment of the support status of the water bodies with TMDLs will be reported in a 5-year review of the TMDL. If full support status has not been obtained, further implementation will be necessary and further reassessment performed until full support status is reached. If full support status is reached, the requirements of the TMDL will be considered complete.

5.3.5.2. Margin of Safety

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

5.3.5.3. Seasonal Variation

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

5.3.6. Implementation Strategies

Implementation strategies for TMDLs produced using PNV-based shade and solar loads should incorporate the load analysis 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 second to monitor progress towards achieving load 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 load analysis tables. Due to the inexact nature of the aerial photo interpretation technique, these tables should not be viewed as complete until verified. Implementation strategies should include Solar Pathfinder monitoring to simultaneously field verify the shade levels 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 TMDL goals are not being met or significant progress is not being made toward achieving the goals.

5.3.7. Conclusions

Effective shade targets were established based on the concept of maximum shading under PNV being resulting in natural background temperature levels (Table 32). Shade targets were derived from effective shade curves developed for vegetation types in Idaho. Existing shade was determined from aerial photo interpretation and partially field verified with Solar Pathfinder data.

All streams in the analysis lacked shade to some degree (Table 28). Thousand Springs Creek tributaries, an AU containing dry washes and small feeder springs to a graminoid meadow/spring dominated system, was in the best condition overall, needing only 0.09% reduction in solar load. Twin Bridges Creek and its tributaries, with extensive beaver workings and dewatered segments, showed the largest relative impacts with 33% and 43% reductions needed in solar load. Leadbelt Creek is similarly impacted with a 39% solar load reduction needed. A substantial amount of shade loss in these watersheds is likely due to natural sources that need to be investigated further. The remaining streams (Antelope Creek, Spring Creek, East Fork Big Lost River, and Big Lost River) require load reductions from 18 to 28%.

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

The four known point sources in the watershed do not require wasteload allocations for temperature because they either do not discharge to listed waters, are too small to affect listed waters, or are no longer a functioning facility with a discharge.

Table 32. Summary of temperature assessment outcomes

Water Body Segment/ Assessment Unit	Pollutant	TMDL(s) Completed	Recommended Changes to Integrated Report	Justification
Big Lost River/ ID17040218SK025_05 ID17040218SK024_05 ID17040218SK015_05 ID17040218SK013_05 ID17040218SK011_05 ID17040218SK010_05 ID17040218SK007_05 ID17040218SK006_06	Temperature	Yes	Move to Category 4a	Potential natural vegetation temperature TMDL completed.
East Fork Big Lost River/ ID17040218SK039_02 ID17040218SK039_03 ID17040218SK033_02 ID17040218SK033_03 ID17040218SK033_04	Temperature	Yes	Move to Category 4a	Potential natural vegetation temperature TMDL completed.
Antelope Creek/ ID17040218SK057_02 ID17040218SK057_03 ID17040218SK052_04 ID17040218SK047_04 ID17040218SK049_04 ID17040218SK049_05 ID17040218SK047_05 ID17040218SK046_05	Temperature	Yes	Move to Category 4a	Potential natural vegetation temperature TMDL completed.
Leadbelt Creek/ ID17040218SK058_02	Temperature	Yes	Move to Category 4a	Potential natural vegetation temperature TMDL completed.
Twin Bridges Creek/ ID17040218SK026_02 ID17040218SK026_03	Temperature	Yes	Move to Category 4a	Potential natural vegetation temperature TMDL completed.
Thousand Springs Creek Tributaries/ ID17040218SK016_02 Also known as Elkhorn Creek	Temperature	Yes	Move to Category 4a	This assessment unit is dry washes and spring fed wetlands. Potential natural vegetation temperature TMDL completed.

5.4. Construction Stormwater Requirements

5.4.1.1. Construction Stormwater

The CWA requires operators of construction sites to obtain permit coverage to discharge stormwater to a water body or municipal storm sewer. In Idaho, EPA has issued a general permit for stormwater discharges from construction sites. In the past, stormwater was treated as a nonpoint source of pollutants. However, because stormwater can be managed on site through management practices or when discharged through a discrete conveyance such as a storm sewer, it now requires an NPDES permit.

5.4.1.2. The Construction General Permit

If a construction project disturbs more than 1 acre of land (or is part of a larger common development that will disturb more than 1 acre), the operator is required to apply for a

Construction General Permit (CGP) from EPA after developing a site-specific Stormwater Pollution Prevention Plan (SWPPP).

5.4.1.3. Stormwater Pollution Prevention Plan

In order to obtain the CGP, operators must develop a site-specific SWPPP. Operators must document the erosion, sediment, and pollution controls they intend to use; inspect the controls periodically; and maintain BMPs throughout the life of the project.

5.4.1.4. Construction Stormwater Requirements

When a stream is on Idaho's §303(d) list and has a TMDL developed, DEQ may incorporate a gross wasteload allocation for anticipated construction stormwater activities. Most loads developed in the past that did not have a wasteload allocation for construction stormwater activities are considered in compliance with provisions of the TMDL if operators obtain a CGP under the NPDES program and implement the appropriate BMPs.

Typically, operators must follow specific requirements to be consistent with any local pollutant allocations. Many communities throughout Idaho are currently developing rules for postconstruction stormwater management. Sediment is usually the main pollutant of concern in construction site stormwater. The application of specific BMPs from DEQ's *Catalog of Stormwater Best Management Practices for Idaho Cities and Counties* (DEQ 2005) 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.

5.4.2. Remaining Available Load/Reserve for Growth

To the extent possible, the remaining available load should be apportioned (future load targets), taking into account both spatial (location) and temporal (seasonal) distribution of sources.

5.5. Public Participation

House Bill 145 (HB145) brought about changes in how WAGs are involved in TMDL development and review. The basic process for developing TMDLs and implementation plans is as follows:

1. DEQ's director appoints basin advisory group (BAG) members for each of Idaho's basins.
2. DEQ develops an Integrated Report every 2 years that highlights which water bodies in Idaho appear to be degraded.
3. DEQ begins the subbasin assessment (SBA) and TMDL process for individual degraded watersheds.
4. DEQ, with help from the BAG, forms a WAG for a specific watershed/TMDL. If there is no WAG, the BAG will act in its stead.
5. With the assistance of the WAG, DEQ develops an SBA and any necessary TMDLs for the watershed.
6. The WAG comments on the SBA/TMDL.
7. DEQ considers and incorporates WAG comments, as appropriate, into the SBA/TMDL.
8. The public comments on the SBA/TMDL.
9. DEQ considers and incorporates public comments, as appropriate, into the SBA/TMDL.
10. DEQ sends the document to EPA for approval.
11. DEQ and the WAG develop, then implement, a plan to reach the goals of the TMDL.

The WAG and the public are key elements in TMDL development. When requested, DEQ provides the WAG with all available information pertinent to the SBA/TMDL, such as monitoring data, water quality assessments, and relevant reports. The WAG also has the opportunity to actively participate in preparing the SBA/TMDL documents.

Once a draft SBA/TMDL is complete, it is reviewed first by the WAG, then by the public. If a WAG is not in agreement with an SBA/TMDL after WAG comments have been considered and incorporated, the WAG's position and the basis for it will be documented in the public notice of public availability of the SBA/TMDL for review. If the WAG still disagrees with the SBA/TMDL after public comments have been considered and incorporated, DEQ must incorporate the WAG's dissenting opinion.

In the final version of this addendum, the distribution list for the draft document and a summary of public comments and participation will be included as Appendices G and H, respectively.

5.6. Implementation Strategies

5.6.1. Time Frame

Implementation strategies for TMDLs may need to be modified if monitoring shows that TMDL goals are not being met or significant progress is not being made toward achieving the goals. After implementation strategies are in place, 20 years are allotted for meeting the sediment and temperature load allocations. This time frame should allow for two or three channel-forming events to occur and for riparian vegetation to stabilize the banks. The bacteria load allocation in Sage Creek is allotted 5 years after implementation projects have been completed to meet the target load.

5.6.2. Approach, Monitoring Strategy, and Responsible Parties

The designated management agencies, WAG, DEQ, and other appropriate participants will plan BMPs specific to each impaired reach with a load allocation. The public will also have the opportunity to be involved with implementation planning. The plan will include measureable milestones and a timeline for implementation. Monitoring conducted with DEQ-approved methods will measure progress toward meeting Idaho’s water quality standards. For assessing sediment load reduction, streambank erosion inventories and McNeil sediment cores should be performed in the same locations used in DEQ’s analysis for this TMDL. Target shade levels are provided for the entire reach of each stream with a temperature TMDL, so shade can be monitored anywhere in each applicable reach. Bacteria will be monitored on Sage Creek near the road crossing of Walker Road as a trend site since that is the location of the DEQ analysis for this TMDL.

5.7. Conclusions

Significant watershed improvement progress has been made since the initial pollutant analyses and load allocations were made in the *Big Lost River Watershed Subbasin Assessment and TMDL* (DEQ 2004). Lead agencies and landowners of key riparian habitat are working cooperatively to increase streambank stability and vegetative cover. Practices dictated by the latest scientific knowledge and technology are being implemented that will lead to a reduction in excess sedimentation and solar load that may currently be impairing beneficial uses such as salmonid spawning and recreational uses. Most of the major gaps between existing pollutant loads and targets are along the main stem Big Lost River, and land managers may focus their efforts here to see the best return for their efforts. Tables 33–37 summarize the findings of this TMDL analysis.

Table 33. Summary of assessment outcomes for waters listed in the 2008 Integrated Report

Water Body Segment/ Assessment Unit	Listed Pollutant(s)	TMDL Completed	Recommended Changes to Idaho's Integrated Report	Justification
Big Lost River, Spring Creek to Big Lost River Sinks ID17040218SK002_06	Sediment; Temperature; Cause unknown (suspected nutrient impairment)	No	Delist sediment, temperature, and cause unknown as pollutants; List in 4c for flow and habitat alteration	Reach is dewatered due to upstream diversions, groundwater withdrawals and unique hydrology
Pass Creek, source to mouth ID17040218SK009_02 (includes Bear Creek)	Combined biota/habitat bioassessments	No	Delist for combined biota/habitat bioassessments as pollutant; List in Category 2;	Meets water quality targets
Big Lost River, Jones Creek to Mackay Reservoir ID17040218SK013_05 and Big Lost River, Thousand Springs Creek to Jones Creek ID17040218SK015_05	Sediment; Cause unknown (suspected nutrient impairment)	Yes	List in Category 4a for sediment and temperature; change cause unknown to temperature	Sediment load allocation; potential natural vegetation temperature TMDL completed
Thousand Spring Creek, source to mouth ID17040218SK016_02	Temperature	Yes	List in Category 4a for temperature; this 2nd-order assessment unit does not contain any portion of Thousand Springs Creek but is in fact dry washes and springs adjacent to the creek	Potential natural vegetation temperature TMDL completed
Willow Creek, source to mouth ID17040218SK020_03	Combined biota/habitat bioassessments	No	List in Category 4c for flow alteration; delist for combined biota/habitat bioassessments as pollutant	Channel dry on most field investigations from diversions, ground water withdrawals, and unique hydrology
Sage Creek, source to mouth ID17040218SK022_02	Fecal coliform	Yes	List in Category 4A; change bacteria type from fecal coliform to *E. coli*	Bacteria TMDL completed
Big Lost River, Burnt Creek to Thousand Springs Creek ID17040218SK024_02	Combined biota/habitat bioassessments	No	List in Category 2; delist combined biota/habitat bioassessment as a pollutant	Meets water quality targets
Big Lost River, Burnt Creek to Thousand Springs Creek ID17040218SK024_03	Combined biota/habitat bioassessments	No	List in Category 2, delist combined biota/habitat bioassessment as a pollutant	Meets water quality targets
Big Lost River, Burnt Creek to Thousand Springs Creek ID17040218SK024_05	Sediment	Yes	List in Category 4a	Sediment TMDL completed
Big Lost River, Summit Creek to and including Burnt Creek ID17040218SK025_02	Combined biota/habitat bioassessments	No	List in Category 2; delist combined biota/habitat bioassessment as pollutant	Meets water quality targets

Water Body Segment/ Assessment Unit	Listed Pollutant(s)	TMDL Completed	Recommended Changes to Idaho's Integrated Report	Justification
Twin Bridge Creek, source to mouth ID17040218SK026_02	Cause unknown, (nutrients suspected impairment)	No	Keep in Category 4a for sediment; delist cause unknown as suspected pollutant	Sediment TMDL approved by U.S. Environmental Protection Agency in 2004 and no evidence of nutrient, temperature, or further impairment
Twin Bridge Creek, source to mouth ID17040218SK026_02	Temperature	Yes	List in Category 4a	Potential natural vegetation temperature TMDL completed
Wildhorse Creek, source to mouth ID17040218SK030_04	Fecal coliform	No	Keep in Category 4a for sediment and temperature; delist fecal coliform as a listed pollutant	Sediment and temperature TMDLs approved by U.S. Environmental Protection Agency in 2004 and no evidence of bacterial or further impairment

Table 34. Sediment load allocations in Big Lost River

Water Body Segment/ AU	Current Load	Load Capacity	Load Allocation	Percent Reduction necessary
Big Lost River above Bartlett Point Road Bridge/ID17040218SK024_05	9 tons per year	4 tons per year	5 tons per year	55%
Big Lost River above Mackay Reservoir/ID17040218SK013_05 and ID17040218SK015_05	206 tons per year	6 tons per year	200 tons per year	97%

Table 35. Bacteria load allocation for Sage Creek (geometric mean of number of colonies per 100 milliliter sample)

Stream	Load Capacity	Natural Background	Margin of Safety	Load Allocation	Total Load	Load Reduction	Percent Reduction
Sage Creek ID17040218SK022_02	126	13	13	100	720	620	86%

Table 36. Summary of assessment outcomes for unlisted waters impaired by temperature

Water Body Segment/ Assessment Unit	Pollutant	TMDL(s) Completed	Recommended Changes to Idaho's Integrated Report	Justification
Big Lost River ID17040218SK025_05 ID17040218SK024_05 ID17040218SK015_05 ID17040218SK013_05 ID17040218SK011_05 ID17040218SK010_05 ID17040218SK007_05 ID17040218SK006_06	Temperature	Yes	Move to Category 4a	PNV TMDL completed; SK025_05 and SK024_05 have U.S. Environmental Protection Agency approved temperature TMDL in 2004; potential natural vegetation applies shade targets
East Fork Big Lost River ID17040218SK039_02 ID17040218SK039_03 ID17040218SK033_02 ID17040218SK033_03 ID17040218SK033_04	Temperature	Yes	Move to Category 4a	PNV TMDL completed; SK033_02 and SK033_04 have U.S. Environmental Protection Agency approved temperature TDML in 2004; potential natural vegetation applies shade targets
Antelope Creek ID17040218SK057_02 ID17040218SK057_03 ID17040218SK052_04 ID17040218SK047_04 ID17040218SK049_04 ID17040218SK049_05 ID17040218SK047_05 ID17040218SK046_05	Temperature	Yes	Move to Category 4a	PNV TMDL completed
Leadbelt Creek ID17040218SK058_02	Temperature	Yes	Move to Category 4a	PNV TMDL completed
Twin Bridges Creek ID17040218SK026_02 ID17040218SK026_03	Temperature	Yes	Move to Category 4a	PNV TMDL completed
Thousand Springs Creek Tributaries ID17040218SK016_02 (also known as Elkhorn Creek)	Temperature	Yes	Move to Category 4a	This assessment unit is dry washes and spring-fed wetlands. Existing shade.

Table 37. Temperature load allocations

Water Body	Current Load (kWh/day)	Load Capacity & Allocation (kWh/day)	Excess Load (kWh/day)	Load Reduction (%)	Average Lack of Shade (%)
Big Lost River, below Mackay Reservoir	8,512,363	6,623,765	1,888,598	22	17
Big Lost River, above Mackay Reservoir	7,038,048	5,293,062	1,744,986	25	21
Antelope Creek	2,453,739	1,755,685	698,054	28	23
East Fork Big Lost River	3,129,889	2,569,939	559,950	18	24
Twin Bridges Creek	249,782	167,567	82,216	33	18
Leadbelt Creek	140,085	85,561	54,523	39	32
Spring Creek	170,349	131,087	39,262	23	20
Twin Bridges Creek Tributaries	86,075	48,867	37,209	43	24
Thousand Springs Creek Tributaries	240,194	239,972	223	<1	1

References Cited

American Geological Institute. 1962. Dictionary of geological terms. Doubleday and Company. Garden City, NY. 545 p.

Armantrout, N.B., compiler. 1998. Glossary of aquatic habitat inventory terminology. American Fisheries Society. Bethesda, MD. 136 p.

Clean Water Act (Federal water pollution control act), 33 U.S.C. § 1251-1387. 1972.

DEQ (Idaho Department of Environmental Quality). 2004. Big Lost River Watershed Subbasin Assessment and TMDL. Boise, ID: DEQ.

DEQ (Idaho Department of Environmental Quality). 2005. Catalog of Stormwater Best Management Practices for Idaho Cities and Counties. Boise, ID: DEQ.

DEQ and EPA (Idaho Department of Environmental Quality and U.S. Environmental Protection Agency). 2003. South Fork Clearwater River Subbasin Assessment and Total Maximum Daily Loads. Boise, ID: DEQ.

EPA (U.S. Environmental Protection Agency). 1996. Biological criteria: Technical guidance for streams and small rivers. EPA 822-B-96-001. EPA, Office of Water. Washington, DC. 162 p.

EPA (U.S. Environmental Protection Agency). 2007. An approach for using load duration curves in the development of TMDLs. Watershed Branch, Office of Wetlands, Oceans and Watersheds. Washington, D.C. 81 p.

Grafe, C.S., C.A. Mebane, M.J. McIntyre, D.A. Essig, D.H. Brandt, and D.T. Mosier. 2002. The Idaho Department of Environmental Quality water body assessment guidance, second edition-final. Department of Environmental Quality. Boise, ID. 114 p.

Hall, T.J. 1986. A laboratory study of the effects of fine sediments on survival of three species of Pacific salmon from eyed egg to fry emergence. National Council of the Paper Industry for Air and Stream Improvement. Technical Bulletin 482. New York, NY.

Hughes, R.M. 1995. Defining acceptable biological status by comparing with reference condition. In: Davis, W.S. and T.P. Simon, editors. Biological assessment and criteria: tools for water resource planning and decision making. CRC Press. Boca Raton, FL. p. 31–48.

Idaho Code § 39.3611. Development and implementation of total maximum daily load or equivalent processes.

Idaho Code § 39.3615. Creation of watershed advisory groups.

Idaho Department of Labor. 2010. Butte County work force trends. January 2010. Regional Economist, Idaho Department of Labor.

Idaho Department of Labor. 2010. Custer County work force trends. January 2010. Regional Economist, Idaho Department of Labor, Idaho Falls, ID.

IDL (Idaho Department of Lands). 2000. Forest Practices Cumulative Watershed Effects Process for Idaho. Boise, ID: IDL.

IDAPA 58.01.02. Idaho water quality standards and wastewater treatment requirements.

Karr, J.R. 1991. Biological integrity: A long-neglected aspect of water resource management. Ecological Applications 1:66–84.

Leopold, L.B., M.G. Wolman, and J.P. Miller. 1964. Fluvial processes in geomorphology. Freeman. San Francisco, CA.

Lohrey, M.H. 1989. Stream channel stability guidelines for range environmental assessment and allotment management plans. U.S. Forest Service, Northwest Region (unpublished).

McNeil, W.J., and W.H. Ahnell. 1964. Success of pink salmon spawning relative to size of spawning bed materials. Washington, DC: U.S. Fish and Wildlife Service. Special Scientific Report—Fisheries No. 469.

Michigan DEQ (Michigan Department of Environmental Quality). 1999. Pollutants controlled calculation and documentation for Section 319 watersheds training manual. Lansing, MI: Michigan DEQ. 59 p.

NRCS (Natural Resources Conservation Service). 1983. Erosion and sediment yield. In: Proceedings from the channel evaluation workshop. Ventura, CA. 54 p.

OWEB (Oregon's Watershed Enhancement Board). 2001. Addendum to Water Quality Monitoring Technical Guide Book: Chapter 14, Stream Shade and Canopy Cover Monitoring Methods. Salem, OR: OWEB.

Pfankuch, D.J. 1975. Stream reach inventory and channel stability evaluation. U.S. Forest Service, Northern Region. Missoula, MT.

Poole, G.C., and C. Berman. 2001. An ecological perspective on in-stream temperature: Natural heat dynamics and mechanisms of human-caused thermal degradation. Environmental Management 27(6):787–802.

Reiser, D.W., and R.G. White. 1988. Effects of two sediment size-classes on survival of steelhead and Chinook salmon eggs. North American Journal of Fisheries Management 8:432–437.

Rood, S.B., J.H. Braatne, and F.M. Hughes. 2003. Ecophysiology of riparian cottonwoods: Stream flow dependency, water relations and restoration. Tree Physiology 23(16):1113-1124.

Rosgen, D.L. 1996. Applied river morphology. Pagosa Springs, CO: Wildland Hydrology. 378 p.

Shumar, M., and J. de Varona. 2009. The Potential Natural Vegetation (PNV) Temperature Total Maximum Daily Load (TMDL) Procedures Manual. Boise, ID: Idaho Department of Environmental Quality.

Strahler, A.N. 1957. Quantitative analysis of watershed geomorphology. Transactions American Geophysical Union 38:913–920.

USGS (U.S. Geological Survey). 1987. Hydrologic unit maps. Denver, CO: USGS. Water supply paper 2294. 63 p.

Water Environment Federation. 1987. The Clean Water Act of 1987. Alexandria, VA: Water Environment Federation. 318 p.

Water Quality Act of 1987, Public Law 100-4. 1987.

Water quality planning and management, 40 CFR Part 130.

GIS Coverages

Restriction of liability: Neither the State of Idaho nor the Idaho Department of Environmental Quality, nor any of their employees, make any warranty, express or implied, or assume any legal liability or responsibility for the accuracy, completeness, or usefulness of any information or data provided. Metadata is provided for all data sets, and no data should be used without first reading and understanding its limitations. The data could include technical inaccuracies or typographical errors. The Idaho Department of Environmental Quality may update, modify, or revise the data used at any time, without notice.

U.S. Bureau of Land Management. 2009. Surface Management Agency for Idaho. <http://insideidaho.org> Updated twice yearly by the Idaho State Office, U.S. Bureau of Land Management, Boise, ID.

Idaho Department of Water Resources. 2009. Subbasins (USGS 1:250,000) Fourth-field hydrologic units.

McGrath, C.L., A.J. Woods, J.M. Omernik, S.A. Bryce, M. Edmondson, J.A. Nesser, J. Shelden, R.C. Crawford, J.A. Comstock, and M.D. Plocher. 2001. Ecoregions of Idaho. Reston, VA: U.S. Geological Survey.

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Glossary

§305(b)

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

§303(d)

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

Acre-foot

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

Adsorption

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

Alevin

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

Algae

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

Alluvium

Unconsolidated recent stream deposition.

Ambient

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

Anthropogenic

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

Anti-Degradation

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

Aquatic
Occurring, growing, or living in water.

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

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

Assessment Database (ADB)
The ADB is a relational database application designed for the U.S. Environmental Protection Agency for tracking water quality assessment data, such as use attainment and causes and sources of impairment. States need to track this information and many other types of assessment data for thousands of water bodies and integrate it into meaningful reports. The ADB is designed to make this process accurate, straightforward, and user-friendly for participating states, territories, tribes, and basin commissions.

Assessment Unit (AU)
A segment of a water body that is treated as a homogenous unit, meaning that any designated uses, the rating of these uses, and any associated causes and sources must be applied to the entirety of the unit.

Assimilative Capacity
The ability to process or dissipate pollutants without ill effect to beneficial uses.

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

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

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

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

Biomass
The weight of biological matter. Standing crop is the amount of biomass (e.g., fish or algae) in a body of water at a given time. Often expressed as grams per square meter.

Biota
The animal and plant life of a given region.

Biotic

A term applied to the living components of an area.

Clean Water Act (CWA)

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

Coliform Bacteria

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

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.

Discharge

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

Disturbance

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

E. coli

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

Ecology

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

Ecological Indicator

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

Ecological Integrity

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

Ecosystem

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

Effluent

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

Endangered Species

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

Environment

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

Ephemeral Stream

A stream or portion of a stream that flows only in direct response to precipitation. It receives little or no water from springs and no long continued supply from melting snow or other sources. Its channel is at all times above the water table (American Geological Institute 1962).

Erosion

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

Exceedance

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

Existing Beneficial Use or Existing Use

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

Extrapolation

Estimation of unknown values by extending or projecting from known values.

Fecal Coliform Bacteria

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

Flow

See *Discharge*.

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

Fully Supporting Cold Water
Reliable data indicate functioning, sustainable coldwater 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.

Geographic Information Systems (GIS)
A georeferenced database.

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

Grab Sample
A single sample collected at a particular time and place. It may represent the composition of the water in that water column.

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

Ground Water
Water found beneath the soil surface saturating the layer in which it is located. Most ground water originates as rainfall, is free to move under the influence of gravity, and usually emerges again as stream flow.

Habitat
The living place of an organism or community.

Headwater
The origin or beginning of a stream.

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

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

Hydrologic Unit
One of a nested series of numbered and named watersheds arising from a national standardization of watershed delineation. The initial 1974 effort (USGS 1987) described four levels (region, subregion, accounting unit, cataloging unit) of watersheds throughout the United States. The fourth

level is uniquely identified by an eight-digit code built of two-digit fields for each level in the classification. Originally termed a cataloging unit, fourth field hydrologic units have been more commonly called subbasins. Fifth and sixth field hydrologic units have since been delineated for much of the country and are known as watershed and subwatersheds, respectively.

Hydrologic Unit Code (HUC)

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

Hydrology

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

Influent

A tributary stream.

Inorganic

Materials not derived from biological sources.

Instantaneous

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

Intergravel Dissolved Oxygen

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

Intermittent Stream

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

Irrigation Return Flow

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

Load Allocation (LA)

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

Load(ing)

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

Load(ing) Capacity (LC)

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

Loam

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

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.

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

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

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

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.

National Pollutant Discharge Elimination System (NPDES)
A national program established by the Clean Water Act for permitting point sources of pollution. Discharge of pollution from point sources is not allowed without a permit.

Natural Condition
The condition that exists with little or no anthropogenic influence.

Nitrogen
An element essential to plant growth, and thus is considered a nutrient.

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.

Organic Matter

Compounds manufactured by plants and animals that contain principally carbon.

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.

Pathogens

A small subset of microorganisms (e.g., certain bacteria, viruses, and protozoa) that can cause sickness or death. Direct measurement of pathogen levels in surface water is difficult. Consequently, indicator bacteria that are often associated with pathogens are assessed. *E. coli*, a type of fecal coliform bacteria, are used by the state of Idaho as the indicator for the presence of pathogenic microorganisms.

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.

Phosphorus

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

Point Source	A source of pollutants characterized by having a discrete conveyance, such as a pipe, ditch, or other identifiable "point" of discharge into a receiving water. Common point sources of pollution are industrial and municipal wastewater.
Pollutant	Generally, any substance introduced into the environment that adversely affects the usefulness of a resource or the health of humans, animals, or ecosystems.
Pollution	A very broad concept that encompasses human-caused changes in the environment 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.
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 effect from human activity and represents the highest level of support attainable. 2) A benchmark for populations of aquatic ecosystems used to describe desired conditions in a biological assessment and acceptable or unacceptable departures from them. The reference condition can be determined through examining regional reference sites, historical conditions, quantitative models, and expert judgment (Hughes 1995).
Riffle	A relatively shallow, gravelly area of a streambed with a locally fast current, recognized by surface choppiness. Also an area of higher streambed gradient and roughness.
Riparian	Associated with aquatic (stream, river, lake) habitats. Living or located on the bank of a water body.
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.

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

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

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

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

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

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

Surface Water

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

Total Maximum Daily Load (TMDL)

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

Tributary

A stream feeding into a larger stream or lake.

Wasteload Allocation (WLA)

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

Water Body

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

Water 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 Standards

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

Water Table

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

Watershed

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

Wetland

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

Appendix A. Unit Conversion Chart

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

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

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

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Appendix B. Data Sources

Water Body	Data Source	Type of Data	When Collected
Big Lost River, East Fork Big Lost River, Antelope Creek, Leadbelt Creek	DEQ State Technical Services Office and Idaho Falls Regional Office	Pathfinder effective shade and stream width	August 2009
Big Lost River, East Fork Big Lost River, Antelope Creek, Leadbelt Creek, Spring Creek, Thousand Springs Creek	DEQ State Technical Services Office	Aerial photo interpretation of existing shade and stream width estimation	Summer 2009
Big Lost River, East Fork Big Lost River, Antelope Creek, Leadbelt Creek, Spring Creek, Thousand Springs Creek	DEQ IDASA Database	Temperature	1993 - Current

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Appendix C. Big Lost River Subbasin Impaired Waters and Locations Monitored by DEQ

The maps and photographs in this appendix display the following information:

- Stream segments identified by assessment unit name and number as listed in the 2008 Integrated Report under Category 5: Impaired Waters
- Monitored location, if applicable
- Field notes recorded at monitored location

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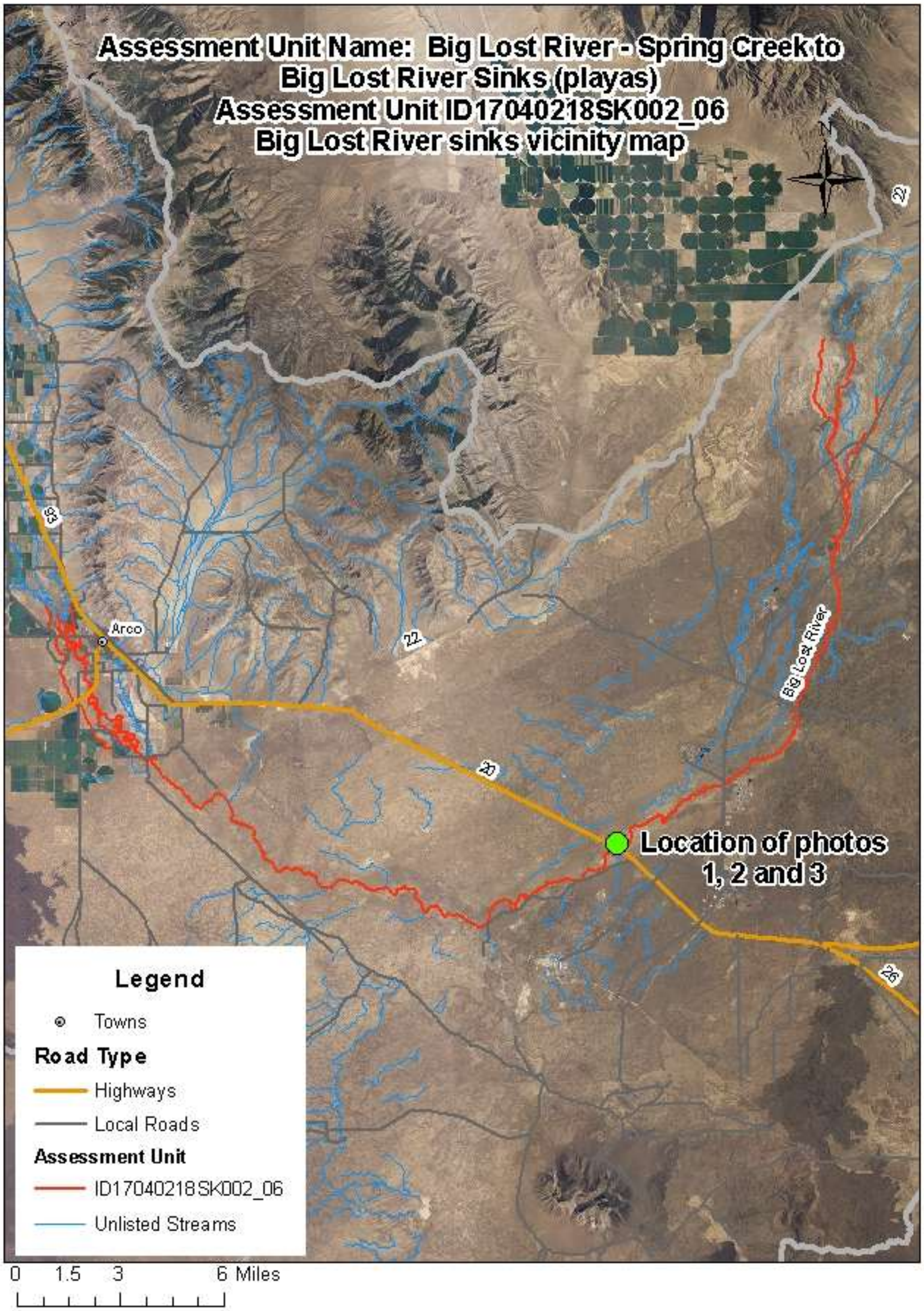

Figure 1. Big Lost River Sinks vicinity map—location of photos 1–3

Photo 1

Photo 2

Photo 3

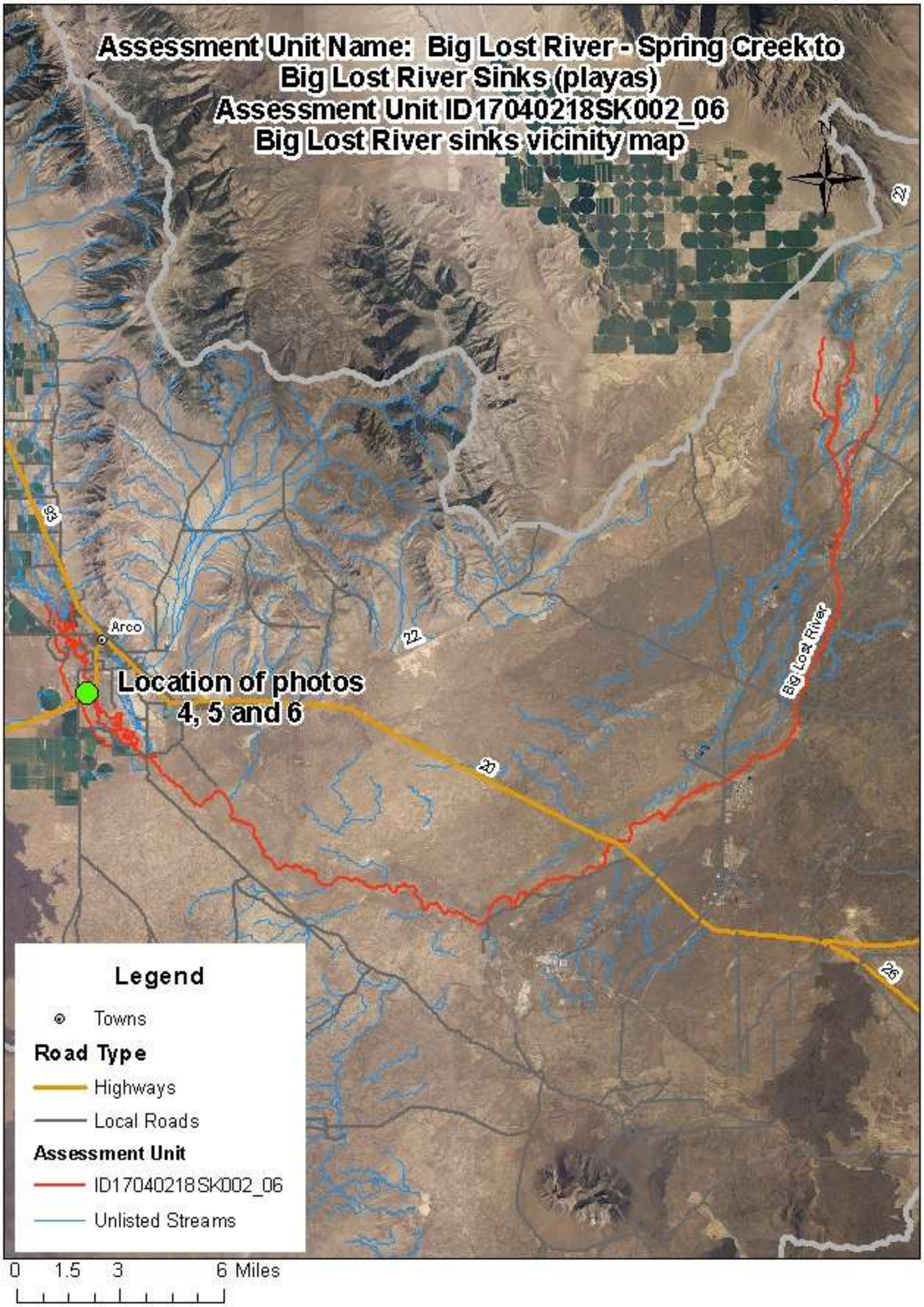

Figure 2. Big Lost River Sinks vicinity map—location of photos 4–6

Photo 4

Photo 5

Photo 6

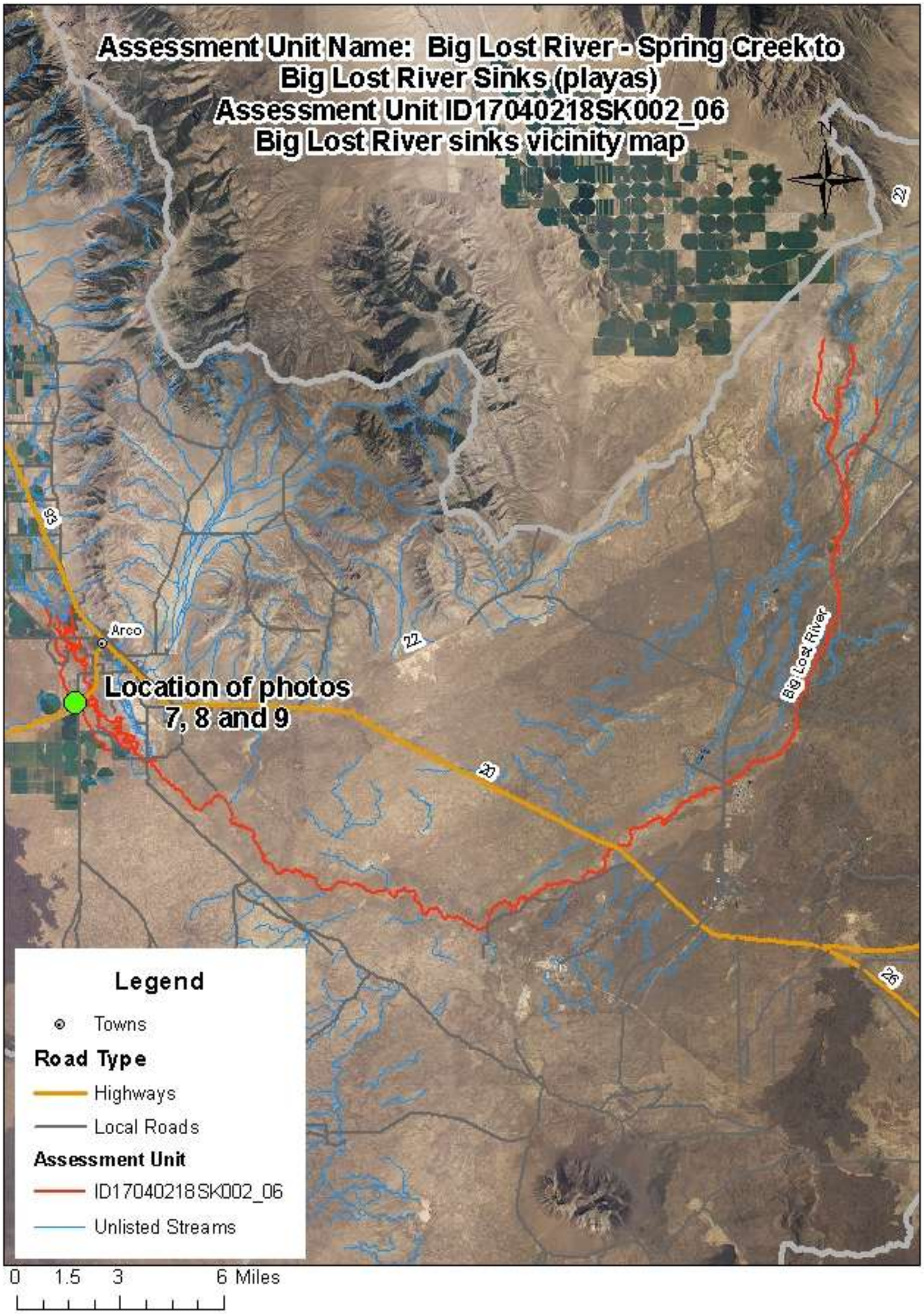

Figure 3. Big Lost River Sinks vicinity map—location of photos 7–9

Photo 7

Photo 8

Photo 9

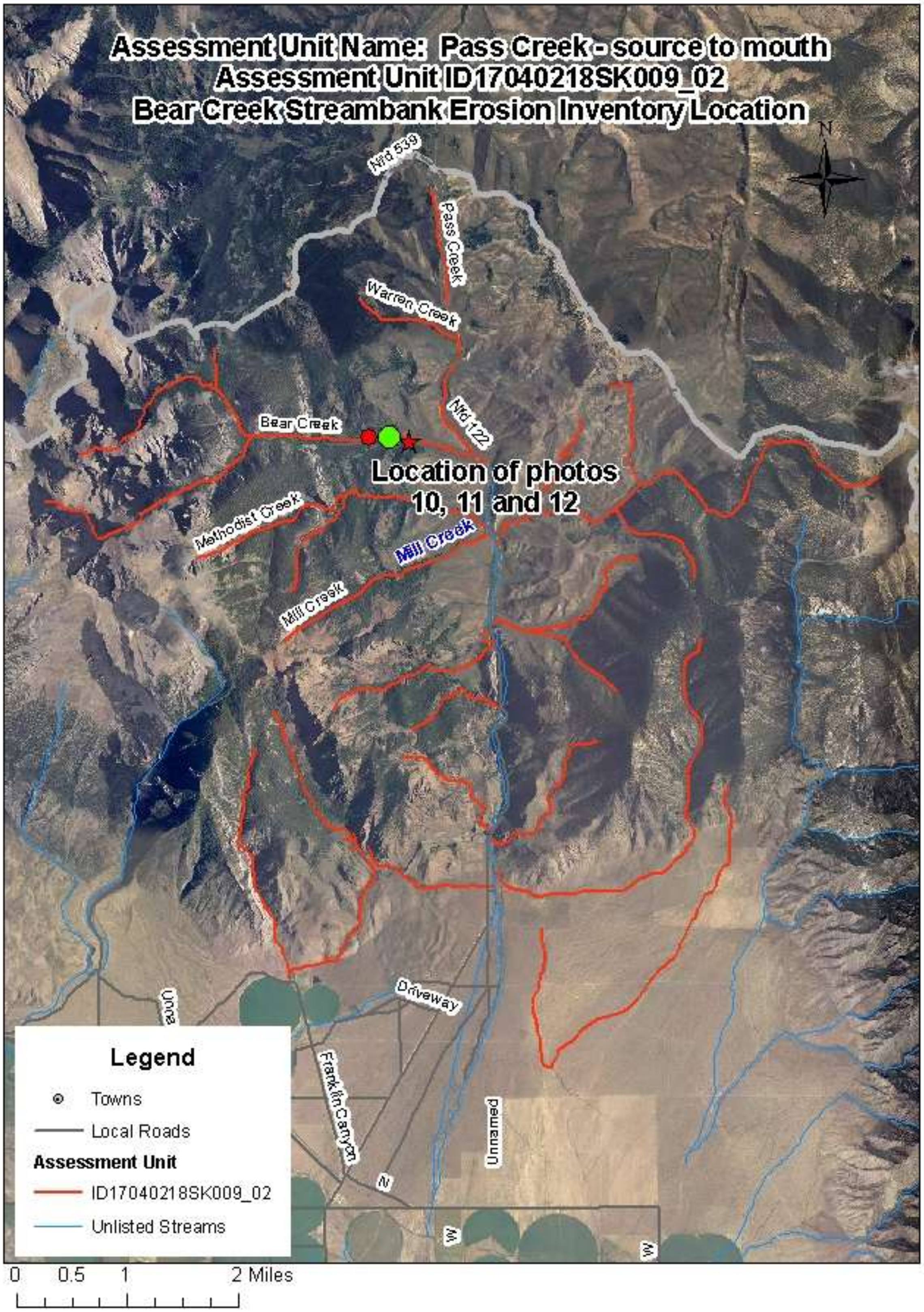

Figure 4. Bear Creek streambank erosion inventory—location of photos 10–12

Photo 10

Photo 11

Photo 12

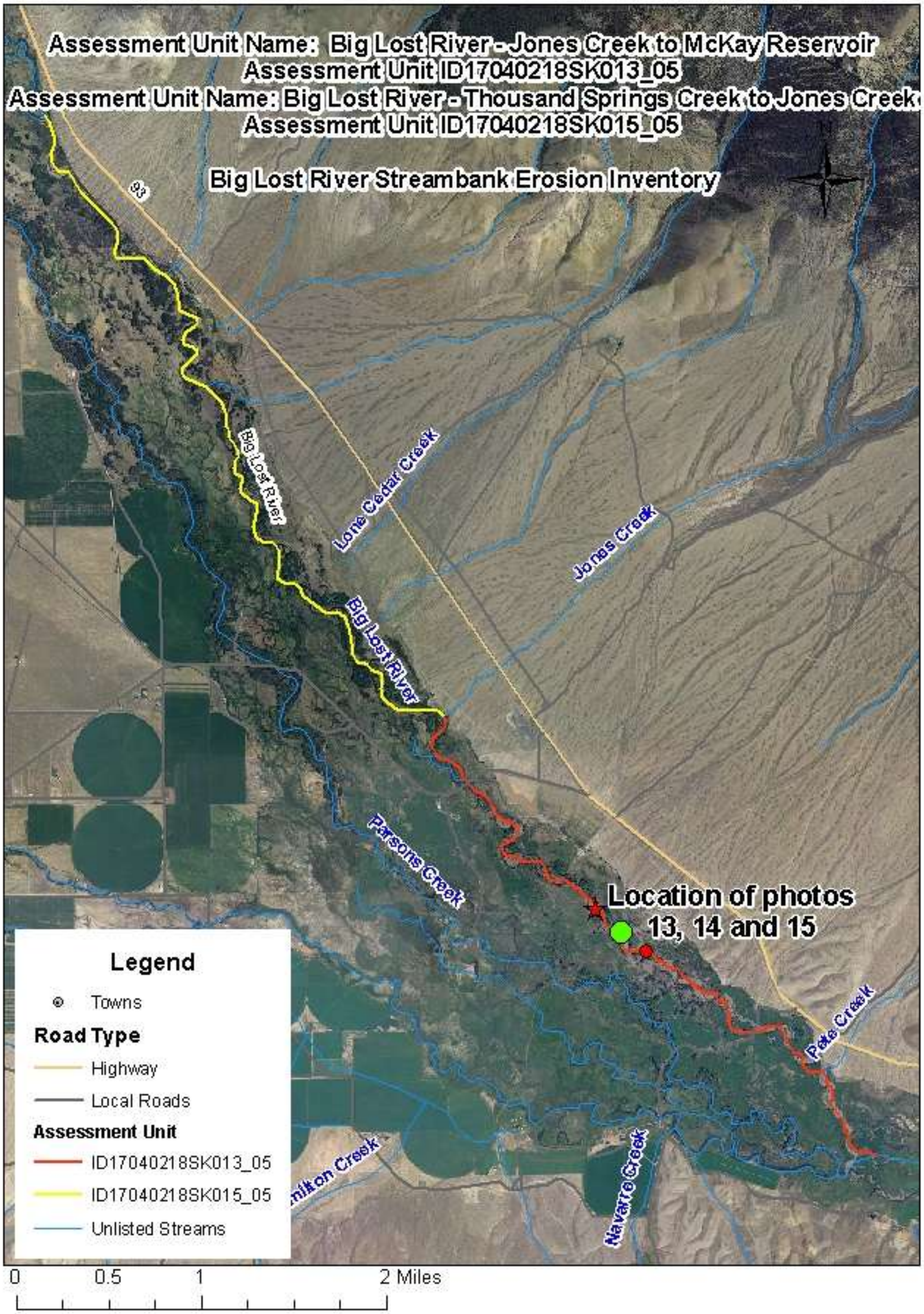

Figure 5. Big Lost River streambank erosion inventory—location of photos 13–15

Photo 13

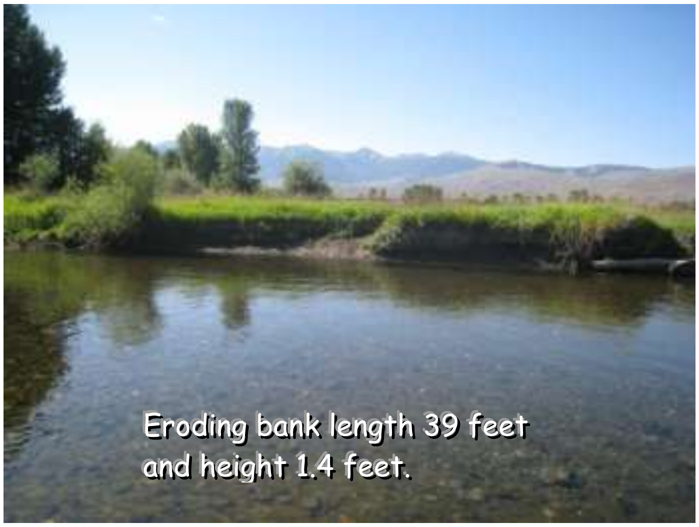

Photo 14

Photo 15

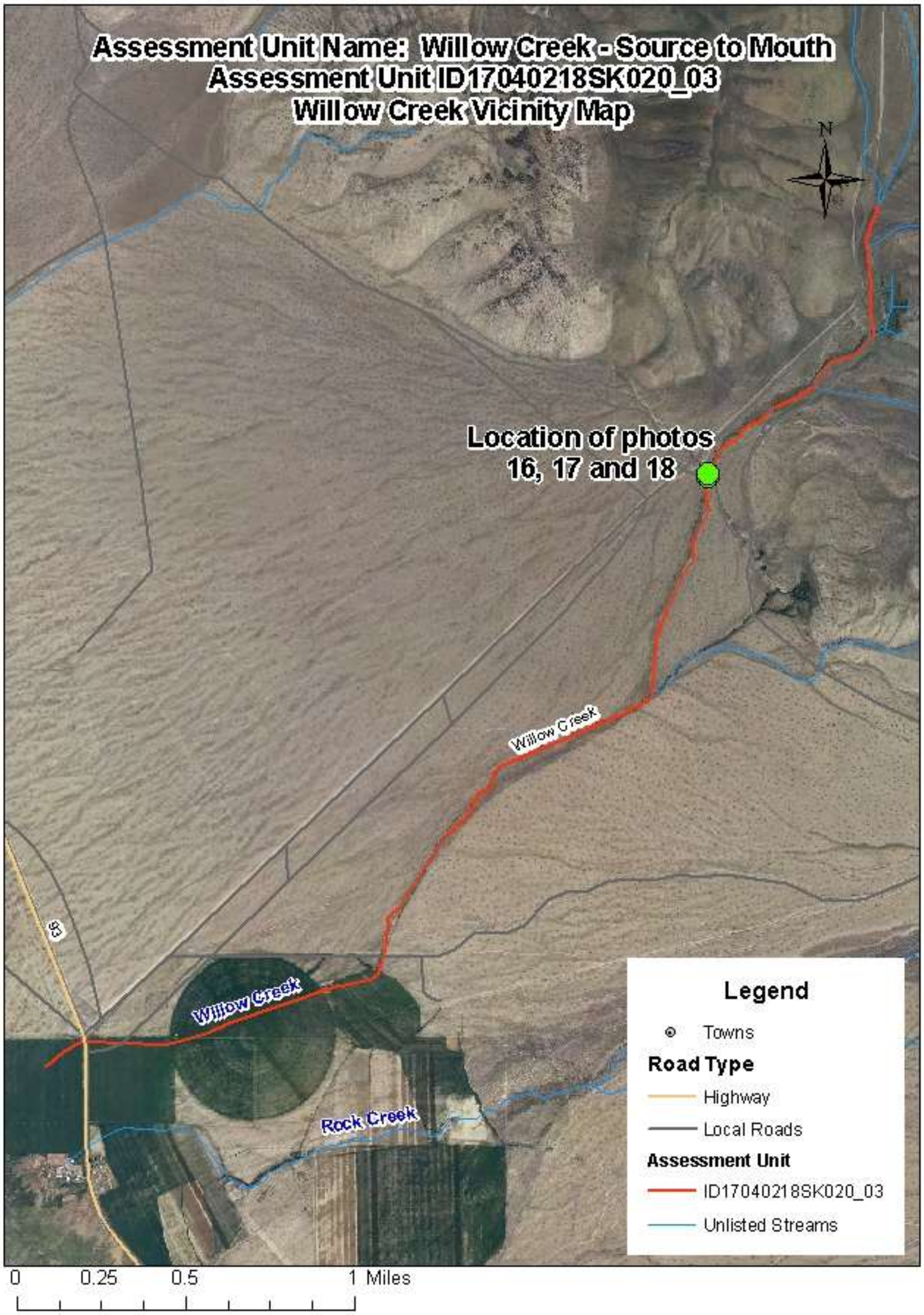

Figure 6. Willow Creek vicinity map—location of photos 16–18

Photo 16

Photo 17

Photo 18

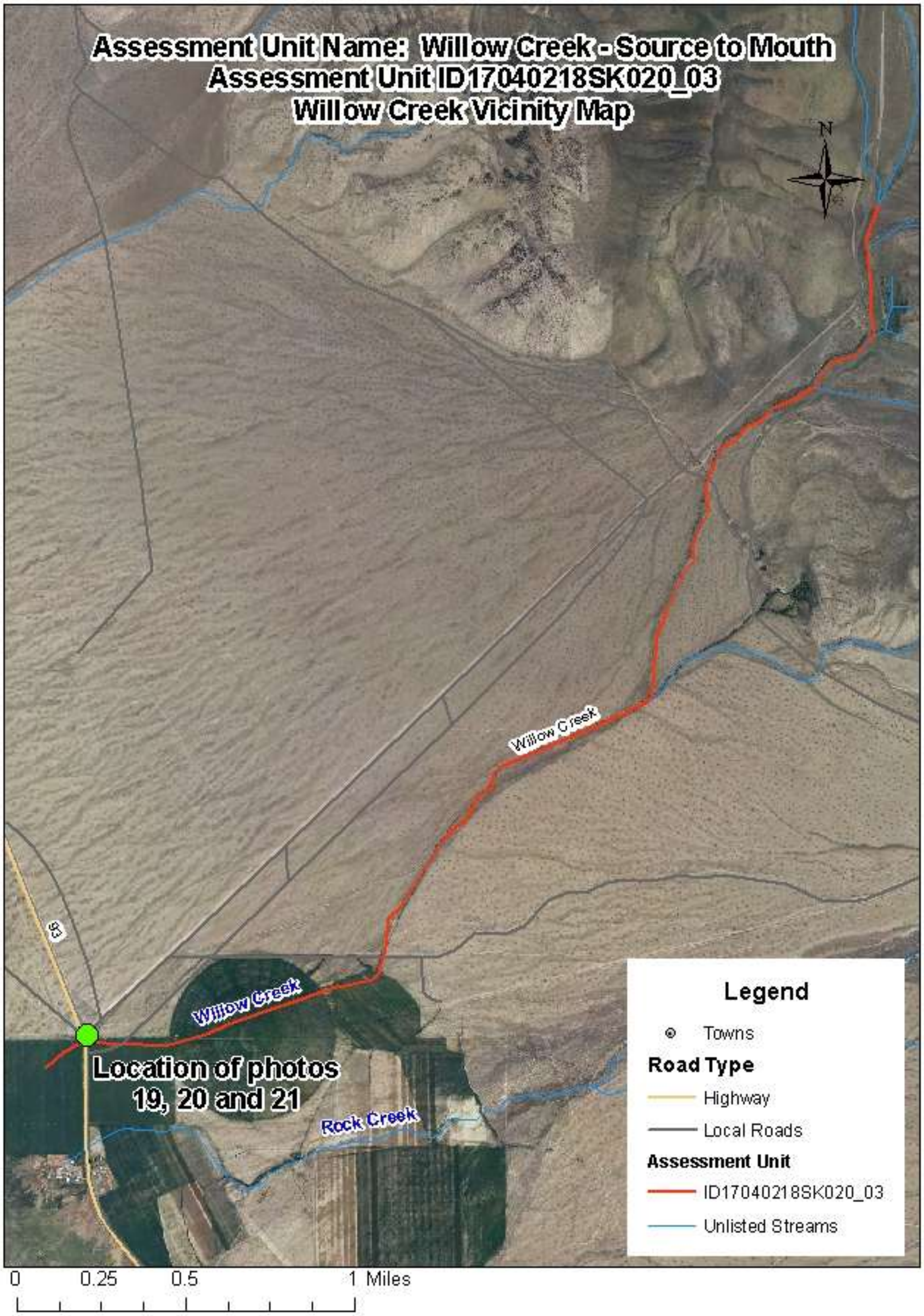

Figure 7. Willow Creek vicinity map—location of photos 19–21

Photo 19

Photo 20

Photo 21

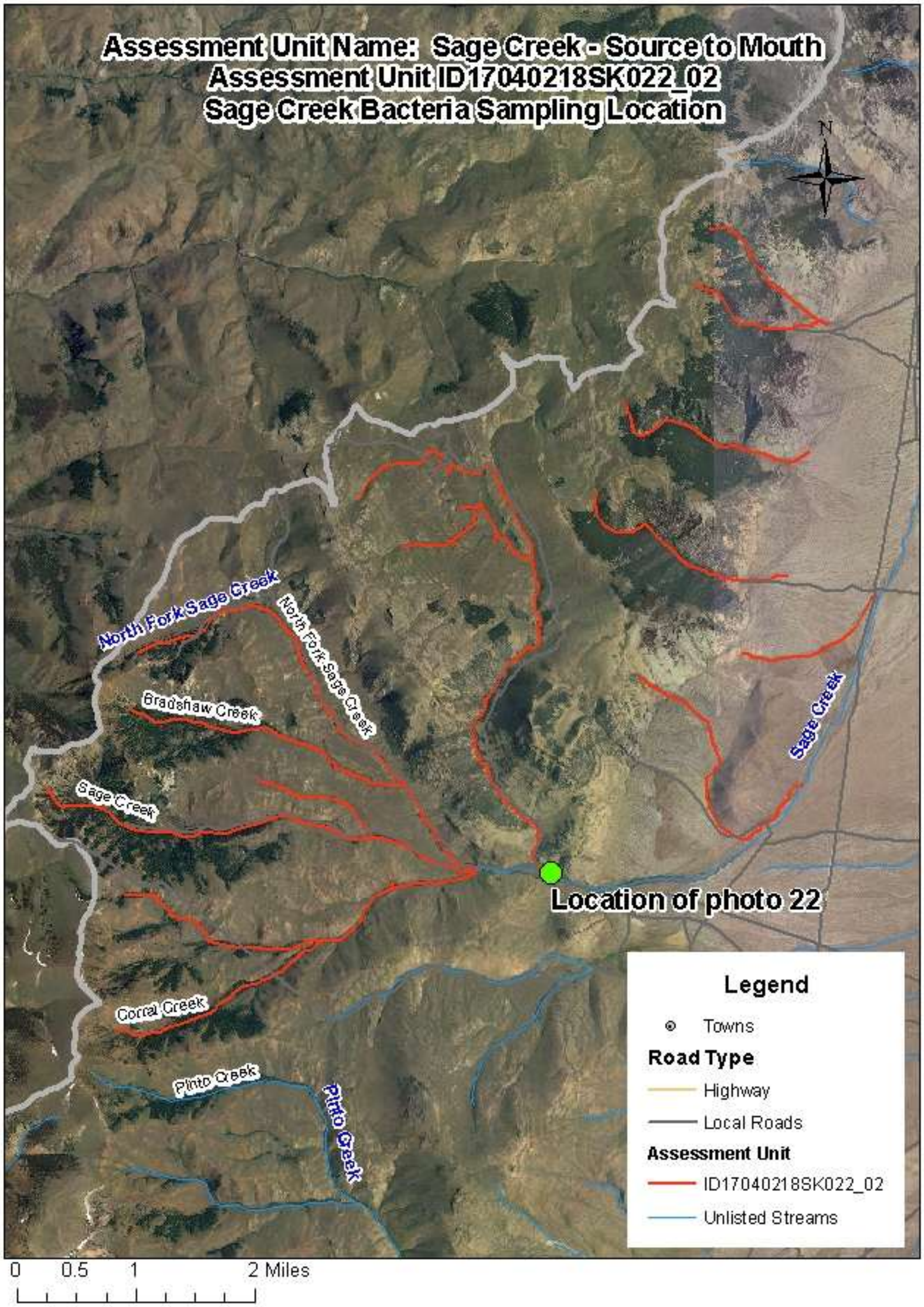

Figure 8. Sage Creek bacteria sampling—location of photo 22

Photo 22

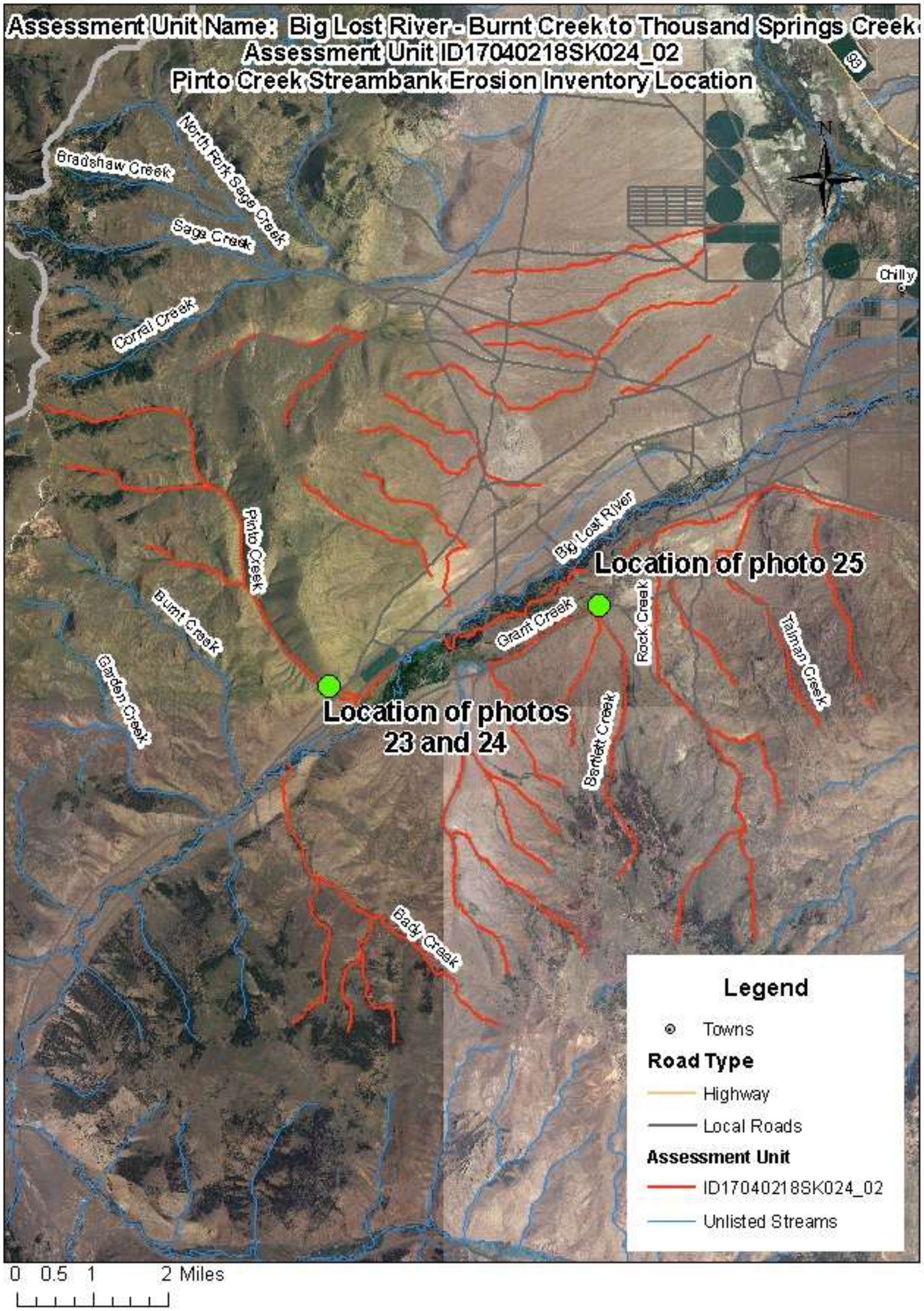

Figure 9. Pinto Creek streambank erosion inventory—location of photos 23–25

Photo 23

Photo 24

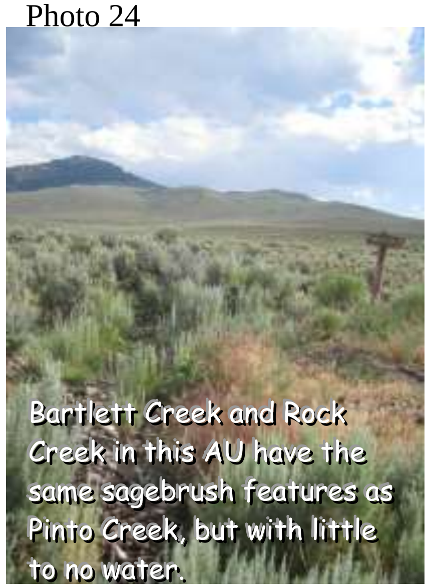

Photo 25

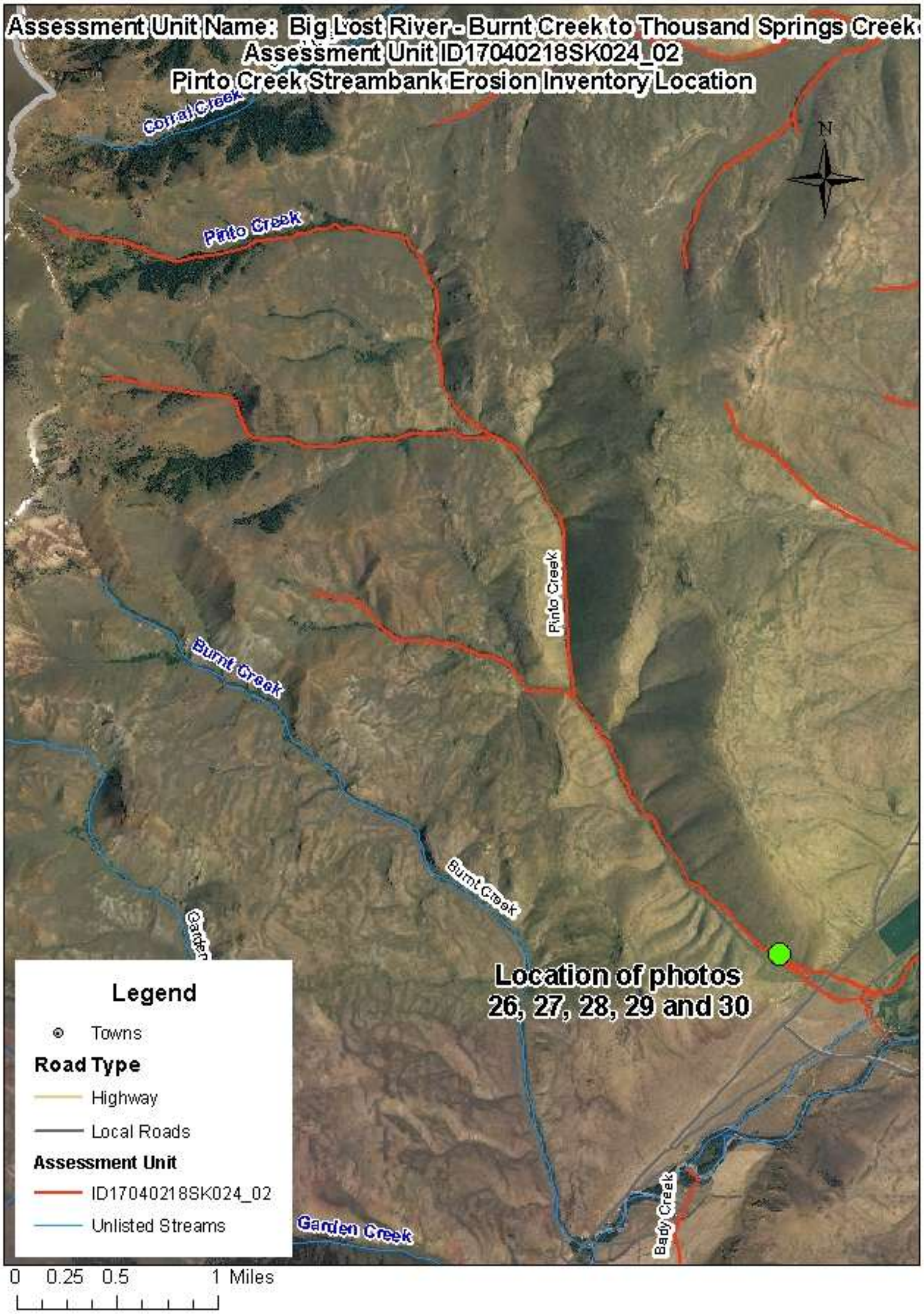

Figure 10. Pinto Creek streambank erosion inventory—location of photos 26–30

Photo 26

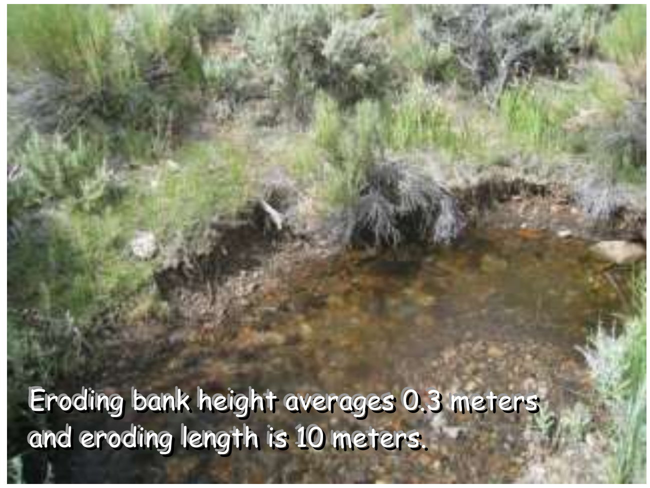

Photo 27

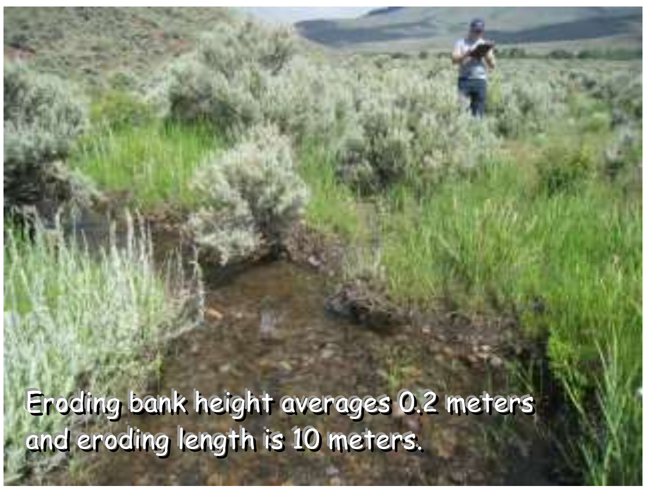

Photo 28

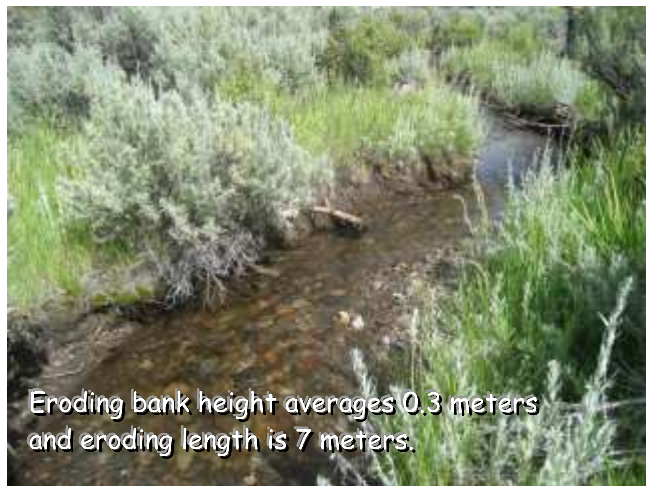

Photo 29

Photo 30

Figure 11. Grant Creek vicinity map—location of photos 31 and 32

Photo 31

Photo 32

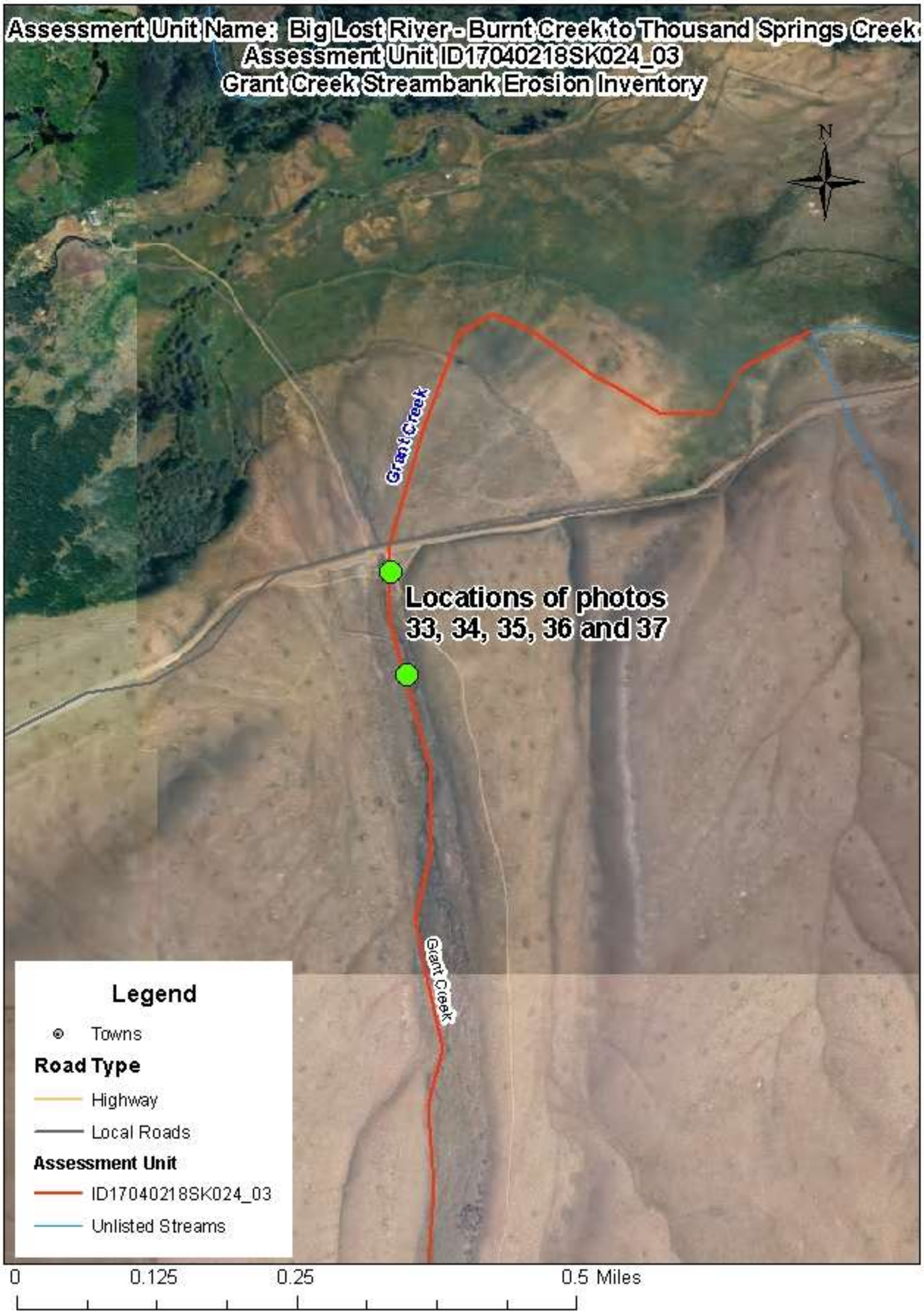

Figure 12. Grant Creek streambank erosion inventory—location of photos 33–37

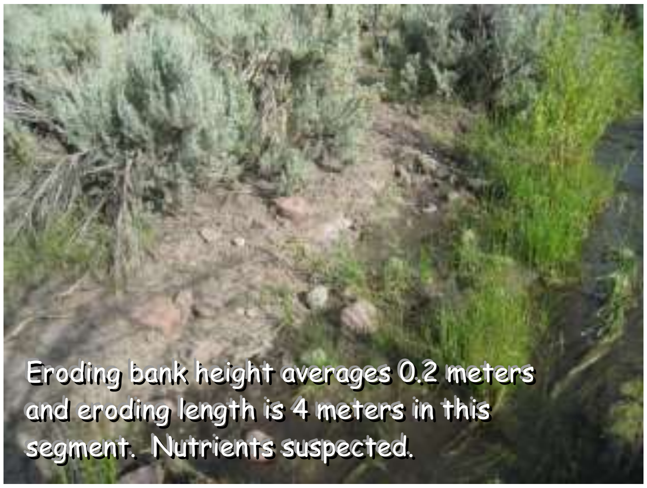

Photo 33

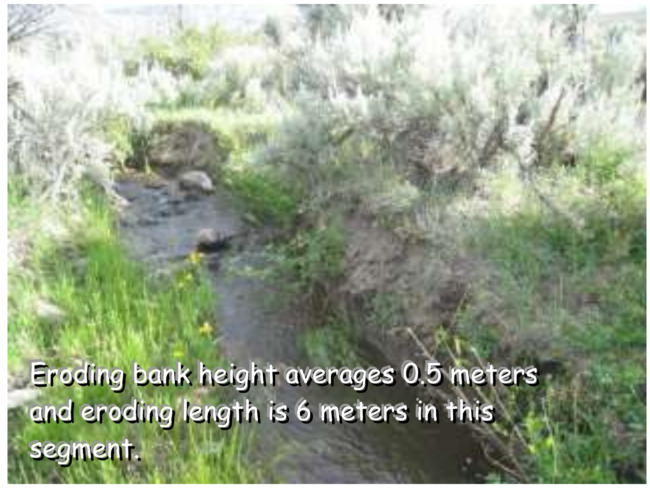

Photo 34

Photo 35

Photo 36

Photo 37

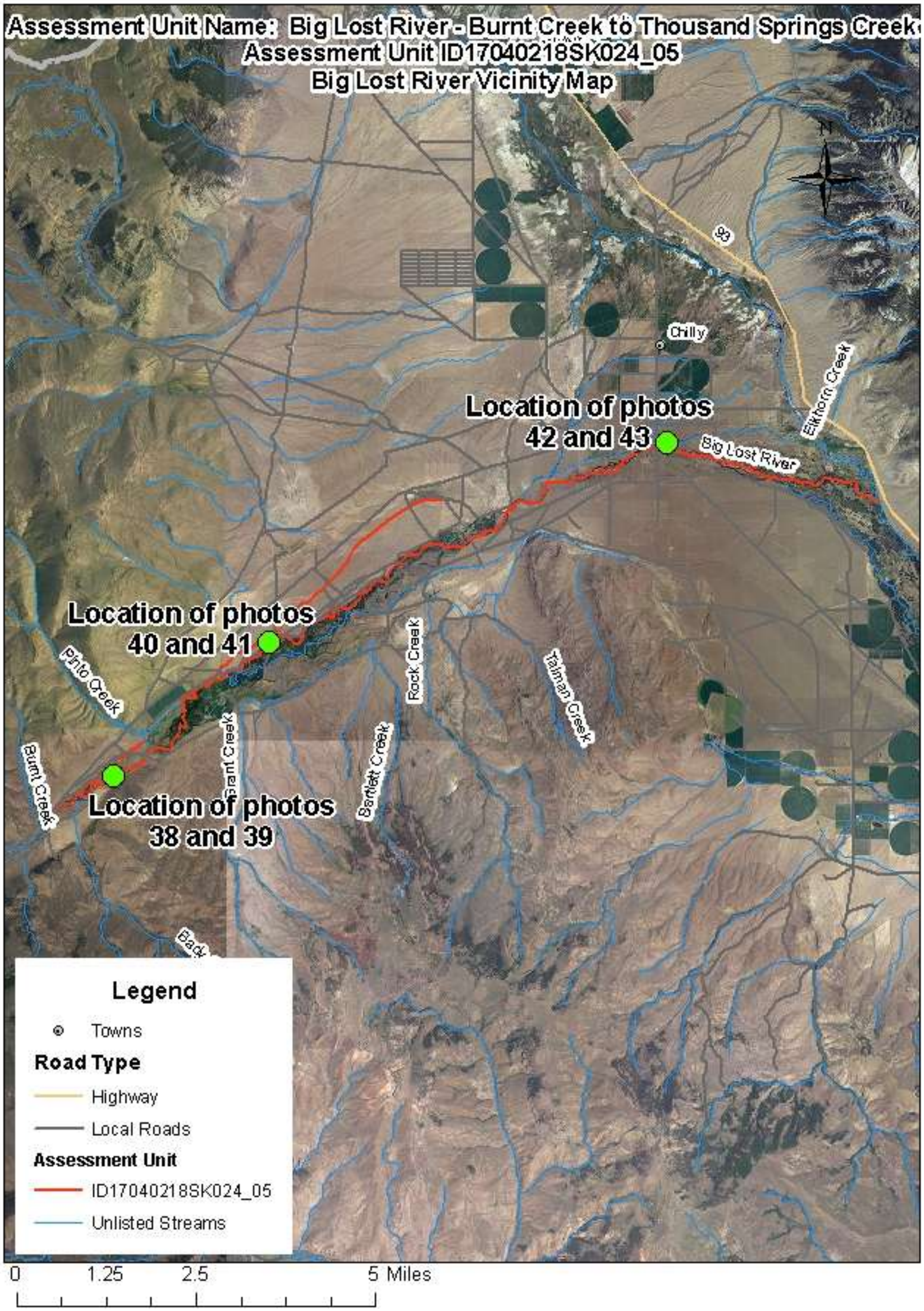

Figure 13. Big Lost River vicinity map—location of photos 38–43

Photo 38

Photo 39

Photo 40

Photo 41

Photo 42

Photo 43

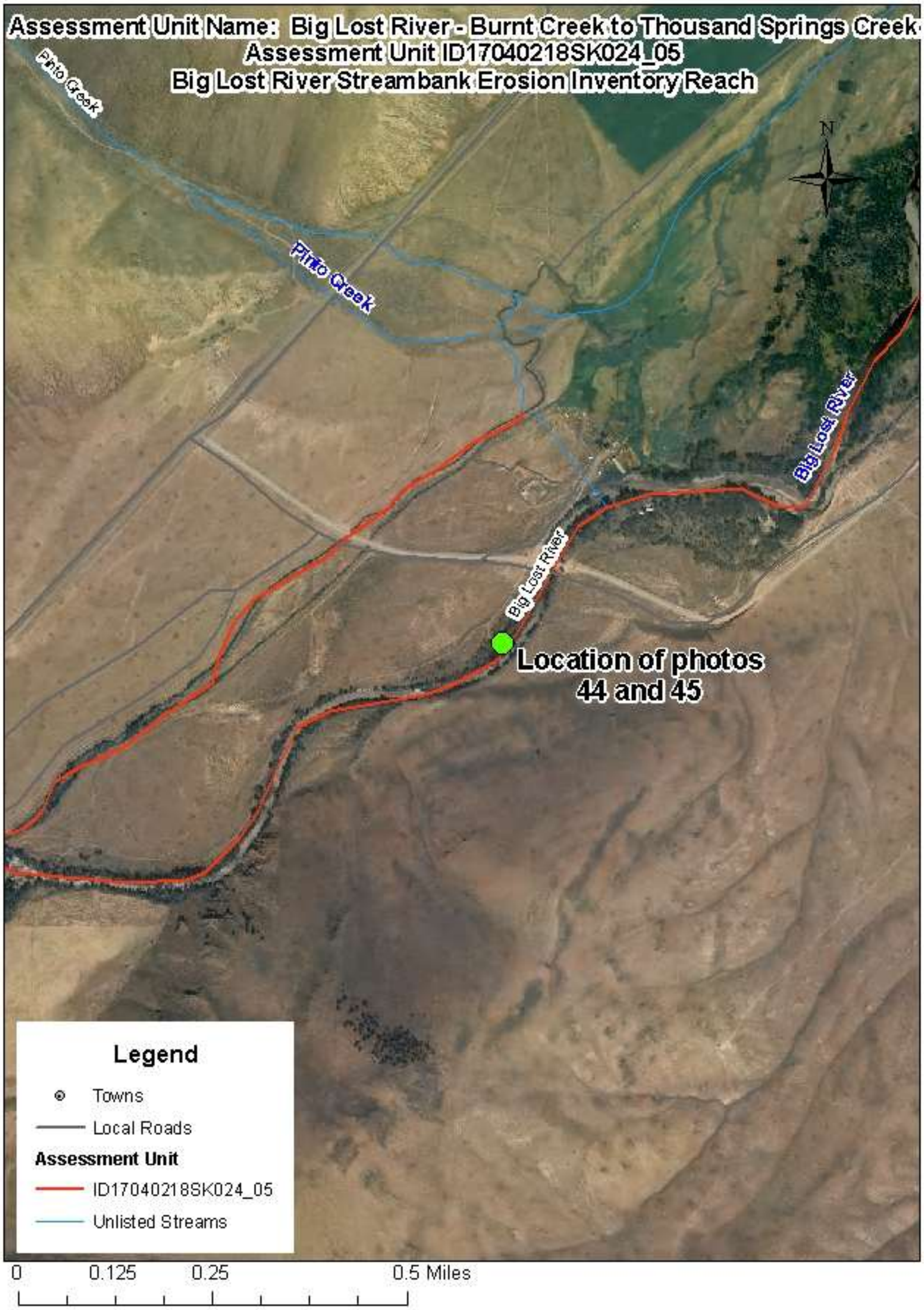

Figure 14. Big Lost River streambank erosion inventory—location of photos 44 and 45

Photo 44

Photo 45

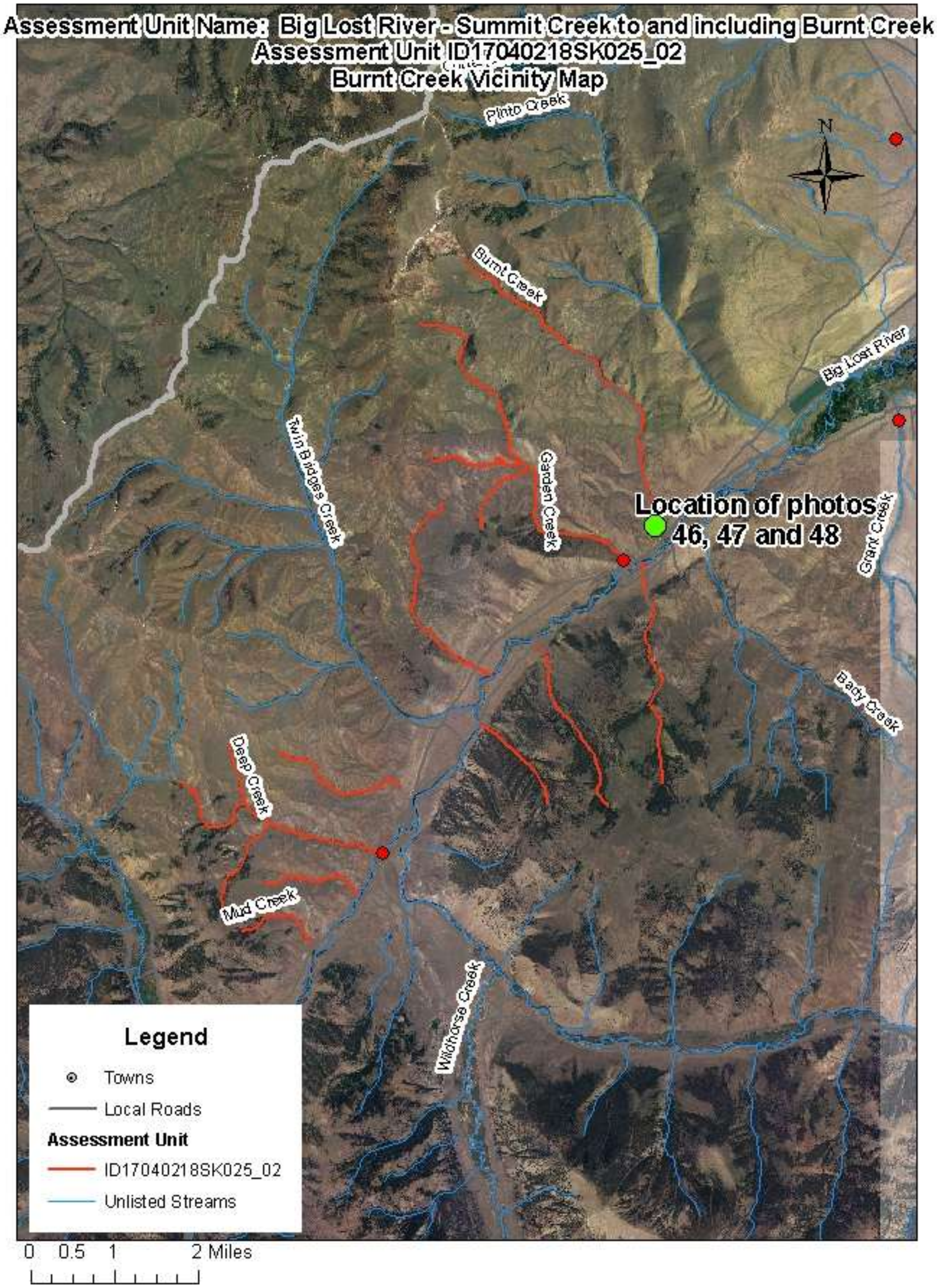

Figure 15. Burnt Creek vicnity map—location of photos 46–48

Photo 46

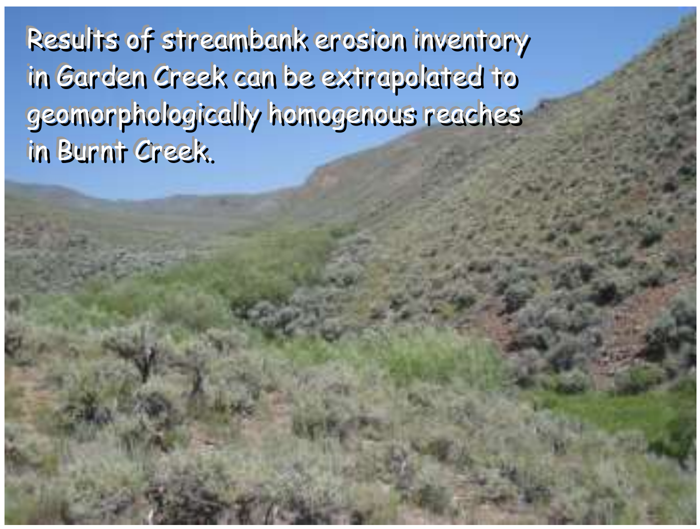

Photo 47

Photo 48

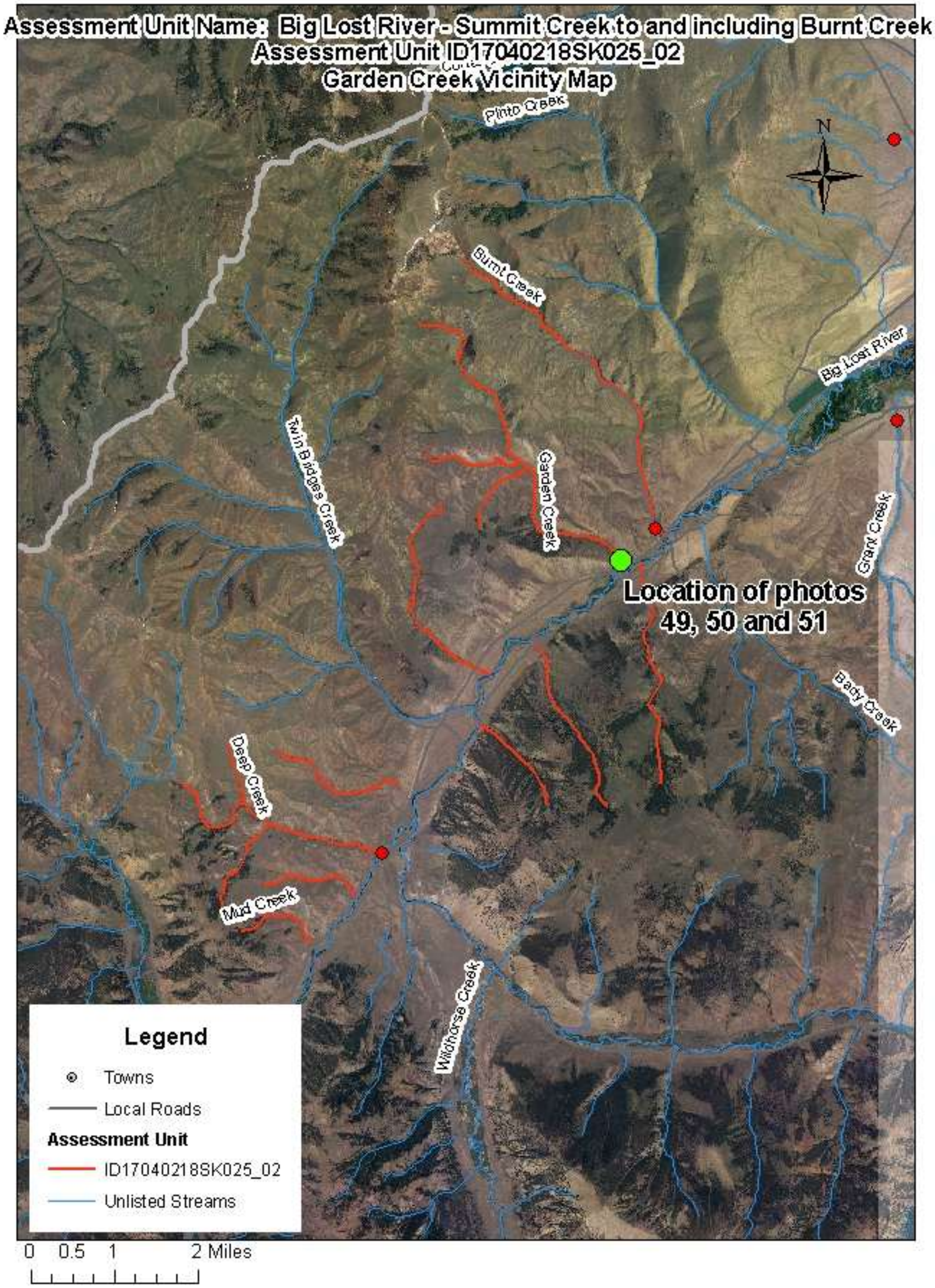

Figure 16. Garden Creek vicinity map—location of photos 49–51

Photo 49

Photo 50

Photo 51

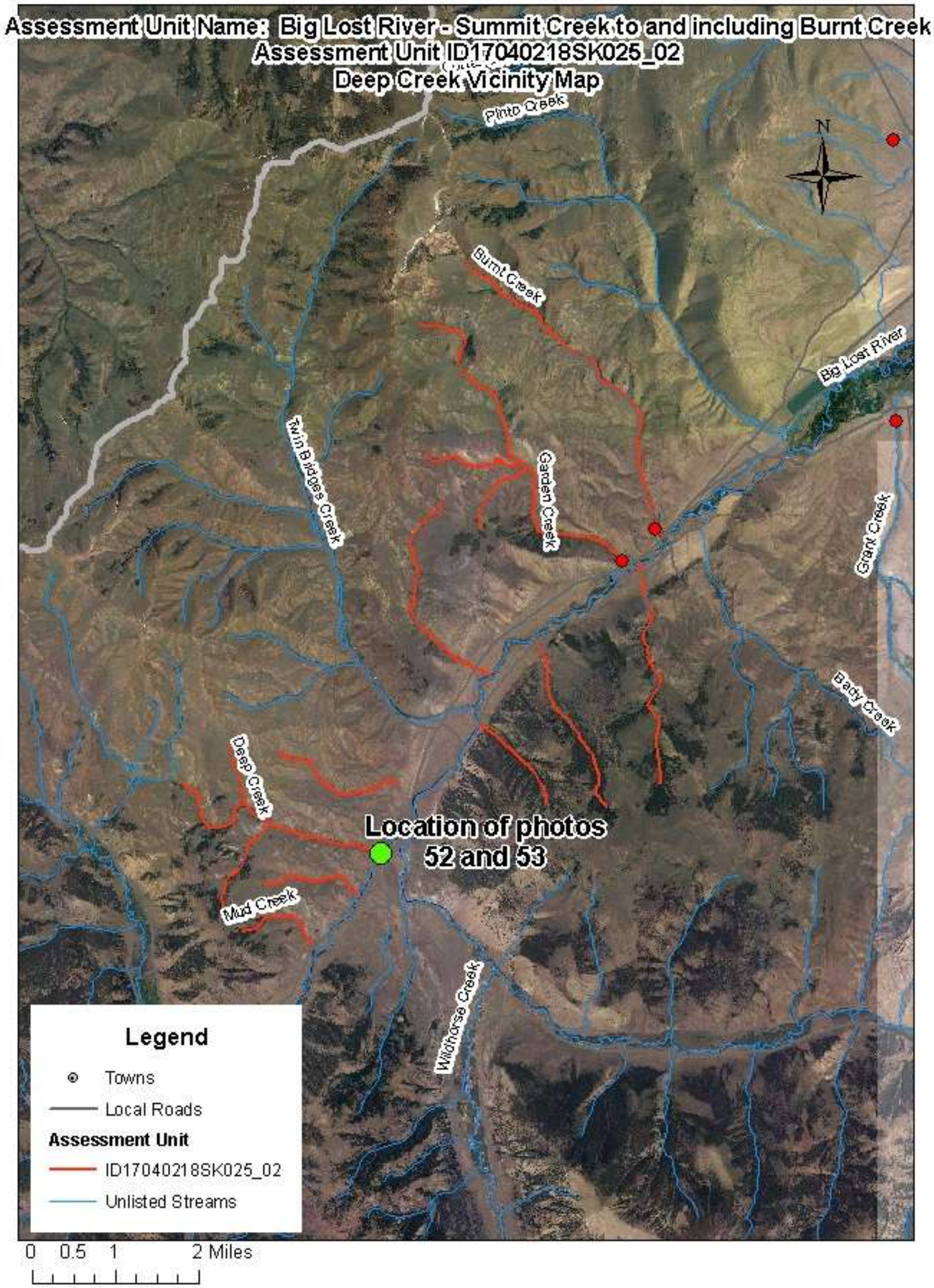

Figure 17. Deep Creek vicinity map—location of photos 52 and 53

Photo 52

Photo 53

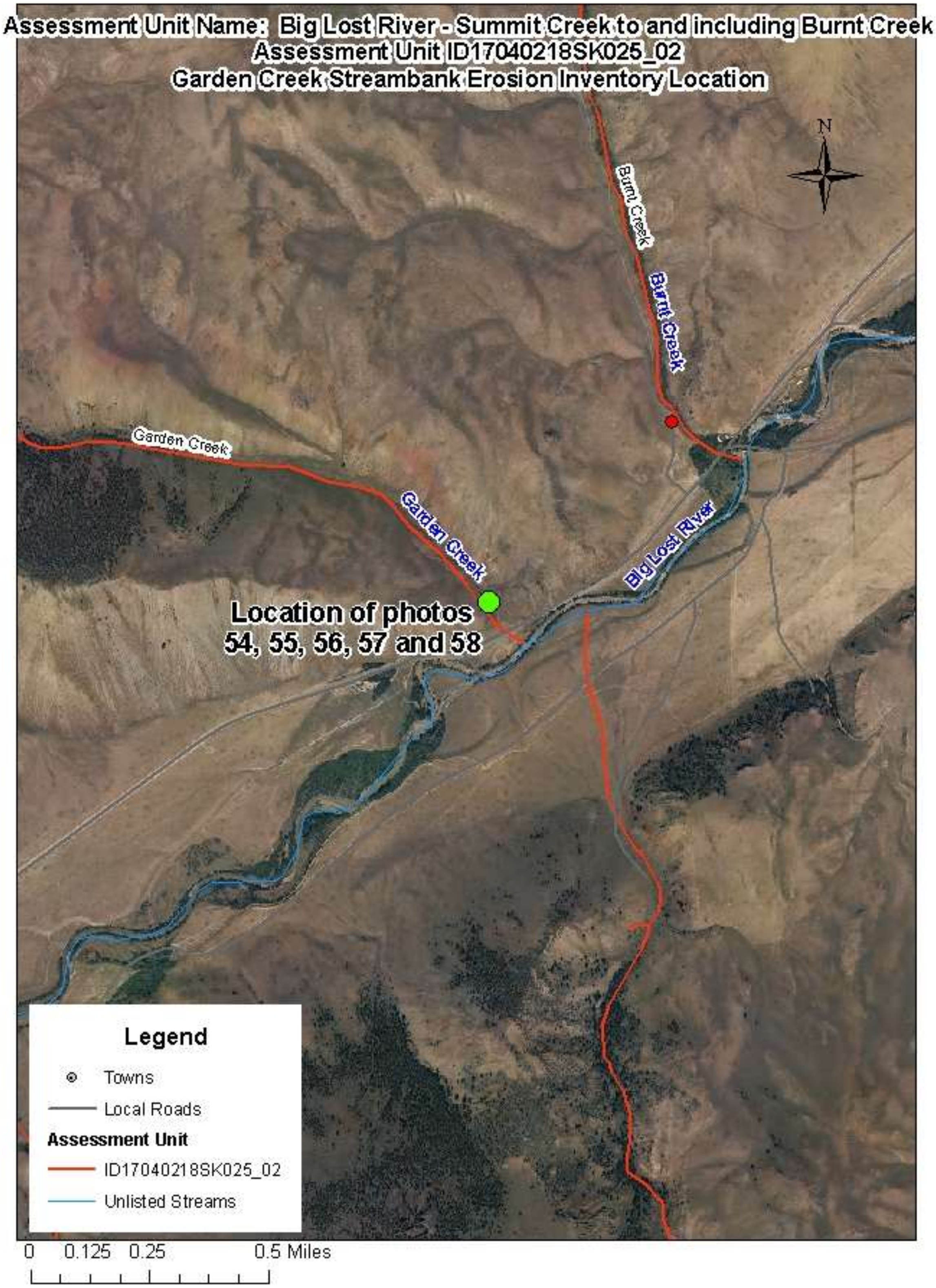

Figure 18. Garden Creek streambank erosion inventory—location of photos 54–58

Photo 54

Photo 55

Photo 56

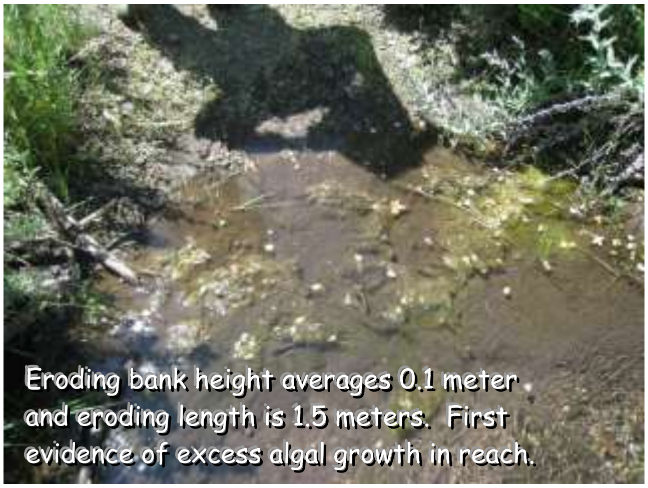

Photo 57

Photo 58

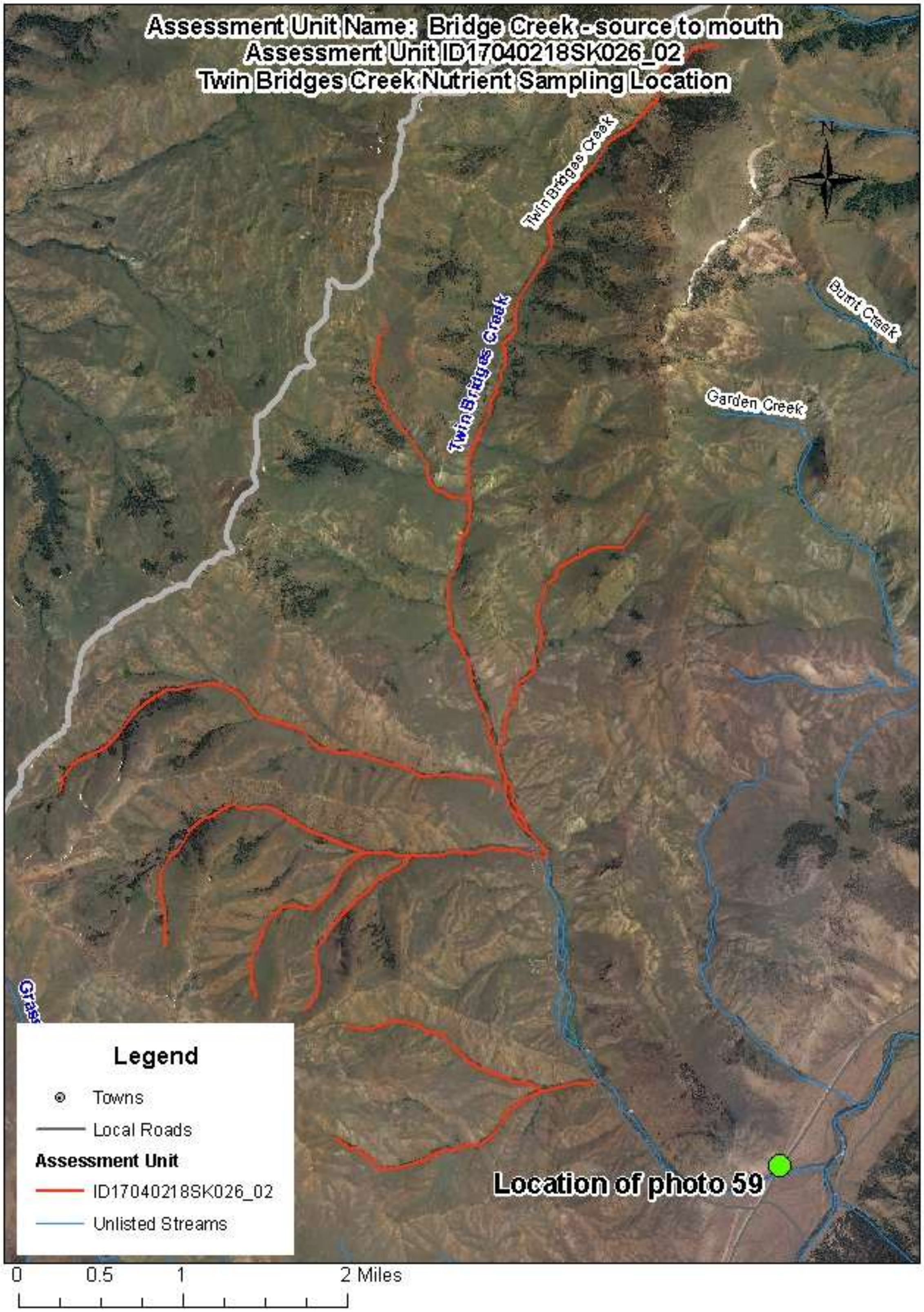

Figure 19. Twin Bridges Creek nutrient sampling—location of photo 59

Photo 59

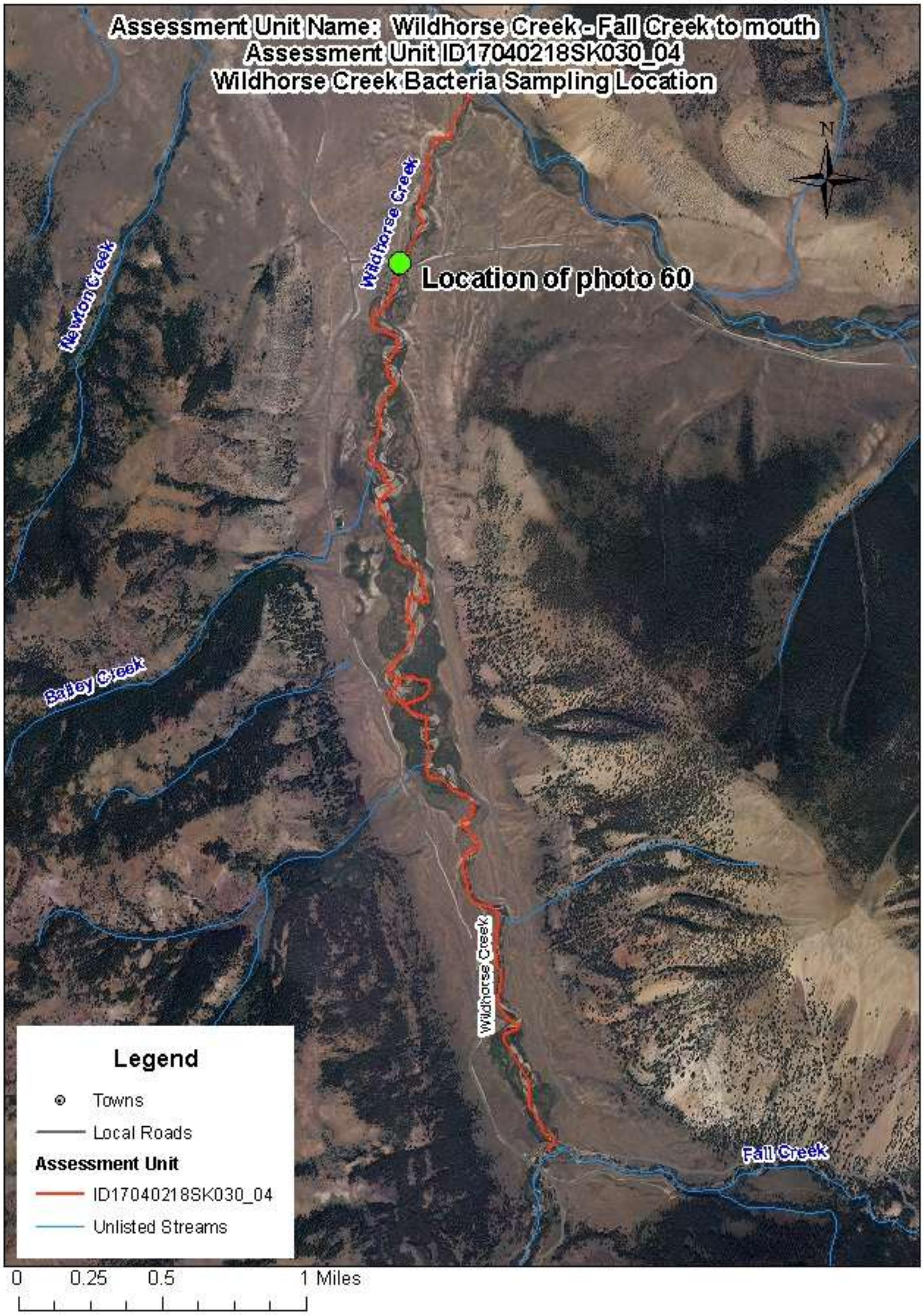

Figure 20. Wildhorse Creek bacteria sampling—location of photo 60

Photo 60

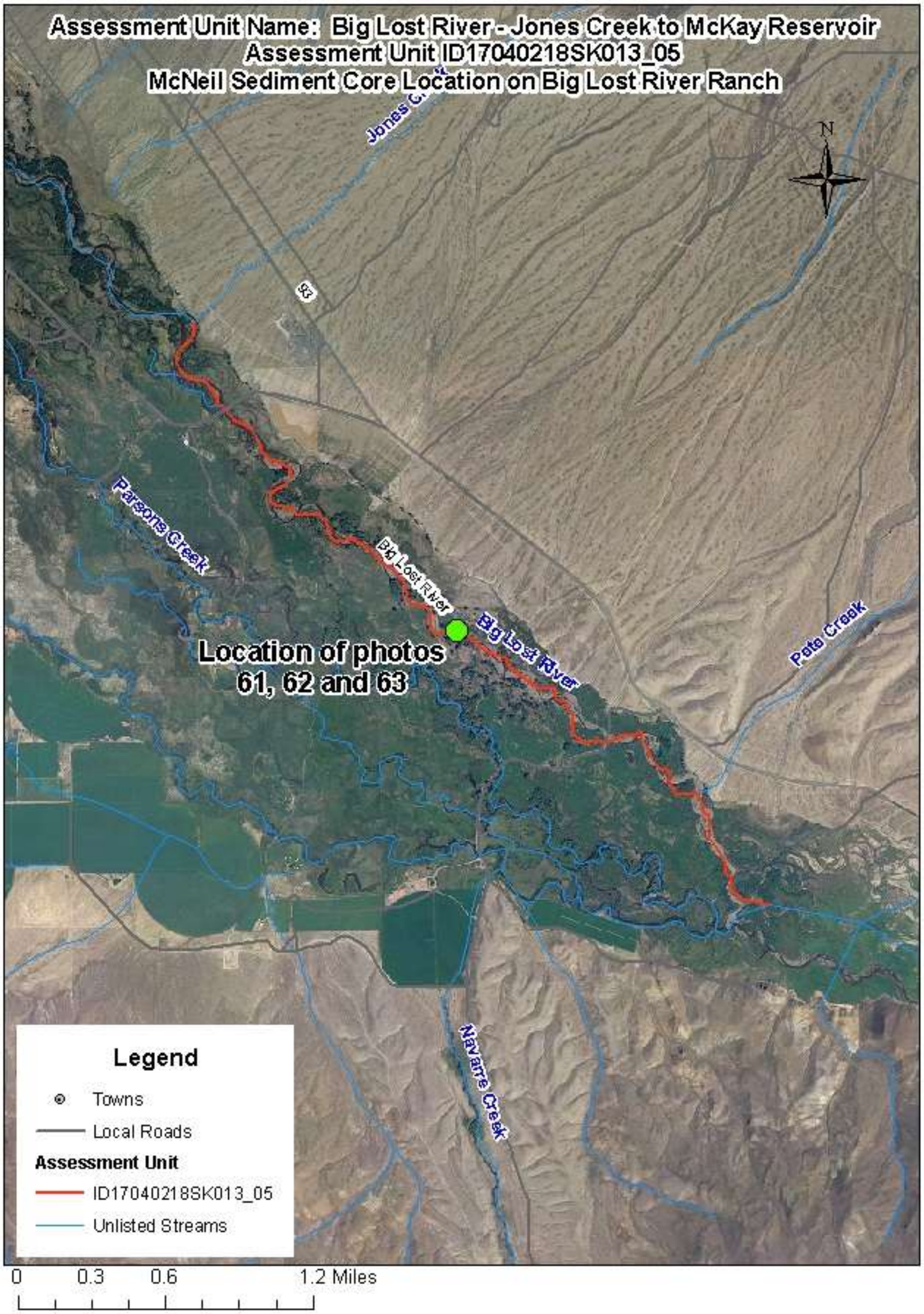

Figure 21. McNeil sediment core location—location of photos 61–63

Photo 61

Photo 62

Photo 63

Appendix D. Salmon-Challis National Forest Stream Bank Stability Data

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Summary Bank Stability Measurements Recorded on the Salmon-Challis National Forest from 1995 through 2009.

	Percent Bank Stability														
Big Lost Subbasin															
	1995	**1996**	**1997**	**1998**	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Alder Creek 1R															85
Antelope Creek 1R	64.5		53.5	65.0	29.0	56.0	57.0	70.0	65.0	84					
Antelope Creek 2R													100.0	95.5	87
Bear Creek 1R													65.0		
Cherry Creek 1R	63.0		56.0	77.0	53.0	74.0	71.0	82.0	87.5	88	73.0		95.5		
EF Big Lost River 1R	87.0	83.0	73.5	97.5	69.5	77.0	73.5	71.5	72.0	92.5	74.0				
EF Big Lost River 2R												42.0	90.0		
EF Big Lost River 3R	53.5	86.5	92.0	89.0	81.5	93.5	89.0	97.5	96.5	100	99.5		100.0	95	
E.F. Navarre Creek 1R															73.5
Muldoon Creek 1R	94.0		77.5	100.0	76.0	83.0	90.0	94.0	97.0	100	78.5				
NF Big Lost River 1R	60.0	52.0	27.5	38.0	30.0	14.0	20.5	26.0	46.0	47	55.5				
NF Big Lost River 2R	70.5	56.5	57.5	69.0	23.0	35.0	46.0	46.0	63.5	86	80.0	85.0	81.0	83	
Pass Creek 1R	90.5			90.0	79.0	82.5	75.5	82.5	80.0	87.5		88.0	95.0	77	
Star Hope Creek 0R	85.0	79.5	59.0	90.0	79.5	81.0	82.5	88.0	81.0	91					
Star Hope Creek 1R	95.0		77.5	96.5	75.5	89.5	70.5	74.5	86.0	95	93.0		95.5		
Wildhorse Creek 1R	89.5		76.5	96.5	67.0	82.5	92.5	92.5	97.0	98	82.0		88.5		

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Appendix E. Laboratory Analyses for Nutrient and Bacteria Data

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Idaho DEQ
Aaron Swift
900 N. Skyline Dr. Suite B
Idaho Falls, ID 83402

Date Submitted: 8/10/2009
Date Reported: 8/18/2009

Certificate of Analysis

Sample Description: Twin Bridges Cr.
Sampling Date: 08-10-2009
Sampling Time: 12:30
Date Received: 08-10-2009
Lab Tracking #: 108090897

Analyte	Result	Units	Method	Analysis Date	Analyst
Total Kjeldahl Nitrogen:N mg/L	< 0.5	mg/L	351.2	08/13/09	RP
Total Phos:P mg/L	0.04	mg/L	365.2	08/12/09	RP

G. Ryan Pattie/la
Lab Director

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Idaho DEQ
Aaron Swift
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Idaho Falls, ID 83402

Date Submitted: 8/10/2009
Date Reported: 8/18/2009

Certificate of Analysis

Sample Description: Sage Cr.
Sampling Date: 08-10-2009
Sampling Time: 11:45
Date Received: 08-10-2009
Lab Tracking #: 108090898

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	1413.6	MPN/100ml	Quantitray	08/10/09	BN

Sample Description: Wildhorse Cr.
Sampling Date: 08-10-2009
Sampling Time: 12:55
Date Received: 08-10-2009
Lab Tracking #: 108090899

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	5.2	MPN/100ml	Quantitray	08/10/09	BN

Sample Description: Challis
Sampling Date: 08-10-2009
Sampling Time: 10:30
Date Received: 08-10-2009
Lab Tracking #: 108090900

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	387.3	MPN/100ml	Quantitray	08/10/09	BN

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Idaho Falls, ID 83402

Date Submitted: 8/13/2009
Date Reported: 8/19/2009

Certificate of Analysis

Sample Description: Challis
Sampling Date: 08-13-2009
Sampling Time: 10:00
Date Received: 08-13-2009
Lab Tracking #: 108091014

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	1413.6	MPN/100ml	Quantitray	08/13/09	BN

Sample Description: Sage Creek
Sampling Date: 08-13-2009
Sampling Time: 11:15
Date Received: 08-13-2009
Lab Tracking #: 108091015

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	272.3	MPN/100ml	Quantitray	08/13/09	BN

Sample Description: Wildhorse Creek
Sampling Date: 08-13-2009
Sampling Time: 12:00
Date Received: 08-13-2009
Lab Tracking #: 108091016

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	19.9	MPN/100ml	Quantitray	08/13/09	BN

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BL 3rd results

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Idaho DEQ
Aaron Swift
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Idaho Falls, ID 83402

Date Submitted: 8/20/2009
Date Reported: 8/21/2009

Certificate of Analysis

Sample Description: Wildhorse Cr.
Sampling Date: 08-20-2009
Sampling Time: 10:30
Date Received: 08-20-2009
Lab Tracking #: 108091168

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	12.1	MPN/100ml	Quantitray	08/20/09	BN

Sample Description: Sage Cr.
Sampling Date: 08-20-2009
Sampling Time: 11:20
Date Received: 08-20-2009
Lab Tracking #: 108091169

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	648.8	MPN/100ml	Quantitray	08/20/09	BN

Sample Description: Challis
Sampling Date: 08-20-2009
Sampling Time: 12:15
Date Received: 08-20-2009
Lab Tracking #: 108091170

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	344.8	MPN/100ml	Quantitray	08/20/09	BN

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4th Rd. Results of BL

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Idaho DEQ
Aaron Swift
900 N. Skyline Dr. Suite B
Idaho Falls, ID 83402

Date Submitted: 8/26/2009
Date Reported: 9/8/2009

Certificate of Analysis

Sample Description: Big Lost
Sampling Date: 08-26-2009
Sampling Time: 9:38
Date Received: 08-26-2009
Lab Tracking #: 108091254

Analyte	Result	Units	Method	Analysis Date	Analyst
Total Kjeldahl Nitrogen:N mg/L	< 0.5	mg/L	351.2	09/04/09	RP
Total Phos:P mg/L	0.02	mg/L	365.2	09/03/09	RP

G. Ryan Pattie/la
Lab Director.

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5th Rd Results for BL

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Date Submitted: 9/2/2009
Date Reported: 9/8/2009

Certificate of Analysis

Sample Description: Challis
Sampling Date: 09-02-2009
Sampling Time: 9:26
Date Received: 09-02-2009
Lab Tracking #: 109091405

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	146.7	MPN/100ml	Quantitray	09/02/09	BN

Sample Description: Wildhorse
Sampling Date: 09-02-2009
Sampling Time: 10:55
Date Received: 09-02-2009
Lab Tracking #: 109091406

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	19.9	MPN/100ml	Quantitray	09/02/09	BN

Sample Description: Sage
Sampling Date: 09-02-2009
Sampling Time: 10:25
Date Received: 09-02-2009
Lab Tracking #: 109091407

Analyte	Result	Units	Method	Analysis Date	Analyst
E. coli MPN/100ml	1413.6	MPN/100ml	Quantitray	09/02/09	BN

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Appendix F. Erosion Inventory Methodology and Results

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Streambank Erosion Inventory

The streambank erosion inventory used to estimate background and existing streambank erosion followed methods outlined in the proceedings from the Natural Resource Conservation Service (NRCS) Channel Evaluation Workshop (NRCS, 1983). Using the direct volume method, sub-sections of 1996 §303(d) watersheds were surveyed to determine the extent of chronic bank erosion and estimate the needed reductions.

The NRCS Stream Bank Erosion Inventory is a field based methodology, which measures streambank/channel stability, length of active eroding banks, and bank geometry (Stevenson, 1994). The streambank/channel stability inventories were used to estimate the long-term lateral recession rate. The recession rate is determined from field evaluation of streambank characteristics that are assigned a categorical rating ranging from 0 to 3. The categories of rating the factors and rating scores are:

Bank Stability:
Do not appear to be eroding - 0
Erosion evident - 1
Erosion and cracking present - 2
Slumps and clumps sloughing off - 3

Bank Condition:
Some bare bank, few rills, no vegetative overhang - 0
Predominantly bare, some rills, moderate vegetative overhang - 1
Bare, rills, severe vegetative overhang, exposed roots - 2
Bare, rills and gullies, severe vegetative overhang, falling trees - 3

Vegetation / Cover On Banks:
Predominantly perennials or rock-covered - 0
Annuals / perennials mixed or about 40% bare - 1
Annuals or about 70% bare - 2
Predominantly bare – 3

Bank / Channel Shape:
V - Shaped channel, sloped banks - 0
Steep V - Shaped channel, near vertical banks - 1
Vertical Banks, U - Shaped channel - 2
U - Shaped channel, undercut banks, meandering channel - 3

Channel Bottom:
Channel in bedrock / noneroding - 0
Soil bottom, gravels or cobbles, minor erosion - 1
Silt bottom, evidence of active downcutting - 2

Deposition:
No evidence of recent deposition - 1
Evidence of recent deposits, silt bars - 0

Cumulative Rating
Slight (0-4) Moderate (5-8) Severe (9+)
From the Cumulative Rating, the lateral recession rate is assigned.

0.01 - 0.05 feet per year **Slight**
0.06 - 0.15 feet per year **Moderate**
0.16 - 0.3 feet per year **Severe**
0.5+ feet per year **Very Severe**

Streambank stability can also be characterized through the following definition and the corresponding streambank erosion condition rating from Bank Stability or Bank Condition above are included in italics. Streambanks are considered stable if they do not show indications of any of the following features:

- Breakdown - Obvious blocks of bank broken away and lying adjacent to the bank breakage. *Bank Stability Rating 3*

- Slumping or False Bank - Bank has obviously slipped down, cracks may or may not be obvious, but the slump feature is obvious. *Bank Stability Rating 2*

- Fracture - A crack is visibly obvious on the bank indicating that the block of bank I about to slump or move into the stream. *Bank Stability Rating 2*

- Vertical and Eroding - The bank is mostly uncovered and the bank angle is steeper than 80 degrees from the horizontal. *Bank Stability Rating 1*

Streambanks are considered covered if they show any of the following features:

- Perennial vegetation ground cover is greater than 50%. *Vegetation/Cover Rating 0*

- Roots of vegetation cover more than 50% of the bank (deep rooted plants such as willows and sedges provide such root cover). *Vegetation/Cover Rating 1*

- At least 50% of the bank surfaces are protected by rocks of cobble size or larger. *Vegetation/Cover Rating 0*

- At least 50% of the bank surfaces are protected by logs of 4 inch diameter or larger. *Vegetation/Cover Rating 1*

Streambank stability is estimated using a simplified modification of Platts, Megahan, and Minshall (1983, p. 13) as stated in *Monitoring Protocols to Evaluate Water Quality Effects of Grazing Management on Western Rangeland Streams* (Bauer and Burton, 1993). The modification allows for measuring streambank stability in a more objective fashion. The lengths of banks on both sides of the stream throughout the entire linear distance of the representative reach are measured and proportioned into four stability classes as follows:

- Mostly covered and stable (non-erosional). Streambanks are Over 50% Covered as defined above. Streambanks are Stable as defined above. Banks associated with gravel bars having perennial vegetation above the scourline are in this category. *Cumulative Rating 0 - 4 (slight erosion) with a corresponding lateral recession rate of 0.01 - 0.05 feet per year.*

- Mostly covered and unstable (vulnerable). Streambanks are Over 50% Covered as defined above. Streambanks are Unstable as defined above. Such banks are typical of false banks" observed in meadows where breakdown, slumping, and/or fracture show instability yet vegetative cover is abundant. *Cumulative Rating 5 - 8 (moderate erosion) with a corresponding lateral recession rate of 0.06 - 0.2 feet per year.*

- Mostly uncovered and stable (vulnerable). Streambanks are less than 50% Covered as defined above. Streambanks are Stable as defined above. Uncovered, stable banks are typical of streambanks trampled by concentrations of cattle. Such trampling flattens the bank so that slumping and breakdown do not occur even though vegetative cover is significantly reduced or eliminated. *Cumulative Rating 5 - 8 (moderate erosion) with a corresponding lateral recession rate of 0.06 - 0.2 feet per year.*

- Mostly uncovered and unstable (erosional). Streambanks are less than 50% Covered as defined above. They are also Unstable as defined above. These are bare eroding streambanks and include ALL banks mostly uncovered, which are at a steep angle to the water surface. *Cumulative Rating 9+ (severe erosion) with a corresponding lateral recession rate of over 0.5 feet per year.*

Streambanks were inventoried to quantify bank erosion rate and annual average erosion. These data were used to develop a quantitative sediment budget to be used for TMDL development.

<u>Site Selection</u>

The first step in the bank erosion inventory is to identify key problem areas. Streambank erosion tends to increase as a function of watershed area (NRCS, 1983). As a result, the lower stream segments of larger watersheds tend to be problem areas. These stream segments tend to be alluvial streams commonly classified as response reaches (Rosgen B and C channel types) (Rosgen, 1996).

Because it is often unrealistic to survey every stream segment, sampled reaches were used and bank erosion rates are extrapolated over a larger stream segment. The length of the sampled reach is a function of stream type variability where streams segments with highly variable channel types need a large sample, whereas segments with uniform gradient and consistent geometry need less. Typically between 10 and 30 percent of streambank needs to be inventoried. Often, the location of some stream inventory reaches is more dependent on land ownership than watershed characteristics. For example, private land owners are sometimes unwilling to allow access to stream segments within their property. Stream reaches are subdivided into *sites* with similar channel and bank characteristics. Breaks between sites are made where channel type and/or dominate bank characteristics change substantially. In a stream with uniform channel geometry there may be only one site per stream reach, whereas in an area with variable conditions there may be several sites. Subdivision of stream reaches is at the discretion of the field crew leader.

<u>Field Methods</u>

Streambank erosion or channel stability inventory field methods were originally developed by the USDA USFS (Pfankuch, 1975). Further developments of channel stability inventory methods are outlined in Lohrey (1989) and NRCS (1983). As stated above, the NRCS (1983) document outlines field methods used in this inventory. However, slight modifications to the field methods were made and are documented.

Field crews typically consist of two to four people and are trained as a group to ensure quality control or consistent data collection. Field crews survey selected stream reaches measuring bank length, slope height, bankfull width and depth, and bank content. In most cases, a Global Positioning System (GPS) is used to locate the upper and lower boundaries of inventoried stream reaches. Additionally, while surveying field crews photograph key problem areas.

Bank Erosion Calculations

The direct volume method is used to calculate average annual erosion rates for a given stream segment based on bank recession rate determined in the survey (NRCS, 1983). The erosion rate (tons/mile/year) is used to estimate the total bank erosion of the selected stream corridor.

The direct volume method is summarized in the following equations:

$$E = [A_E * R_{LR} * \_{B}]/2000 \text{ (lbs/ton)}$$

where:

E = bank erosion over sampled stream reach (tons/yr/sample reach)

A_E = eroding area (ft^2)

R_{LR} = lateral recession rate (ft/yr)

$\_{B}$ = bulk density of bank material (lbs/ft^3)

The bank erosion rate (E_R) is calculated by dividing the sampled bank erosion (E) by the total stream length sampled:

$$E_R = E/L_{BB}$$

where:

E_R = bank erosion rate (tons/mile/year)

E = bank erosion over sampled stream reach (tons/yr/sample reach)

L_{BB} = bank to bank stream length over sampled reach

Total bank erosion is expressed as an annual average. However, the frequency and magnitude of bank erosion events are greatly a function of soil moisture and stream discharge (Leopold et al, 1964). Because channel erosion events typically result from above average flow events, the annual average bank erosion value should be considered a long term average. For example, a 50 year flood event might cause five feet of bank erosion in one year and over a ten year period this events accounts for the majority of bank erosion. These factors have less of an influence where bank trampling is the major cause of channel instability.

The *eroding area* (A_E) is the product of linear horizontal bank distance and average bank slope height. Bank length and slope heights are measured while walking along the stream channel. Pacing is used to measure horizontal distance, and bank slope heights are continually measured and averaged over a given reach or site. The horizontal length is the length of the right or left bank, not both. Typically, one bank along the stream channel is actively eroding. For example, the bank on the outside of a meander. However, both banks of channels with severe headcuts or gullies will be eroding and are to be measured separately and eventually summed.

Determining the *lateral recession rate* (R_{LR}) is one of the most critical factors in this methodology (NRCS, 1983). Several techniques are available to quantify bank erosion rates: for example, aerial photo interpretation, anecdotal data, bank pins, and channel cross sections.

To facilitate consistent data collection, the NRCS developed rating factors used to estimate lateral recession rate. Similar to methods developed by Pfankuch (1975), the NRCS method measures bank and channel stability, and then uses the ratings as surrogates for bank erosion rates.

The *bulk density* ($_B$) of bank material is measured ocularly in the field. Soil bulk density is the weight of material divided by its volume, including the volume of its pore spaces. A table of typical soil bulk densities can be used, or soil samples can be collected and soil bulk density measured in the laboratory.

References

Compton, R.R. 1996. Interpretation of aerial photos.

Flanagan, D.C., and M.A. Nearing (Editors). USDA Water Erosion Prediction Project Hillslope Profile and Watershed Model Documentation. NSERL Report No. 10. USDA-ARS National Soil Erosion Laboratory, W. Lafayette IN. 9.1-9.16

Hall, T.J. 1986. A laboratory study of the effects of fine sediments on survival of three species of Pacific salmon from eyed egg to fry emergence. National Council of the Paper Industry for Air and Stream Improvement. Technical Bulletin 482. New York.

IDEQ. 1999b. 1998 303(d) List. Idaho Division of Environmental Quality. Surface Water Program. January. 473 pp.

Leopold, L.B., M.G. Wolman and J.P. Miller. 1964. Fluvial processes in geomorphology. Freeman. San Francisco, CA.

Lohrey, M.H. 1989. Stream channel stability guidelines for range environmental assessment and allotment management plans. U.S. Forest Service, Northwest Region (unpublished).

McNeil W.J. and W.H. Ahnell. 1964. Success of pink salmon spawning relative to size of spawning bed materials. US Fish and Wildlife Service, Special Scientific Report-Fisheries No. 469.

National Resources Conservation Service. 1983. Erosion and sediment yield. In: proceedings from the channel evaluation workshop. Ventura, CA. 54 p.

Pfankuch, D.J. 1975. Stream reach inventory and channel stability evaluation. U.S. Forest Service, Northern Region. Missoula, MT.

Reiser, D.W. and R.G. White. 1988. Effects of two sediment size-classes on survival of steelhead and Chinook salmon eggs. North American Journal of Fisheries Management. 8: 432-437.

Rosgen, D.L. 1996 Applied River Morphology. Wildland Hydrology. Pagosa Springs, CO. 378pp.

Stevenson, T.K. 1994. USDA-NRCS, Idaho. Channel erosion condition inventory description. Memorandum to Paul Shelton, District Conservationist, Montpelier FO, Idaho, 5/24/94: describing estimation of streambank, road and gully erosion. USDA NRCS. 1983.Channel evaluation Workshop, Ventura, California, November 14-18, 1983. Presented at U.S. Army Corps of Engineers Hydrologic Engineering Center training session by Lyle J. Steffen, Geologist, Soil Conservation Service, Davis, CA. December 14,1982.

USDA FS. 1997. Challis Creek Watershed Analysis. Salmon-Challis National Forest, Challis Ranger District. June 1997.

McNeil Sediment Core Sampling Form

Stream	Big Lost River					
Date	7/1/2009					
Location:	Big Lost River Ranch					
Lat/Lon:	N:	43.98299				
	W:	113.7517				
Site Desc:	Cobbles					
Personnel:	Aaron Swift, Jack Rainey					
Rosgen Channel:		C				
Reach Gradient:						
Geology: (Q G V S)		V, S				
Target Species		CTT				
Sample Number		**1**	**2**	**3**		
Seive Size (inches)		ML	ML	ML		
2.5		1670	2320	235		
1		1990	2340	2900		
0.5		1170	850	1260		
0.25		830	710	1000		
1.0 - 0.25" Subtotal		3990	3900	5160		
#4		225	220	260		
#8		700	450	590		
#20		1400	630	750		
#70		590	530	730		
#270		55	10	25		
<0.25" Subtotal		2970	1840	2355		
Sample Total						
W/O 2.5"		6960	5740	7515	Mean	Std. Dev.
% Fines W/O 2.5"		**0.426724**	**0.320557**	**0.313373**	**0.353552**	**0.063471**
Sample Total						
W 2.5"		8630	8060	7750	Mean	Std. Dev.
% Fines W 2.5"		0.344148	0.228288	0.303871	0.292102	0.05882

Stream Bank Erosion Inventory Worksheet			Stream Segment Location	
Stream	Bear Creek		GPS Coordinates	
Section	Lower Reach		Upstream	N 43.98808
Land Use	Forest Service/Recreation			W 113.46830
Field Crew	Aaron Swift, Jack Rainey		Downstream	N 43.98743
				W 113.46072

Stream Bank Erosion Calculations		
AVE. Bank Height:	1.8	feet
bank to bank Eroding Seg. Length	178	feet
Percent eroding bank	0.04	
Bank erosion over sampled reach (E)	1	tons/year/sample reach
Erosion Rate (E_R)	2	tons/mile/year
Feet of Similar Stream Type	40550	feet*
Eroding bank extrapolation	3185.49	feet
Total stream bank erosion	**18**	tons/year
Inv. bank to bank length (L_{BB})	4800	feet
(Inventoried stream length X 2)		

*Similar stream type = Strahler 2nd order streams in ID17040218SK009_02
1st order presumed non-erosive

Individual Bank Measurements

Total Inventoried Bank Length	Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
2400	3.3	2	Gravel	2
	4.8	1.2		
	36	6		
	39	1.4		
	12	1.2		
	9	1		
	18	1.3		
	30	1.2		
	15	1		
	4.8	2		
	6	1.2	Cobbles	
2400	177.9	1.7727273	sec. total	2
			Recession Rate	0.03
Total Inventoried Length	Total Erosive Length			
2400	177.9	1.77	Ave. Rec.Rank	2
			Ave. Rec.Rate	0.030

Stream Bank Erosion Reduction Calculations

	Bank erosion over sampled reach (E)	4	tons/year/sample reach			
	Erosion Rate (E_R)	10	tons/mile/year			
	Feet of Similar Stream Types	40550.40	feet			
	Eroding bank extrapolation	17180.16	feet			
	Total stream bank erosion	**79.9**	tons/year			
Eroding Area		Reach erosion rate		Eroding Area with Load Reductions	Load capacity	
630.7363636		0.993	tons/year	1701.818	4.467	tons/year
Recession Rate				Recession Rate		
0.03				0.050		
Bulk Density				Bulk Density		
105				105.000		
for very cobbly loam		0.993	tons/year		4.467	tons/year/sample
		Current Load			Load Allocation	
Eroding Area		**Average Reach erosion rate**			**Total Reduction**	
631		**0.993**	**tons/year/sample**		**-3.474**	**tons/year/sample**
Recession Rate						
0.03						
Avg. Bulk Density						
105						

Stream Bank Erosion Inventory Worksheet	
Stream	Big Lost River
Section	Big Lost River Ranch
Land Use	Private
Field Crew	Aaron Swift, Jack Rainey

Stream Segment Location	
GPS Coordinates	
Upstream	N 43.98634
	W 113.75707
Downstream	N 43.98299
	W 113.75166

Stream Bank Erosion Calculations		
AVE. Bank Height:	3.4	feet
bank to bank Eroding Seg. Length	1440	feet
Percent eroding bank	0.32	
Bank erosion over sampled reach (E)	206	tons/year/sample reach
Erosion Rate (E_R)	483	tons/mile/year
Feet of Similar Stream Type	46464	feet*
Eroding bank extrapolation	31176.96	feet
Total stream bank erosion	**4452**	tons/year
Inv. bank to bank length (L_{BB})	4500	feet
(Inventoried stream length X 2)		

*Similar stream type = ID17040218SK013_05 and 015_05

Downstream of reservoir, diversion return flows, high runoff, fluctuating stream flows

Individual Bank Measurements

Total Inventoried Bank Length	Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
2250	540	3.3	Sand	9
	450	3.9		
	90	3.3		
	60	2		
	300	4.3	Cobbles	
2250	1440	3.36	sec. total	9
			Recession Rate	0.5
Total Inventoried Length	Total Erosive Length			
2250	1440	3.36	Ave. Rec.Rank	9
			Ave. Rec.Rate	0.500

Stream Bank Erosion Reduction Calculations

	Bank erosion over sampled reach (E)		6	tons/year/sample reach			
	Erosion Rate (E_R)		15	tons/mile/year			
	Feet of Similar Stream Types		46464.00	feet			
	Eroding bank extrapolation		19485.60	feet			
	Total stream bank erosion		**139.1**	tons/year			
Eroding Area		Reach erosion rate		Eroding Area with Load Reductions		Load Capacity	
9676.8		206	tons/year	3024.0		6	tons/year
Recession Rate				Recession Rate			
0.5				0.05			
Bulk Density				Bulk Density			
85					85		
for silt loam		206	tons/year			6	tons/year/sample
		Current Load				Load Allocation	
Eroding Area		**Average Reach erosion rate**				**Total Reduction**	
9677		**206**	**tons/year/sample**			**199 tons/year/sample**	
Recession Rate							
0.5							
Avg. Bulk Density							
85							

Load allocation required

Stream Bank Erosion Inventory Worksheet	
Stream	Pinto Creek
Section	2nd Order
Land Use	Grazing, BLM
Field Crew	Aaron Swift, Jack Rainey

Stream Segment Location	
	GPS Coordinates
Upstream	N 44.00434
	W 114.03185
Downstream	N 43.00353
	W 114.02917

Stream Bank Erosion Calculations		
AVE. Bank Height:	0.8	feet
bank to bank Eroding Seg. Length	312	feet
Percent eroding bank	0.19	
Bank erosion over sampled reach (E)	1	tons/year/sample reach
Erosion Rate (ER)	5	tons/mile/year
Feet of Similar Stream Type	149318	feet*
Eroding bank extrapolation	55575.60	feet
Total stream bank erosion	**145**	tons/year
Inv. bank to bank length (LBB)	1686	feet
	(Inventoried stream length X 2)	

*Similar stream type = Strahler 2nd order streams in ID17040218SK024_02
1st order presumed non-erosive

Individual Bank Measurements

Total Inventoried Bank Length	Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
843	6.6	0.7	Gravel	2
	32.8	1		
	13.1	0.7		
	23	1		
	13.1	1		
	19.7	0.7		
	9.8	0.7		
	32.8	0.7		
	3.3	1		
	13.1	1		
	23	1		
	6.6	1		
	29.5	0.7		
	3.3	0.3		
	13.1	0.7		
	13.1	0.7		
	32.8	1		
	23	1	Sand	
843	311.7	0.8277778	sec. total	2
			Recession Rate	0.03
Total Inventoried Length	Total Erosive Length			
843	311.7	0.83	Ave. Rec.Rank	2
			Ave. Rec.Rate	0.030

Stream Bank Erosion Reduction Calculations

	Bank erosion over sampled reach (E)		1	tons/year/sample reach			
	Erosion Rate (ER)		5	tons/mile/year			
	Feet of Similar Stream Types		149318.00	feet			
	Eroding bank extrapolation		60064.40	feet			
	Total stream bank erosion		**130.5**	tons/year			
Eroding Area		Reach erosion rate		Eroding Area with Load Reductions		Load Capacity	
516.0366667		0.813	tons/year	279.127		0.733	tons/year
Recession Rate				Recession Rate			
0.03				0.050			
Bulk Density				Bulk Density			
105				105.000			
for gravelly loam		0.813	tons/year			0.733	tons/year/sample
		Current Load				Load Allocation	
Eroding Area		**Average Reach erosion rate**				**Total Reduction**	
516		**0.813**	**tons/year/sample**			**0.080**	**tons/year/sample**
Recession Rate							
0.03							
Avg. Bulk Density							
105							

Stream Bank Erosion Inventory Worksheet	
Stream	Grant Creek
Section	Lower Reach
Land Use	Grazing/BLM
Field Crew	Aaron Swift, Jack Rainey

Stream Segment Location	
GPS Coordinates	
Upstream	N 43.999866
	W 113.994816
Downstream	N 44.00333
	W 113.99504

Stream Bank Erosion Calculations		
AVE. Bank Height:	1.8	feet
bank to bank Eroding Seg. Length	178	feet
Percent eroding bank	0.11	
Bank erosion over sampled reach (E)	0	tons/year/sample reach
Erosion Rate (E_R)	2	tons/mile/year
Feet of Similar Stream Type	7392	feet*
Eroding bank extrapolation	1833.06	feet
Total stream bank erosion	**3**	tons/year
Inv. bank to bank length (L_{BB})	1590	feet
(Inventoried stream length X 2)		

*Similar stream type = Strahler 3rd order streams in ID17040218SK024_03
3rd order is the only listed portion

Individual Bank Measurements				
Total Inventoried Bank Length	Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
795	13.1	0.7	Gravel	2
	6.6	3.3		
	3.3	1.6		
	19.7	0.7		
	19.7	1.6		
	3.3	1.6		
	3.3	0.7		
	9.8	0.3		
	3.3	0.7		
	3.3	0.7		
	3.3	1.0		
	3.3	0.7		
	3.3	0.7	Sand	
795	95.14436	1.0852009	sec. total	2
			Recession Rate	0.03
Total Inventoried Length	Total Erosive Length			
795	95.14436	1.09	Ave. Rec.Rank	2
			Ave. Rec.Rate	0.030

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	1	tons/year/sample reach
Erosion Rate (E_R)	6	tons/mile/year
Feet of Similar Stream Types	7392.00	feet
Eroding bank extrapolation	3274.80	feet
Total stream bank erosion	**9.3**	tons/year

Eroding Area	Reach erosion rate		Eroding Area with Load Reductions	Load Capacity	
206.5014946	0.325	tons/year	345.094	0.906	tons/year
Recession Rate			Recession Rate		
0.03			0.050		
Bulk Density			Bulk Density		
105			105.000	**Total for segments after reduction**	
for gravelly loam	0.325	tons/year		0.906	tons/year/sample
	Current Load			Load Reduction	
Eroding Area	**Average Reach erosion rate**			**Total Reduction**	
207	**0.325**	**tons/year/sample**		**-0.581**	**tons/year/sample**
Recession Rate					
0.03					
Avg. Bulk Density					
105					

Stream Bank Erosion Inventory Worksheet	
Stream	Big Lost River
Section	Bartlett Point Road bridge and upstream
Land Use	BLM/Grazing/Recreation
Field Crew	Aaron Swift, Jack Rainey

Stream Segment Location	
GPS Coordinates	
Upstream	N 43.999866
	W 113.994816
Downstream	N 44.00333
	W 113.99504

Stream Bank Erosion Calculations		
AVE. Bank Height:	2.9	feet
bank to bank Eroding Seg. Length	750	feet
Percent eroding bank	0.23	
Bank erosion over sampled reach (E)	9	tons/year/sample reach
Erosion Rate (ER)	29	tons/mile/year
Feet of Similar Stream Type	113256	feet*
Eroding bank extrapolation	52230.00	feet
Total stream bank erosion	**640**	tons/year
Inv. bank to bank length (LBB)	3300	feet
(Inventoried stream length X 2)		

*Similar stream type = Strahler 5th order streams in ID17040218SK024_05
5th order is the only listed portion in this AU

Individual Bank Measurements

Total Inventoried Bank Length	Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
1650	210	1.3	Gravel	4
	30	2.3		
	90	1.3		
	240	1.6		
	60	9.8		
	120	1		
1650	750	2.8833333	sec. total	4
			Recession Rate	0.05
Total Inventoried Length	Total Erosive Length			
1650	750	2.88	Ave. Rec.Rank	4
			Ave. Rec.Rate	0.050

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	4	tons/year/sample reach
Erosion Rate (ER)	13	tons/mile/year
Feet of Similar Stream Types	113256.00	feet
Eroding bank extrapolation	45962.40	feet
Total stream bank erosion	**281.6**	tons/year

Eroding Area	Reach erosion rate		Eroding Area with Load Reductions	Load Capacity		
4325	9.191	tons/year	1903.000	4.044	tons/year	
Recession Rate			Recession Rate			
0.05			0.050			
Bulk Density			Bulk Density			
85			85.000	**Total for segments after reduction**		
for silt loam	9.191	tons/year		4.044	tons/year/sample	
	Current loading rate			Load Allocation		
Eroding Area	**Average Reach erosion rate**			**Total Reduction**		
4325	**9.191**	**tons/year/sample**		**5.147**	**tons/year/sample**	
Recession Rate						
0.05						
Avg. Bulk Density						
85						

Load Allocation Needed

Stream Bank Erosion Inventory Worksheet		Stream Segment Location	
Stream	Garden Creek	GPS Coordinates	
Section		Upstream	N 43.98031
Land Use	BLM/Grazing		W 114.06252
Field Crew	Aaron Swift, Jack Rainey	Downstream	N 43.97895
			W 114.06109

Stream Bank Erosion Calculations

AVE. Bank Height:	1.8	feet
bank to bank Eroding Seg. Length	178	feet
Percent eroding bank	0.14	
Bank erosion over sampled reach (E)	0	tons/year/sample reach
Erosion Rate (ER)	3	tons/mile/year
Feet of Similar Stream Type	26136	feet*
Eroding bank extrapolation	7742.57	feet
Total stream bank erosion	**17**	tons/year
Inv. bank to bank length (LBB)	1230	feet
(Inventoried stream length X 2)		

*Similar stream type = Strahler 2nd order streams in ID17040218SK025_02
1st order presumed non-erosive

Individual Bank Measurements

Total Inventoried Bank Length	Erosive Bank Lngth	Average Bank Slope Hgt	Bank Material	Recession Rank
615	3.3	1.3	Gravel	2
	6.6	0.7		
	3.3	2.0		
	3.3	1.6		
	3.3	2.0		
	3.3	1.3		
	6.6	1.3		
	3.3	3.3		
	3.3	1.3		
	3.3	1.3		
	6.6	3.3		
	3.3	0.7		
	3.3	1.0		
	3.3	0.7		
	4.9	1.0		
	3.3	0.7		
	3.3	0.7		
	4.9	0.3		
	16.4	0.3		
	8.2	0.3		
	4.9	0.3		
615	102	1.2	sec. total	2
			Recession Rate	0.03
Total Inventoried Length	Total Erosive Length			
615	102	1.20	Ave. Rec.Rank	2
			Ave. Rec.Rate	0.030

Stream Bank Erosion Reduction Calculations

Bank erosion over sampled reach (E)	1	tons/year/sample reach
Erosion Rate (ER)	7	tons/mile/year
Feet of Similar Stream Types	26136.00	feet
Eroding bank extrapolation	10700.40	feet
Total stream bank erosion	**33.8**	tons/year

Eroding Area	Reach erosion rate		Eroding Area with Load Reductions	Load Capacity	
245.406832	0.387	tons/year	295.9	0.777	tons/year
Recession Rate			Recession Rate		
0.03			0.05		
Bulk Density			Bulk Density		
105			105	Total for segments after reduction	
for cobbly to gravelly loam	0.387	tons/year		0.777	tons/year/sample
	Current loading rate			Load Allocation	
Eroding Area	**Average Reach erosion rate**			**Total Reduction**	
245	0.387	**tons/year/sample**		-0.390	**tons/year/sample**
Recession Rate					
0.03					
Avg. Bulk Density					
105					

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Appendix G. Distribution List

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Appendix H. Public Comments/Public Participation

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