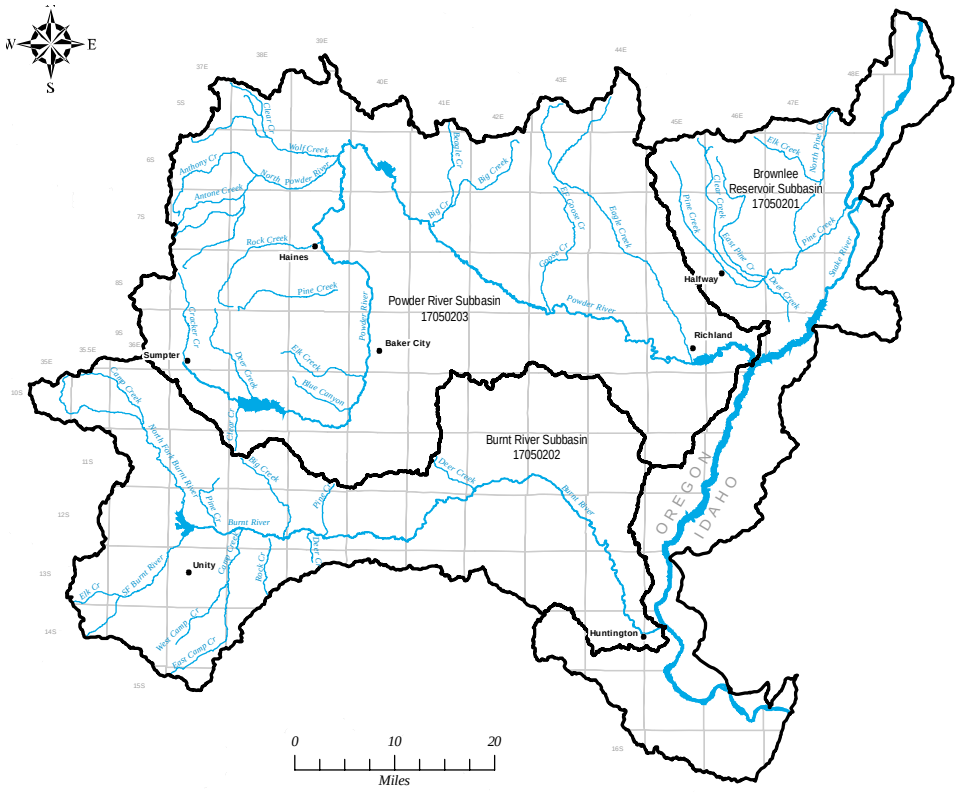
RECLAMATION

Managing Water in the West

LITERATURE REVIEW OF THE POWDER BASIN, OREGON

STREAM SYSTEMS, WATER STORAGE, AND STREAM HEALTH AS THEY PERTAIN TO THE BASIN AND WATER SCIENCE



U.S. DEPARTMENT OF THE INTERIOR
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US DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION
SNAKE RIVER AREA OFFICE
BOISE, IDAHO

MAY 2008

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STREAM SYSTEMS, WATER STORAGE, AND STREAM HEALTH AS THEY PERTAIN TO THE BASIN AND WATER SCIENCE

US DEPARTMENT OF THE INTERIOR
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SNAKE RIVER AREA OFFICE
BOISE, IDAHO

MAY 2008

PREPARED BY
BROWNE CONSULTING, LLC
BAKER CITY, OREGON

IN COOPERATION WITH
POWDER BASIN WATER AND STREAM HEALTH COMMITTEE
BAKER CITY, OREGON

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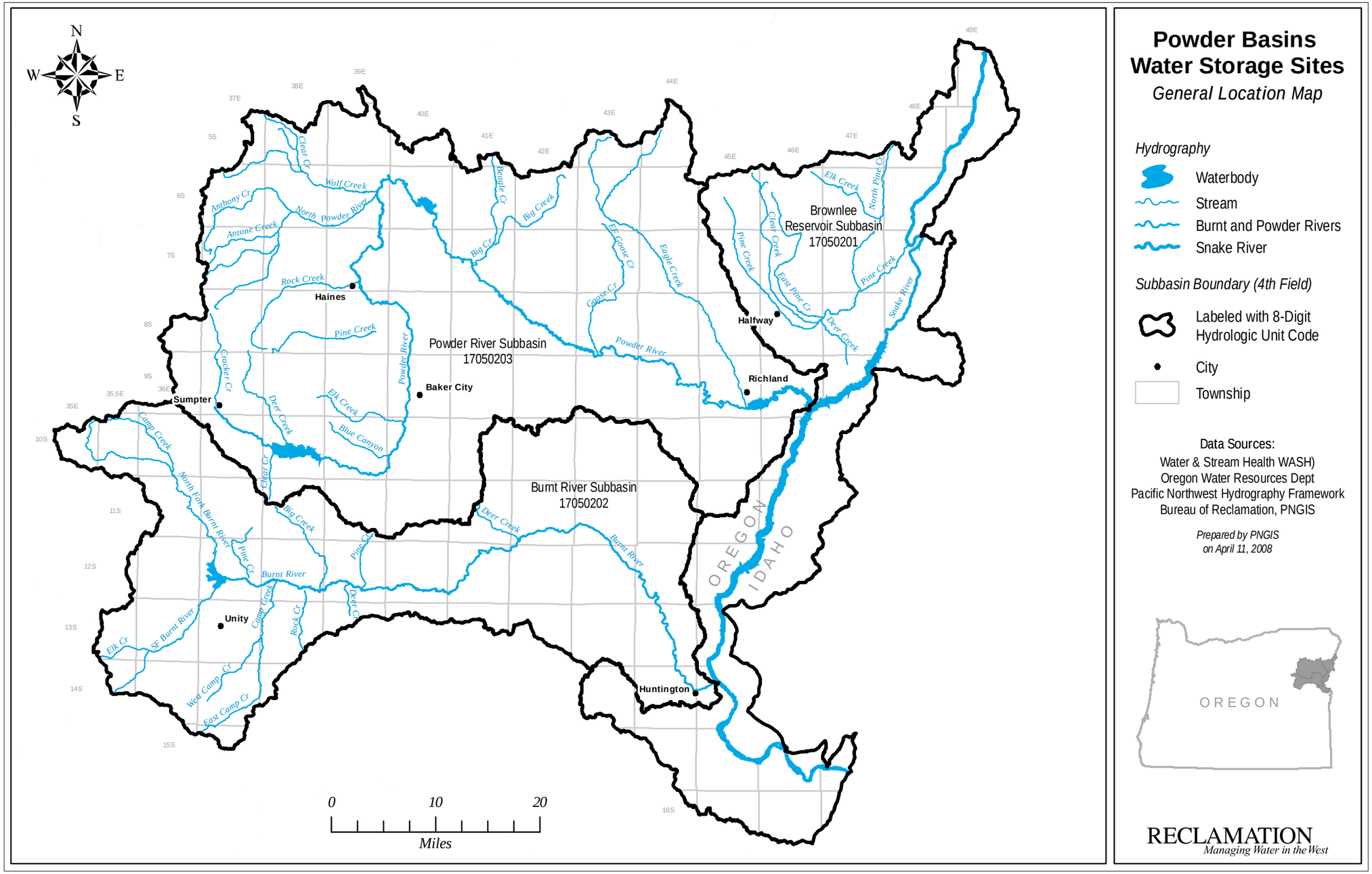

Figure 1. General Location Map of "Powder Basin" (HUC 170502, the Middle Snake-Powder Basin Subregion) and its component subbasins.

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In Text	Full Citation
Reclamation 2008	*Literature Review of the Powder Basin, Oregon, Stream Systems, Water Storage, and Stream Health as they Pertain to the Basin and Water Science.* May 2008. Bureau of Reclamation, Snake River Area Office, Boise, ID. Prepared by Browne Consulting, LLC, Baker City, OR, in cooperation with Powder Basin Water and Stream Health Committee, Baker City, OR. *[this document]*

In Text	Full Citation
Armstrong 1999	National Recreation Lakes Study Commission. June 1999. *Reservoirs of Opportunity, Final Report.* Bob Armstrong, commission chairman, Washington, DC.
Baker County ACD 2004	Baker County Association of Conservation Districts. November 2004. *Supplement to the Powder and Burnt Subbasin Plans.* Baker City, OR. 8 pp.
BPA 1997	Bonneville Power Administration. October 1997. *Bull Trout Life History, Genetics, Habitat Needs, and Limiting Factors in Central and Northeast Oregon 1996 Annual Report.* Prepared for Bonneville Power Administration, Environment Fish and Wildlife Program (Portland, OR) by Oregon Department of Fish and Wildlife (Portland, OR) and USFS North Fork John Day Ranger District (Ukiah, OR). http://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=34342-2
Hutchinson and Fortune 1967	Hutchison, J.M. and Fortune, J.P. Jr. 1967. *The Fish & Wildlife Resources of the Powder Basin and their Water Requirements.* Oregon State Game Commission A report with recommendations to the Oregon State Water Resources Board; "Federal Aid to Fish Project F-69-R-5." Portland, OR.
Nowak 2004a	Nowak, M. Cathy. May 2004a. *Burnt River Subbasin Plan, DRAFT.* Cat Tracks Wildlife Consulting. Prepared for Northwest Power and Conservation Council; http://www.nwcouncil.org/fw/subbasinplanning (as of April 2008)
Nowak 2004b	Nowak, M. Cathy. May 2004b. *Powder River Subbasin Plan.* Cat Tracks Wildlife Consulting. Prepared for Northwest Power and Conservation Council; http://www.nwcouncil.org/fw/subbasinplanning (as of April 2008)
Powder Basin WC 2000	Powder Basin Watershed Council. August 2000. *Pine Creek Watershed Assessment Volume 1 – Report; Volume 2 – Appendices.* Baker City, OR.

Acronyms and Abbreviations

BLM	US Bureau of Land Management of the ***DOI***
Reclamation	US Bureau of Reclamation of the ***DOI***
cfs	cubic feet per second
DOI	US Department of the Interior
ESA	Endangered Species Act
HEL	highly erodible land
NEPA	National Environmental Protection Act
NRCS	US Natural Resources Conservation Service (successor to ***SCS***) of the ***USDA***
OAR	Oregon Administrative Rules
ODA	Oregon Department of Agriculture
ODF	Oregon Department of Forestry
ODFW	Oregon Department of Fish and Wildlife
ORS	Oregon Revised Statutes
OSU	Oregon State University
OWEB	Oregon Watershed Enhancement Board
OWRD	Oregon Water Resources Department
P.L. 566	US Watershed Protection and Flood Prevention Act of 1954 (Public Law 83–566). Provides for assistance to states, local governments, and tribes by ***NRCS***.
RMS	Resource Management System
SCS	US Soil and Conservation Service of the ***USDA***
SWCD	Soil and Water Conservation District
USDA	US Department of Agriculture
FWS	US Fish and Wildlife Service of the ***DOI***
USFS	US Forest Service of the ***USDA***
WASH	Powder Basin Water and Stream Health Committee

1. INTRODUCTION

1.1 BACKGROUND

"Water is the lifeblood of the American West and the foundation of its economy."[1/]

Residents of the Powder Basin can attest to the truth of that statement, as water in their semi-arid climate is frequently in short supply. People's livelihood in the Powder Basin, regardless of their occupation, is either directly or indirectly influenced by water quality and quantity. Critical economic sectors in the area that are significantly influenced by water quality and quantity include agriculture, recreation, environment (fish and aquatic ecosystems, wildlife and terrestrial ecosystems), and energy (power generation).

Presently, there is not sufficient storage to capture spring runoff and provide for water needs during the summer months, such as maintaining adequate streamflow for aquatic species and wildlife, irrigation, and even municipal uses.

Several years ago, recognizing present and future unfulfilled demands for water, local citizens and water groups from the Burnt River and Power River subbasins formed the Powder Basin Water and Stream Health Steering Committee (WASH). The organization requested the US Bureau of Reclamation's Snake River Area Office in Boise, Idaho to provide resources. These would be used to "complete a literature review and assess the quantity and quality of existing data relevant to water management opportunities to enhance water quantity and quality." In 2007, a "statement of work" was agreed on by WASH and Reclamation, and a contract was made with a consultant familiar with the Powder Basin and its natural resources.

This literature review includes existing dams and reservoirs (some of which could be enlarged) and potential sites for new storage facilities. Not all watersheds were examined for sites. The investigations by Reclamation that are continuing from this literature review will look only at sites in the Burnt River Subbasin and Powder River Subbasin.

The Powder Basin is formally called the "Middle Snake–Powder Basin Subregion" and is located in northeast Oregon. It has three "subbasins" — Burnt River, Powder River, and Brownlee Reservoir; these are shown in the General Location Map (Figure 1) on page *iii*. Maps later in this report show each subbasin and its component "watersheds." Table 1 on page 7 show the names and "hydrologic unit codes" (HUC) for these drainages.

1/ Water 2025 is a initiative of the Department of the Interior and the Bureau of Reclamation; information regarding the program can be found at http://www.usbr.gov/water2025/ (as of April 2008).

1.2 APPROACH

There are currently numerous efforts underway all directly related to water quantity and quality in the Burnt River and Powder River subbasins. The Steering Committee's goal is to implement a long-term water management plan. In order to systematically ascertain the most economically viable solution, a logical approach was developed. It is a three-phase approach with which all potential projects will be evaluated.

In order to accomplish this task a literature review must be performed. The literature review is a compilation of information from all facets that pertains to "what is known about the Powder River and Burnt River Subbasins' stream systems, water storage, and stream health as it pertains to the basins' water science."

In order to do a thorough and comprehensive compilation of documents, information was collected for over a year. Additionally, the literature review project was announced at numerous meetings where people were informed of the effort and asked to relay pertinent documents to project management. Some of the meetings included Keating Soil & Water Conservation District, Lower Powder Irrigation District, Pine Valley Information Session, Powder Valley Water Control District, and Powder Basin Water and Stream Health Committee meetings. Agency and district offices were either contacted or visited in person to obtain relevant material. Research locations are listed in Subsection 1.4 "Sources."

1.3 REPORT ORGANIZATION

The document is organized in a way so as to be as user-friendly and accessible as possible.

Chapter 2 describes the physical locations of the areas being investigated.

Chapter 3 describes the process of the reviewing various documents and how the abstracts were made. It also notes "data gaps" (lack of available information).

Chapters 4 through 9 contain the abstracts of documents selected for their pertinence. Within each chapter, the abstracts are listed chronologically from most recent to the oldest. Each listing includes the document title, the year of publication, the "author" (the agencies or individuals), and [in brackets] the "in-text" citation that will be used to refer to the document in this and future Bureau of Reclamation reports. There are separate chapters for the Powder Basin; Burnt River Subbasin; one for each of three groupings of watersheds ("drainage areas") in the Powder River Subbasin; the Pine Creek Watershed; and "related regional abstracts for studies that encompassed more than one geographic area or were relevant to the key subbasins, but was not specifically conducted there.

Chapter 10 is a list of recommendations. Once data analysis was completed, we were able to ascertain what information is completely lacking from a specific geographic area, and what information must be simply updated. In other words, the Recommendations chapter depicts what studies are necessary in order to pursue long-term water management in certain areas.

Chapter 11 is a table with an alphabetical listing of the "In Text" citations, the complete reference ("Full Citation") to the document cited, and a content-analysis indicating which topics (shown in Table 2) that each document addresses.

Chapter 12 contains tables and graphs ("figures") analyzing percent of topics within each study area and timeframe; it is a visual reference guide and is organized in the same manner as described above. This reference guide lists subjects covered under each document, the author, and relevant geographic area. A data analysis was conducted to determine what is known about each area and what is not.

Chapter 13 has a table and three maps showing existing and potential damsites.

1.4 SOURCES

Documents depicted in this literature review can be found variously at the office of Browne Consulting LLC, the Baker County Library, the agencies listed in Subsection 1.4.1, and on the Internet (Subsection 1.4.2). The majority of the documents or their relevant excerpts were copied and are on file at Browne Consulting.

1.4.1 Document Sources

- Bureau of Reclamation, Pacific Northwest Region Office, Boise, ID
- Bureau of Reclamation, Snake River Area Office, Boise, ID
- Bureau of Reclamation, La Grande Field Office, La Grande, OR
- Wallowa-Whitman National Forest Headquarters, Baker City, OR
- Wallowa-Whitman National Forest, Whitman District Office, Baker City, OR
- Bureau of Land Management (BLM), Vale District, Baker Field Office, Baker City, OR
- Oregon Water Resources Department (OWRD), Baker City and Salem, OR
- Oregon Department of Fish and Wildlife (ODFW),Baker City Field Office, Baker City, OR
- Baker County Water and Stream Health Committee, Baker City, OR
- Baker City Library, Baker City, OR
- US Department of Agriculture (USDA) Baker City Service Center, Baker City, OR — location of Natural Resources Conservation Service (NRCS),

various local Soil and Water Conservation Districts (SWCD), and Powder Basin Watershed Council

- Oregon Department of Fish and Wildlife (ODFW), La Grande, OR
- Burnt River Irrigation District, Hereford, OR
- Burnt River Soil and Water Conservation District, Baker City, OR
- Keating Soil and Water Conservation District, Baker City, OR
- Powder Valley Water Control District, North Powder, OR [irrigation district in Baker and Union counties]
- Pine Valley Water Users Association, Halfway, OR
- West Eagle Water Control District, Richland, OR [irrigation district in Baker County]

1.4.2 Internet sites:

- StreamNet – http://www.streamnet.org (March 2008)
- Summit (Universities and Colleges) – available at Baker County Library which has a subscription to website.
- Fish and Wildlife Service – http://www.fws.gov/
- Federal Register – http://www.gpoaccess.gov/fr/index.html
- Natural Resource Conservation Service – http://www.nrcs.usda.gov/
- Oregon Water Resources Department – the OWRD website has an interactive mapping tool which aids with water availability determinations, peak flows, water rights, adjudication information, stream gage information, and other extremely helpful options. http://egov.oregon.gov/OWRD/MAPS/index.shtml#Interactive_Water_Right_Maps,.

2. LOCATIONS AND DESCRIPTIONS

2.1 THE POWDER BASIN [SUBREGION]

The "Powder Basin" (formally the "Middle Snake–Powder Basin Subregion") is located in northeast Oregon. The Powder Basin is bordered to the north by the Wallowa Mountains, to the west by the Blue Mountains, and to the east by the Snake River. Within the Powder Basin, a series of mountains separate the Powder River Subbasin from the Burnt River Subbasin on the south. Figure 1 shows this area.

2.2 BURNT RIVER SUBBASIN

The Burnt River Subbasin encompasses 705,600 acres (ODA 2007); about half is privately owned and the rest is either USFS or BLM (Kerns 2007).

Figure 3 on page 20 shows this subbasin and its watersheds. There are a total of 830 miles of major streams in the Burnt River Subbasin (ODA 2007). The main tributaries of the subbasin are the North Fork and South Fork of the Burnt River, which originate in the Blue Mountains and converge at Unity Reservoir. Unity Reservoir stores 24,972 acre-feet of spring runoff used for multiple uses (Franke 2007). The Burnt River water system is above ten Snake River and Columbia River dams (Kerns 2007). There are neither anadromous fish nor bull trout present in the streams of the subbasin, and none of the streams are listed as "essential fish habitat" for threatened or endangered species (Streamnet 2007).

2.3 POWDER RIVER SUBBASIN

The Powder River Subbasin encompasses 1,096,900 acres that include several main tributaries: the Powder River, North Powder River, Eagle Creek (near Richland), and Pine Creek[2/] (near Halfway) for a total of 1,668 miles of major streams in the subbasin (NRCS 2007). The Powder River is 144 miles long and drains more than 1,540 square miles (Franke 2007). Figure 4 on page33 and Figure 5 on page 37 show this subbasin and its watersheds.

The Powder River originates in the Elkhorn Range of the Blue Mountains, flows into Phillips Reservoir, which has a storage capacity of 90,500 acre-feet, then into the Baker Valley. The North Powder River originates farther north in the same mountain range, and has two existing water storage sites; Wolf Creek Reservoir has a storage capacity of 10,800 acre-feet of excess spring runoff, and Pilcher Creek Reservoir has a storage capacity of 5,910 acre-feet (ODA 2007). The Powder River and North

2/ Pine Creek was included as part of the Powder River Subbasin by NRCS (2007), even though USGS places the Pine Creek Watershed unit is in the Brownlee Reservoir Subbasin.

Powder River converge above Thief Valley Reservoir, which has a storage capacity of 17,400 acre-feet, terminating 78 miles later in the Brownlee Reservoir on the Snake River (ODA 2007). The Powder River water system is above ten Snake River and Columbia River dams (Kerns 2007).

2.4 PINE CREEK WATERSHED

The Pine Creek Watershed is located in the northeast corner of Baker County and is part of the Brownlee Reservoir Subbasin. It covers approximately 195,800 acres, ranging from valley land along the Snake River at approximately 2,000 foot elevation up to sub-alpine forest at 7,000 foot elevation. It originates on the Imnaha divide in the Eagle Cap Wilderness at Pine Lakes, then flows east into the Hells Canyon Reservoir on the Snake River (Powder Basin WC 2000). The Pine Creek water system is above nine Snake River and Columbia River dams. Figure 6 on page 45 shows this watershed within its subbasin.

There are numerous high lakes throughout the basin that various types of dams were built onto for late season release of water during settlement times. That period of history was a key phase of development within the basin and is rich with history pertaining to the advance of the high lakes for water storage.

2.5 TOPOGRAPHY

The steep topography of the Powder Basin causes water to pass through the system rapidly. During the spring months (usually April through June), there is intense runoff, often leading to flooding and its inherent consequences, such as erosion, riparian area degradation, and increased water turbidity. One example is the North Powder Watershed, which discharges on average 380 cubic feet per second (cfs) during that key runoff time. However, the mid-to-late-summer months are often marked by water shortages. It should be remembered that some degree of spring flooding is not always a bad thing; where there's proper flood plain connection and the stream is in a proper functioning condition, flooding can be an important part of the natural stream processes.

The topography of the area also largely influences the amount of precipitation received in a year. As a result of being surrounded by high mountains, precipitation in the valleys average 10.6”, while in the mountains there is an average of approximately 35” of precipitation, predominantly in the form of snow pack. These factors result in water not utilized for irrigation and other consumptive uses leaving the basin in the spring months followed by very dry conditions in the summer months. Large portions of rivers and streams are dewatered, fisheries are depleted, crops suffer, recreation slows, and wildlife has to travel to find water.

Due to the semi-arid climate and steep terrain, even very few senior water rights holders have season-long (March 1 through October 31) water. Between the spring

and fall, streamflows can vary from 3 cfs to 3,000 cfs (Franke 2007). The average total yield for streamflow in the Powder River Subbasin is 180,230 acre-feet, but the average yield during the May-September period is 68,418 acre-feet (as measured at the Powder River near Richland) (OWRD 2000). For the Burnt River Subbasin, the average total yield for streamflow is 61,416 acre-feet, but the May- September average yield is only 32,574 acre-feet (as measured at the Burnt River, near Hereford) (NRCS 2007).

Table 1. Hydrologic Unit Names and Codes of the Powder Basin (Middle Snake – Powder Basin Subregion; HUC 170502)

Burnt River Subbasin (4th level HUC 170502 02)	
Watershed Name	*HUC (5th level)*
North Fork Burnt River	170502 **0201**
South Fork Burnt River	170502 **0202**
Camp Creek	170502 **0203**
Burnt River–Big Creek	170502 **0204**
Burnt River–Auburn Creek	170502 **0205**
Burnt River–Burnt River Canyon	170502 **0206**
Pritchard Creek	170502 **0207**
Lower Burnt River	170502 **0208**
Powder River Subbasin (4th level HUC 170502 03)	
Watershed Name	*HUC (5th level)*
Upper Powder River	170502 **0301**
Powder River–Sutton Creek	170502 **0302**
Powder River–Baldock Slough	170502 **0303**
Powder River–Rock Creek	170502 **0304**
North Powder River	170502 **0305**
Powder River–Wolf Creek	170502 **0306**
Big Creek	170502 **0307**
Powder River–Ruckles Creek	170502 **0308**
Powder River–Love Creek	170502 **0309**
Eagle Creek	170502 **0310**
Lower Powder River	170502 **0311**
Brownlee Reservoir Subbasin (4th level HUC 170502 01)	
Watershed Name	*HUC (5th level)*
Snake River–Hog Creek	170502 **0101**
Snake River–Birch Creek	170502 **0102**
Snake River–Rock Creek	170502 **0103**
Snake River–Brownlee Creek	170502 **0104**
Wildhorse River	170502 **0105**
Pine Creek	170502 **0106**
Snake River–Indian Creek	170502 **0107**

3. ANALYTIC PROCESS AND DATA GAPS

3.1 OVERVIEW

The Powder Basin [subregion] encompasses 1,096,900 acres, and 78 documents regarding the stream systems in this basin were reviewed. The Powder Basin was separated into five large geographic drainage areas in which most of the studies were conducted: the Burnt River drainage area (the entire subbasin); Upper Powder, North Powder, and Lower Powder drainage areas, each containing several named watersheds; and the Pine Creek drainage area (the entire watershed).

Table 2 lists the topics addressed in the documents reviewed and their definitions. "Water Issues" are group together.

Topics that were not addressed in this statistical analysis are: Land Use/Ownership, Peer Reviewed, and the "author" (Agency/Organization) that wrote the document. Chapter 11 is a table of the references for all documents and all relevant topics identified in each document.

Table 2. Definitions of Topics.

Topic	Subject Area
geology	soils, land formations, subsurface strata
hydrology	general water movement and amount in drainage basin
streamflow	cubic feet per second within channel
topography	land surface features
biology	all living plants and animals
climatological data	information relating to weather patterns including precipitation and temperature fluctuations
Water issues	
stream temperature	relating to the average daily temperature of water in a stream
water use	anything that surface water can be utilized for
water usage projections	future water needs
irrigation	water specifically used for agriculture purposes
water rights	certified or permitted rights to water pertaining to Western Water Law
recreation	enjoyable pastimes and activities
economy	all financial aspects of the area
Not addressed	
industry/commerce	specific commercial enterprise
estimated cost	predicted cost of a project
land use/ownership	management and owner of a property
peer reviewed	a document reviewed by subject experts

The timeframe of the documents reviewed ranged from the 1930s to 2007, with practically no documents available for review during the 1980s. No documents were reviewed that contained information on endangered species within the relevant subbasins. There is information available on known presence or absence of endangered species only in areas that have had projects on them which had a federal nexus. For example, a new diversion that had federal funding would have had to address endangered species and there should be information available, but only for a very limited area. Also, very few documents were peer reviewed.

It is believed that there are documents created by NRCS that should be included within this report, but were not available to the reviewers at the time it was written. The NRCS had been contacted numerous times to request applicable documents; however, apparently the documents are in storage on the west side of the State and difficult to access.

3.2 POWDER BASIN [SUBREGION]

For ease of categorization, this section refers to documents that pertain to more than one subbasin within the Powder Basin. The majority of the documents contained information on geology, water use, hydrology and topography. Information ranged in date from 1965 through 2007, with no information available during the 1980s. Topics greatly lacking information are: water issues, biology, climatological data, and economy/industry. The information reviewed was typically general, not addressing a specific project or area.

3.3 BURNT RIVER SUBBASIN

The Burnt River Subbasin encompasses 705,600 acres and 31 documents were reviewed. The majority of the articles contained information on the subbasin's geology and hydrology with little emphasis on climatological data, water use, and economics. The earliest documents addressed the need for irrigation and flood control with the establishment of the Ricco Dam. Most recent (2000-2007) information very generally addressed hydrology, water use, and land use issues. Excellent comprehensive information is available on the subbasin water temperatures. No documents contained information on current water need and water usage projections. Main categories that are lacking necessary information pertaining to long-term water management and water storage include: water issues/needs, biological data (endangered species), climatological data, hydrologic data, and economic data.

Documents that will be valuable for reference in the future development of long-term water management are *Burnt River Basin Water Temperature Modeling Study* (Reclamation 2001a); *Use Attainability Assessment (Temperature Standard)* (Larson and Borman 2000); *Appendix B – Elevation, Thermal Environment etc.*" (Meays

2000); *Burnt River – Shade, Soil Temperature* etc. (Larson and Borman 1999); and *ENG – Ricco Dam, Preliminary Cost Estimate* (NRCS 1994).

3.4 UPPER POWDER RIVER DRAINAGE AREA

The Upper Powder River Drainage Area is two watersheds in the upper reaches of the Powder River and its tributaries upstream from Mason Dam; these are "Upper Powder River Watershed" and "Powder River–Sutton Creek Watershed." This drainage area contains 105,345 acres and drains the southwest slopes of the Elkhorn Mountains.

Eight documents were reviewed that pertained specifically to this area. They ranged in date from 1934 to 2001. There were three decades from which no documents were written: the 1940s, 1980s, and the 1990s. Many of the older documents reviewed pertain specifically to what Reclamation refers to as the Baker Project, now known as Mason Dam or Phillips Lake. There are no other specific multiple-use water storage sites referenced for this subbasin.

3.5 NORTH POWDER RIVER DRAINAGE AREA

The North Powder Drainage Area includes four watersheds and contains 292,084 acres drained by a 30-mile reach of the Powder River. It begins at the mouth of Salmon Creek and ends just below the Thief Valley Dam. The watersheds are "Powder River–Baldock Slough," "Powder River–Rock Creek," "North Powder River," and "Powder River–Wolf Creek." This area includes Salmon Creek, Pine Creek (at the base of the Elkhorns), Rock Creek, Big Muddy Creek, Little Muddy Creek, the North Powder River, Wolf Creek, and all other systems that are tributaries to the Powder River along the base of the Elkhorn Mountains.

Twelve documents were reviewed pertaining to the above-described area. There is also a substantial amount of information available on Wolf Creek Reservoir and surrounding area as well as Pilcher Creek Reservoir. Both of those projects have been constructed and are operating efficiently. Additionally, there are several documents which pertain to a potential water storage site on the North Powder River; most of the research done in this area was conducted in the late 1970s. Documents pertaining to this area covered all topics; however, most of them are outdated and often only generally addressed a topic. Much of this information lacks specificity and will not be of much use for long-term water management and storage. The few topics that were addressed adequately for each specific area are geology and topography; the other topics that must be addressed in future studies include: hydrology and streamflow, water issues, climatological data, economics/industry, and estimated costs of projects.

Water users in Thief Valley Reservoir area have expressed interest in increasing the capacity of the dam. Reclamation did an appraisal-level study for reservoir volume increase at the dam (Reclamation 2001b) and an unfinished watershed assessment (Reclamation 2004c). These are recent studies, so only the cost would likely have to be updated. The question remains to what degree endangered species would have to be addressed, whereas there is an existing project and very little impact to plants, animals, and fish with the proposed project.

3.6 LOWER POWDER RIVER DRAINAGE AREA

The Lower Powder River Drainage Area includes five watersheds. This area stretches from just below Thief Valley Dam to the confluence of the Powder River and Brownlee Reservoir. The watersheds are Big Creek, Eagle Creek, Powder River–Ruckles Creek, Powder River–Love Creek, and Lower Powder River. There were no documents available for review regarding this drainage area. Consequently, there is very little record about the drainage area its potential water storage sites, if any. It should be noted that locals have discussed one near the landslide on Highway 86.

3.7 PINE CREEK WATERSHED

The Pine Creek Watershed is located in the northeast corner of Baker County; it is part of the Brownlee Reservoir Subbasin. It is bordered by the Eagle Cap Wilderness and the Snake River, and encompasses approximately 195,800 acres.

Only two documents were reviewed for this watershed; one published in 1968, the other in 1972. If any new data or information were produced in the last 35 years, none were able to be found.

These two documents reviewed specifically addressed a potential water storage site located on East Pine Creek and how the water would be distributed for safe release during the summer months and the impact of the potential project. This project was originally under the purview of NRCS. As a result of very few NRCS documents not being available at the time of writing, there may be additional documents pertinent to the area that are not included in this review.

The above mentioned reviews contained information on biology, water rights, and hydrology. No climatological data, stream temperature, and water usage projections were addressed.

3.8 RELATED REGIONAL DOCUMENTS

Documents in this section included study areas that pertain to the Powder Basin subregion and beyond, or documents that contained excellent information pertaining to a specific topic. For example, the *National Recreation Lakes of Study Commission*

Final Report [Armstrong 1999] contains recreational information that is relevant to the Powder Basin.

In this category, topics that were not addressed include: water issues including water rights and water usage projections. There is excellent information pertaining to bull trout and recreation specific to water use. These documents are relatively newer ranging from 1979 through 2003 with no information available in the 1980s.

3.9 MISSING DOCUMENTS

There are relevant documents that were not available at the time of writing. In the Pine Valley area, it is evident that there are documents that exist that were not able to be located that would have precipitated the writing of the documents that are included. Additionally, it is believed that there are documents written by the NRCS that that pertain to the North Powder area and also possibly a potential water storage site on Highway 86. It was also noted that there should be some documentation for a potential dam at Elertsons Meadow as well as documents produced by CH2M Hill for Pacific Power that were apparently destroyed in a fire.

If and when these missing documents are located, Reclamation and the WASH Committee have agreed to add an addendum to this literature review.

4. POWDER BASIN [SUBREGION] ABSTRACTS

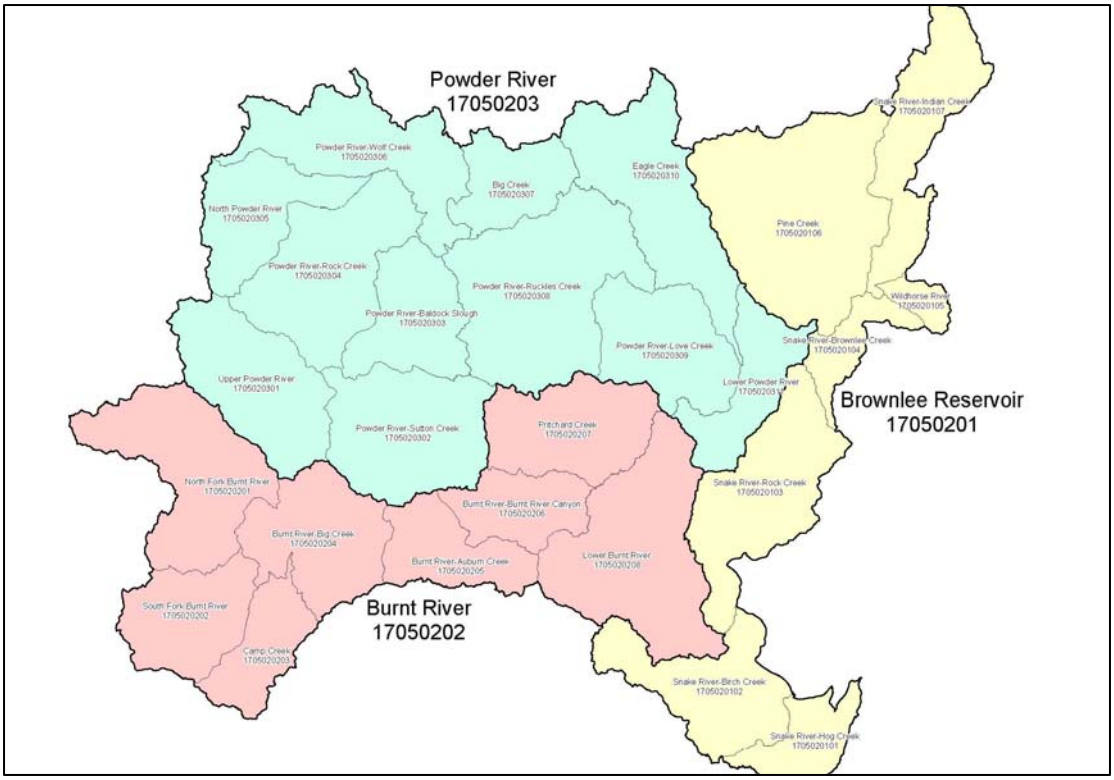


Figure 2. (Map) Powder Basin with 4th level subbasins and 5th level watersheds.

***Oregon Administrative Rules, Chapter 690, Division 509 Powder Basin Program*.** 2007. Oregon Water Resources Department. [OWRD 2007]

This document provides the OARs for Division 509, the Powder Basin Program. The Powder Basin can be found on the State Water Resources Board Map 9.6. This document discusses classifications, out-of-basin appropriations, water quality, reservation applications and process. Also addressed in this document are the South and North Fork Burnt River Reservations, Burnt River, Pine Creek, Eagle Creek and Powder River Subbasin Reservation of water. Can be found on-line at http://arcweb.sos.state.or.us/rules/OARS_600/OAR_690/690_509.html .

***Elkhorn Wildlife Area Long Range Management Plan (Draft)*.** 2006. Oregon Department of Fish and Wildlife. [ODFW 2006].

This document is a long-range plan for the Elkhorn Wildlife Area (EWA) for approximately ten years. This process involves the development of goals, specific objectives, and management strategies to achieve those goals. This plan describes issues and provides actions to address them. The management plan will be reviewed in 2011 in order to make any revisions and will be revised in its entirety in 2016.

The EWA consists of eight tracts: Shaw Mountain, North Powder, Antelope Peak, Muddy Creek, Roth, Salmon, Elk Creek, and Auburn. A brief description of each tract can be found on pages 9-12 of this draft plan. It also addresses the area's biological resources, cultural resources, and the social environment.

Three goals are recognized for the EWA upon which objectives were made.

Goal 1: To minimize or alleviate conflicts caused by deer and elk to privately owned land and agricultural crops.

- Objective 1.1: To provide supplemental feed for up to 1,400 wintering elk and up to 800 deer.
- Objective 1.2: To develop and maintain habitats to attract and hold wintering deer and elk.

Goal 2: To protect, enhance, and restore habitat diversity for all other beneficial wildlife on the area, compatible with Goal 1.

- Objective 2.1: To protect, enhance, and restore habitats for other wildlife consistent with Goal 1.
- Objective 2.2: To maintain and enhance wildlife area facilities, structures, and equipment to conduct habitat management and public use project on the wildlife area.

Goal 3: To provide a variety of quality recreational and educational opportunities to the public which are compatible with Goals 1 and 2.

- Objective 3.1: To provide approximately 4,000 hunting, trapping, and angling use days annually.
- Objective 3.2: To provide approximately 30,000 wildlife viewing and education/interpretation use day annually.

This document provides strategies for addressing the above-mentioned goals and objective.

This draft provides background information as well as a description of the environment, climate, topography, and habitat types. Included are various figures, tables, and appendices.

Powder River Subbasin Plan. 2004. M. Cathy Nowak, Cat Tracks Wildlife Consulting. Prepared for Northwest Power and Conservation Council; see at http://www.nwcouncil.org/fw/subbasinplanning [Nowak 2004]

This document is a subbasin overview, species characterization and status, effects, limiting factors/conditions, and a management plan. Included are various tables, figures, appendices, and appendix.

The purpose of the plan is to achieve a healthy ecosystem for aquatic and terrestrial species supporting sustainable resource-based activities.

Beliefs of the planning team include:

- Natural resource-based economies coexisting and aiding in the recovery of the ecosystem.
- The need for a scientific foundation in order to diagnose the ecosystem's problems, design, prioritize, monitor, and evaluate management to achieve plan objectives.
- The understanding of the plan in context of existing natural resource plans (i.e., fish and wildlife, Agricultural Water Quality Plans, etc.)

This document addresses social impacts such as livestock, farming, recreation, and development (urban growth). The overall intent is to provide a structure for implementation, research, and planning in the subbasin. Several entities were instrumental in the development of this subbasin plan.

Potential Impacts of the Proposed Designation of Bull Trout Critical Habitat in the Hells Canyon Complex/Baker County: A Regional Economic Analysis. 2004. Sorte, B.; Carr, J.; and Tanaka, J. Oregon State University, Corvallis, OR. [Sorte et al. 2004]

This document focused on the economic impact to Baker County due to the proposed designation of the Bull Trout Critical Habitat. The area of focus was on the economy of agriculture and mining, both highly dependent on water use. The economy of Baker County and the Hells Canyon Complex was very different from other regions, therefore, it was analyzed separately to explain the impact of this new designation. The cost of water due to the critical habitat designation will increase. Facts and figures of Baker County average earnings as compared to Oregon and the Nation concludes that Baker County is economically distressed. There are few, if any, alternatives to replace the losses in agriculture and mining. Tables explain the increase and reduction of agriculture and mining in average and dry years. The loss of water use would result in economic losses to the county economy at about $25 million and 808 jobs in an average year; $28 million and 1,284 jobs in a dry year.

Reclamation, Partners Reach Minimum Streamflow Agreement for Powder River. October 2004. Bureau of Reclamation, Pacific Northwest Region, Boise, ID. News released dated October 26, 2004. [Reclamation 2004b]

This article addresses the agreement between Bureau of Reclamation and several other public sector agencies in Eastern Oregon. It was agreed upon that starting in November the Powder River will have minimum flows of 6.0 to 6.5 cfs. This agreement works in conjunction with the Baker Valley Warren Act, which provides for the release of 10 cfs for minimum streamflow excluding periods of irrigation shortages. Minimum flow requirements will help Powder River maintain water quality and a healthy habitat for fisheries.

Baker County Water Resources (Draft). 1995. Baker County Planning Department, Baker City, OR. [Baker County 1995]

This document is a draft discussing Baker County's water resources. Water resources are identified by basin and then broken down by subbasin. Data is gathered and an analysis is performed for each location.

Three "subbasins" are defined within the Powder Basin — Burnt River, Powder River, and Pine Creek — and each drains into the Snake River.

This report addresses the area's geology, water flows, water rights, water quality, water use, water issues, storage, water systems, and rural development. Due to the area's growth, lifestyle changes, and economic development, there is a need for more water. Unless the area's need for more water is addressed, the county's development is restrained, thus limiting potential opportunities (that is, recreational, increase cropland, fish habitat, and industrial). This draft contains figures, tables, and maps representative to each site.

An Economic Study of Three Small Watershed Projects in Midlife. 1981. R.G. Kraynick and H.H. Shevener, Department of Agriculture, Oregon State University, Corvallis, OR. [Kraynick and Shevener 1981]

Relevant portions of this document focus on Wolf Creek and analysis economic costs and benefits associated with the construction of the dam. The entire entity of the document evaluates three small watershed projects from a "total performance" standpoint. Projects reviewed are Skipanon, Sutherlin, and Wolf Creek. Benefits and costs were shown both mathematically and graphically. Included in this report are figures and tables representative of each site.

The objective of this evaluation was to determine if the total economic benefits from a project exceed associated costs. This document provides background on each watershed as well as benefits and costs analysis.

The Wolf Creek project was designed to help alleviate late season water deficiencies provide a new waterway system, and possible recreation. The project began in 1972 and became fully operational in 1977, serving approximately thirty farmers in the district. With the construction of the dam, farmers were required to update their irrigation systems and rotate crops more frequently. Farm costs increased 35%, with total farm receipts increasing 66%.

Primary benefits for irrigation and recreation were 663,000 per year in 1979, thus indicating secondary benefits.

A resource survey of river energy and low-head hydrologic power potential in Oregon. Appendix 9; Powder Basin. 1979. Oregon State University, Corvallis, OR. [OSU 1979]

This document contains very little literature; however, it provides drainage basin maps, statistics for reaching hydroelectric potential, and a spreadsheet containing feasibility, transmission, and load restraint statistics.

Subjects addressed in Oregon include water power, stream measurements, and rivers. Various figures and maps are contained within this appendix.

Annual Report Fishery Division. 1967. Oregon Department of Fish and Wildlife (C.R. Sayer). [ODFW 1967]

Relevant portions of this report discuss chemical rehabilitation in the Powder River. Included in this report are various tables identifying and comparing species and populations during chemical rehabilitations. Attached is a progress report on the Powder River rehabilitation. Chemicals used include liquid rotenone and Fintrol-5. Areas of rehabilitation are Powder River from Mason Dam to Thief Valley Dam and Powder River through Sumpter Valley. A total of 134.4 miles of stream and 250 acres of surface were treated.

The Fish & Wildlife Resources of the Powder Basin and their Water Requirements. August 1967. Oregon State Game Commission (Hutchison, J.M. and Fortune, J.P. Jr.). A report with recommendations to the Oregon State Water Resources Board; "Federal Aid to Fish Project F-69-R-5." Portland, OR. [Hutchison and Fortune 1967].

This report contains a general description of fish and wildlife resources and their influencing factors and aspects of streamflow in the Powder Basin. Field studies were performed in 1965 and in 1966 upon which data was retrieved and evaluated.

Discussion is primarily given to the inventory and distribution of fish which is greatly determined by elevation and water temperature. Factors affecting fish resources are biological, spawning, rearing, passage, food, shelter, suitable medium (water quality), and temperature. This report also addresses the problems faced by fish resources, which include: low and warm flows, high turbidities, and extreme siltation. Most of these problems can be attributed to irrigation and can be remedied through suitable streamflows.

Fish Management activities include fish stocking, habitat improvement, habitat inventories, fish population status, and inventories of fish angler status. A streamflow study was conducted on eight streams for fish production and angling.

Discussion is also given to Wildlife Resources. Wildlife resources in the Powder Basin encompass 4% of deer hunting, 5% of elk hunting, and 1% of fur harvesting in Oregon. Game distribution is predominantly controlled by quality of water and the availability of cover. Included in this report are various maps, tables, and appendixes.

USDA Report on Water and Related Land Resources Powder Drainage Basin Oregon. 1966. State of Oregon Water Resources Board and US Department of Agriculture, Salem, OR. [OWRD and USDA 1966]

The purpose of this report is to provide past and present uses of water and related land resources, to supply production data from the uses of the resources, to assess the magnitude of water related problems (i.e., erosion, flooding, and drainage), indicate possible direction of future water use, and land for agriculture, forestry and other uses, and last to outline a program for water and land resource management.

A survey and investigation on the Powder Drainage Basin was conducted for planning the area's water resource development. Information needed for the study included:

- Kind and location of desirable developments
- Amounts of water required
- The physical opportunities for developments
- Economic aspects.

This document provides a general description of area, discusses the area's economic needs, and defines water-related problems, needs, and opportunities. Water influences all segments of the communities' economy and irrigation is the major consumption of water.

Opportunity exists to increase production acreage; however, these require more water. Approximately 2,350 acres flood every five years and 1,800 need drainage. Flooding from the annual spring snowmelt causes economic and land damage. The opportunity to capture water and provide flood protection, recreation, and land treatment exists. Sixteen watersheds were investigated for P.L. 566 action.

Included in the report are various tables, figures, and maps.

***Powder River Drainage Basin Survey of Literature*.** 1965. State of Oregon Water Resources Board. [OWRD 1965]

This document is a survey providing a brief summary of available literature and date of the Powder River Drainage Basin. Included in this survey are physical, climatic, hydrologic, cultural, and economic aspects. Resources can be found in various State and Federal agencies.

***Records of Wells, Water Levels and Chemical Quality of Water in Baker Valley, Baker County, Oregon*.** 1965. Ducret, G.L. Jr. and Anderson, D.B., US Geologic Survey, Salem, OR. [Ducret and Anderson 1965]

The purpose of this report is to update and provide current information on groundwater resources, in order to assist in the development of Baker Valley's water resources. Data provided include: a record of wells, drillers' logs, water level fluctuations, and groundwater analysis. This report also contains an explanation of how wells are designated through a numbering system.

5. BURNT RIVER SUBBASIN ABSTRACTS

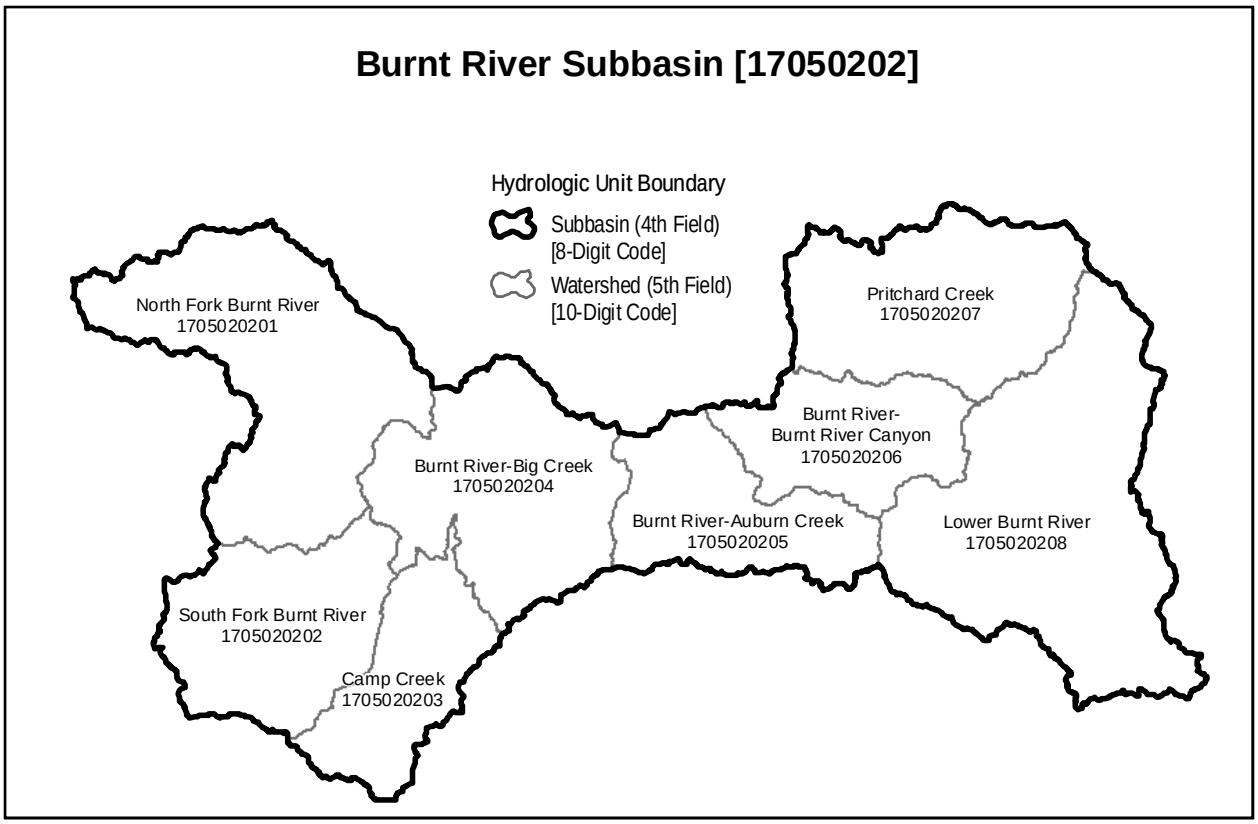


Figure 3. (Map) The Burnt River Subbasin has eight watersheds.

Lest We Forget – Remembrances of Upper Burnt River in Baker County, Oregon. 2007. Compiled and edited by members of the Burnt River History Group and published by the Burnt River Heritage Center. [Burnt River HC 2007]

There is a section in the publication entitled: "Water Development & Delivery." It noted that the Unity Dam was completed in 1938 and began to store water in 1939. The District covers approximately 20,000 acres and serves 75 members. Over time, there have been five other areas in the Burnt River subbasin that have been considered for storage: Petticoat, Antlers, Ricco, Dark Canyon, and Hardman on the South Fork.

Additionally, ditches and their construction, prioritization dates, and areas that they serve are discussed. Other private reservoirs include:

Whited Reservoir	512 acre-feet; in-channel	South Fork Burnt River
Beaverdam Reservoir	—	—
Elms Reservoir	300 acre-feet; off-channel	South Fork Burnt River
Higgins Reservoir	>1,700 acre-feet	Camp Creek & Bull Run Creek
Shaw Reservoir	—	—
Davidson reservoir	—	Burnt River (SW of Hereford)
Morfitt Reservoir	150 acre-feet; off-channel	South Fork Burnt River
Murray Reservoir	—	Camp Creek

Burnt River – 17050202 – 8-Digit Hydrologic Unit Profile. 2006. USDA Natural Resources Conservation Service, Water Resources Planning Team. [NRCS 2006]

This document includes many charts and figures that summarize the Burnt River Subbasin. The 705,600 acre subbasin is mostly rangeland (52%), forestland (33%), and pasture (14%). There is a map of the land use, precipitation, and CRA (common resource area). The total number of water rights is 48,765 acres. A chart of the subbasin includes summaries of the stream data, land use, and land capability class. The percent of listed stream miles that exceed state water quality standards is 97. A chart includes resource concerns such as soil erosion. This document ends with a summary about the conservation plans on private lands.

Burnt River Agriculture Water Quality Management Area Plan. 2003. Burnt River Local Advisory Committee in cooperation with Oregon Department of Agriculture and Burnt River Soil and Water Conservation District. [Burnt River LAC 2003]

This purpose of this plan is to provide guidance and identify strategies to reduce water pollution in the Burnt River Subbasin. A water quality issue on private agriculture land is addressed in this plan. See also the *Burnt River Water Temperature Study* (Duncan 2002). This plan will identify strategies to minimize the affects of agriculture activities on water temperature. Some water quality objectives include limiting streambank erosion, improve riparian vegetation, and expand the current monitoring program. ODA has some authority to regulate pollution control. The plan implementation strategy includes education, cooperation, monitoring, evaluation, and landowner involvement.

Request for Appraisal Study. 2002. Burnt River Irrigation District, Baker City, OR. Letter regarding Bureau of Reclamation to U.S. Representative Walden (February 20, 2002) from Burnt River I.D. Supported by letter to U.S. Representative Walden from Oregon Sen. Ted Ferrioli (February 28, 2002). [Burnt River I.D. 2002]

This letter is a request made by the Burnt River I.D. for an appraisal study for two multipurpose storage facilities. The two sites requested for study were the Hardman Site (on the South Fork Burnt River) and the Ricco Site (on the North Fork Burnt River). Beneficial uses include irrigation, streamflow enhancement, recreation, and economic development (i.e., water quality, increase wildlife habitat, and power generation). Included in this document are statistics on both proposed sites. Reclamation included funding in the FY 2005 budget to conduct an appraisal study for the two dam sites.

Burnt River Water Temperature Study Steering Committee Final Report. 2002. Produced for Burnt River Steering Committee by David Duncan & Associates, Boise, ID. [Duncan 2002]

This document is a final report for the Burnt River Water Temperature Committee. This report defines the work that was completed in order to address four objectives. These objectives include:

- Factors contributing to stream temperatures
- Temperature management alternatives
- Develop and test a surrogate
- 1010 Plan.

An area of study includes the Burnt River Subbasin in eastern Oregon. Field data were compiled and analyzed on water temperatures, streamflows, and other environmental factors in 1997 through 1999. Factors that were found to contribute to stream temperature include elevation, aspect, topographic features, flow, channel width and depth, vegetative shade, and reservoirs.

In order to evaluate the effects of management practices on the Burnt River, a stream temperature computer model was used. The effects of shade and irrigation efficiencies were modeled independently and in conjunction with each other.

Great discussion was given in the development of a surrogate which could aid landowners in identifying problems and solutions. Options for surrogates included temperature and healthy stream. No process was developed for a temperature surrogate, and the ability to define and measure that of a healthy stream was extremely difficult. A healthy stream needs to take into consideration the physical conditions of streams and riparian areas.

A "1010" plan was expected to be completed in 2002, which would identify factors associated with agricultural lands. This plan was developed by ODA, with the assistance of a local water committee, and defined the department's role in assisting and advising producers with watersheds.

Burnt River Basin Water Temperature Modeling, Final Report. 2001. Bureau of Reclamation Water Quality and Land Suitability Group (K.A. Mangelson), Denver, CO. [Reclamation 2001a]

This study focuses on instream water temperatures in the Burnt River Basin in eastern Oregon. Field monitoring was done in 1997-1999 for instream water temperatures, climatologic data, streamflows, and other environmental factors. Study goals were to "scientifically define the factors that contribute to instream water temperatures and develop and evaluate alternative approaches for dealing with water temperature concerns."

A computer model was developed for a selected section of the mainstem of Burnt River from Unity Dam to confluence with Clarks Creek. Significance of each factor affecting instream temperature was determined through regression analysis. Fish and Wildlife Services SNTEMP stream temperature model equations were used. This model was used to determine "the effects of management scenarios on instream temperatures," which are detailed within the report.

Findings showed that during the irrigation season, instream temperatures for the Burnt River and most tributaries regularly exceed the 64 degree criterion, not only for the 7-day-maximum daily instream temperatures, but for the 7-day-mean daily instream temperature as well. On the North Fork Burnt River, instream water temperatures exceed 80 degrees in mid-to-late summer, and very low streamflows contribute to this. During the study years, Oregon's 64 degree criterion was exceeded in both 7-day mean and 7-day maximum for most of the summer. The South Fork stream temperatures are generally cooler than the North Fork, and the streamflow is significantly higher during the summer. Even still, 7-day instream water temperatures exceeded 64 degrees for periods of time during the summers. Below Unity Reservoir, temperatures also exceeded 64 degrees, generally from early June to late September.

Factors contributing to instream temperatures are identified as:

1) Elevation – water temperatures in the Burnt River Subbasin naturally increase 2 degrees per 500 feet drop in elevation.
2) Aspect.
3) Natural Heat Sources and Conditions – Burnt River Canyon is relatively pristine, provides shade, no grazing, good riparian vegetation, and yet stream

temperatures rise due to heat radiating from canyon walls, high air temperatures, and perhaps absence of subsurface flows.

4) Air Temperature – there is a very high correlation between air temperatures and mean and maximum daily instream temperatures.
5) Shade.
6) Width-depth Ratios – as width relative to depth increases, so does surface area, increasing heat energy exchange between the environment and the stream.
7) Storage Dams and Reservoirs – "Higher flows slow the warming process. Larger streamflows take longer to increase in temperature than smaller flows. Without Unity Reservoir, the streamflows in the Burnt River during the summer and fall months would be much lower" (pg. *iv*). Before Unity Dam was constructed, flows during the hottest part of the summer were probably 10-15 cfs, and with the dam, they average 90-130 cfs (pg. 55). Reservoir outflow cools river water early in the irrigation season, but warms the river later in the year. For most of the irrigation season, inflow to Unity Reservoir, which is primarily irrigation return flows, are lower than temperatures of outflow from the reservoir. Both Whited and Unity Reservoirs are subject to stratified temperatures; warmer temperatures on top of the reservoir, lower below. The temperature difference is significant, and warmer water is released early in the season while cooler water is released later. The temperature effects of the reservoir are seen most strongly in the first five miles and largely disappear ten miles below. If water is released from the upper portion of the reservoir, the water will be warmer and warm the stream water in the near vicinity of the reservoir; however, the warming effects decrease with greater distance from the reservoir outlet.
8) Irrigation Diversion Dams – determined to be insignificant on the Burnt River, other than the effects of reducing instream flows.
9) Irrigation Return Flows – tend to be cooler than river temperatures, reducing instream temperatures.

Computer modeling predicted that increased water system efficiencies would result in increased instream water temperatures, due to decreased return subsurface flows.

When calculated using the model, increased riparian shade would only have a slight cooling effect and would not significantly improve instream temperatures.

Hardman and Ricco Reservoir Projects – Key Issues and Feasibility Evaluation Process. 2001. Produced for Burnt River Irrigation District by Newton Consultants, Inc. [Newton 2001]

This four-page document focused on the most critical issues that needed to be resolved prior to implementation of the Hardman and Ricco water storage projects. The feasibility of the proposed projects includes studying cost, affordability, and funding sources. There are some environmental issues and constraints that need to be identified among the many permit requirements. It appears some of these issues have already been addressed, but the steps outlined in this document will provide the Burn River I.D. board of directors a plan to implement the reservoir projects.

Middle Burnt River Coordinated Resource Management Plan. 2000. Burnt River Soil and Water Conservation District, Hereford, OR. [Burnt River SWCD 2000]

The goal of the many contributors to write this plan was to "bring the Burnt River Basin to its full potential through cooperative resource management." The mission of the plan was to manage the natural resources and community in a sustainable way with science and feasible economics. The list of objectives included education, wildlife, water conservation, and more. The list of problems included weed invasions, wildlife, wildfire, mining, and others. Maps included ownership, range sites, vegetation, and waterways. This document contains a "Resource Management System" (RMS) for pasture (irrigation and sub-irrigated), irrigated cropland, stream fisheries, livestock grazing, noxious weeds, wildlife, big game wildlife, watershed, forestry, and recreation. Each RMS has very detailed lists of the actions, needs, and recommendations for each topic. A summary of the proposed action for each RMS is included and will be reviewed annually.

Use Attainability Assessment (Temperature Standard) – Burnt River Watershed. 2000. Larson, L. and Borman, M., Rangeland Resources Department, Oregon State University, Corvallis, OR. [Larson and Borman 2000]

This report was conducted as a result of the Water Quality section — 303(d) — of the US Clean Water Act, and requirements of OAR 340-41-[basin](3) and Senate Bill 1010. Natural conditions of a water body became the water quality standard within each basin; therefore, certain water bodies were added to the 303(d) list. The 303(d) list triggers regulatory actions for agriculture lands (SB 1010). The studies conducted within this report focused on the influence of the thermal environment and land use on water temperature with the Burnt River watershed.

A literature review was included in this report. The documents summarized included earth radiation, water temperature, thermal environment, groundwater, and other topics relating to the report studies.

A two-year study along four streams on the headwaters of the north and south forks of the Burnt River was included in this report. The air temperature, water

temperature, and soil temperature was studied at all four streams. The result is atmospheric conditions influence stream temperature over all other factors.

The mainstem of the Burnt River was also studied. First, the amount of shade was correlated with the amount of gravel within the soil profile: the greater the amount of gravel, the greater amount of shade. Next, the subsurface return flow was studied with no conclusion due to not adequate date. The soil temperature was concluded to be 2 ºF to 3 ºF above the mean air temperature. The final study compared different land use types as different segments of the Burnt River. The air, water, and soil temperature was taken at the each segment. The segments were grouped into two general land use types. The conclusion of this study stated that the land uses of hay meadow and grazing were found to be temperature neutral in their impact upon river temperature.

Appendix B Elevation, Thermal Environment, and Stream Temperature on Headwater Streams in Northeastern Oregon (Thesis). 2000. C.L. Meays, Oregon State University, Corvallis, OR. [Meays 2000]

This document is a thesis examining the association of stream temperatures with an area's thermal environment. Areas of concentration were Barney, Elk, Greenhorn, and Stevens Creeks on the Burnt River. Streamflows were conducted July thru August in both 1998 and 1999. During this time period, data was collected including stream discharge, air, soil, and water temperature at 150-meter increments. Elevation ranged from 1370 m to 1830 m for each stream. An analysis was performed daily for each site.

It was determined that elevation was significantly associated with air, soil, and water temperatures. Similar findings were found on each creek after analyzing the thermal environments and stream temperatures. Barney Creek had the highest mean daily air, water, and soil temperatures, with Elk Creek having the lowest.

The thermal environment and its respective elevation appeared to have the greatest impact on stream temperature. Included in this document are various figures, tables, and an appendix with concepts and definitions.

Burnt River – Shade, Soil Temperature, and Groundwater Recharge Estimates, A First Approximation. 1999. Larson, L. and Borman, M., Rangeland Resources Department, Oregon State University, Corvallis, OR. [Larson and Borman 1999]

The mainstem Burnt River was researched to gather data about the shade, soil temperature, and groundwater recharge. This data was compiled to establish a starting point and provide guidance regarding site potential. The shade estimates

were grouped by the type of substrate: wet meadow/meadow, sodic meadow and loamy bottom, river wash, and channelized. Soil temperature was estimated for the area using many sources. Groundwater recharge study concludes that the irrigation creates a longer time period saturation zone, which will extend the time period of groundwater discharge. One conclusion made is that shade does not cool warm water.

Request for Department Stand on Water Storage Reservoirs, North and South Forks of the Burnt River. 1998. Oregon Department of Fish and Wildlife (J.E. Zarnowitz). [ODFW 1998]

This letter was addressed to the Burnt River Irrigation District from ODFW, specifically addressing the proposed reservoirs on the north and south forks of the Burnt River. ODFW will require fish passage for on-stream dams where fish populations exist; redband trout were identified within these two forks of the Burnt River. Some concerns that the letter addressed are increased big game damage, wetlands, and introduction of exotic species. ODFW has requested surveys of the fish and wildlife population that may be impacted, feasibility study for fish passage, and others. Two alternatives are also suggested.

Fatal Flaw Analysis – Meeting material. 1997. J. Van Staveren, Pacific Habitat Services, Inc. [Van Staveren 1997].

This document is a list of areas of concern for a Fatal Flaw Analysis meeting. The list includes most environmental concerns that would need to be addressed prior to the implementation of the proposed reservoirs on the North and South Fork Burnt River (Ricco and Hardman reservoirs). Wetlands will likely be the most complicated issue due to mitigation requirements by Oregon Department of State Lands and ACOE. There are some wildlife and plant species of concern that may be affected. Redband trout area is on the sensitive species list and is resident in the North Fork and South Fork of the Burnt River. There do not appear to be any cultural resource issues.

Highly Erodible Land and Wetland Conservation Determination for Tract 4407. 1997a. A.J. Geriz, USDA Natural Resources Conservation Service. [Geriz 1997a].

This document is a standard form used to record the highly erodible land and wetland determination of a tract of farm land. This tract of land includes T-4407, owned by Russel Ricco in Section 25 along the North Fork Burnt River. No HEL determination

was made. Twelve acres of wetland was determined. Maps indicating the wetland areas were included.

Highly Erodible Land and Wetland Conservation Determination for Tract 4408. 1997b. A.J. Geriz, USDA Natural Resources Conservation Service. [Geriz 1997b].

This document is a standard form used to record the highly erodible land and wetland determination of a tract of farm land. This tract of land includes T-4408, owned by Russel Ricco along the North Fork Burnt River. No HEL determination was made. 10.8 acres of wetland was determined. A map indicating the wetland areas was included.

Highly Erodible Land and Wetland Conservation Determination for Tract 4409. 1997c. A.J. Geriz, USDA Natural Resources Conservation Service. [Geriz 1997c].

This document is a standard form used to record the highly erodible land and wetland determination of a tract of farm land. This tract of land includes T-4409, the proposed Ricco Reservoir in Section 28 along the North Fork Burnt River. No HEL determination was made. Twenty-two acres of wetland were determined. Maps indicating the wetland areas were included.

Ricco Proposed Reservation – Wetland Conservation Determination for Forest Service. 1997b. USDA Natural Resources Conservation Service (C.A. Bradford). [NRCS 1997b]

This document is a standard form used to record the highly erodible land and wetland determination of a tract of land. This determination is for the proposed Ricco Reservoir lands within the USFS properties only. No HEL determination was made. 10.8 acres of wetlands were identified. A map was included showing the wetland areas.

Highly Erodible Land and Wetland Conservation Determination for Tract 4410. 1997d. A.J. Geriz, USDA Natural Resources Conservation Service. [Geriz 1997d]

This document is a standard form used to record the highly erodible land and wetland determination of a tract of farm land. This tract of land includes T-4410, owned by John Hays along the North Fork Burnt River. No HEL determination was made. 8.4 acres of wetland were determined. Maps indicating the wetland areas were included.

Hardman Proposed Reservation – Wetland Conservation Determination for Forest Service. 1997a. USDA Natural Resources Conservation Service (C.A. Bradford). [NRCS 1997a].

This document is a standard form used to record the highly erodible land and wetland determination of a tract of land. This determination is for the proposed Hardman Reservoir lands within the UWFS properties only. No HEL determination was made. 18.2 acres of wetlands were identified. A map was included showing the wetland area.

Proposed Amendments to the Powder River Basin. 1996. Letter from J. Zarnowitz, Oregon Department of Fish and Wildlife. [ODFW 1996]

This letter was addressed to the ODFW during a public review comment period regarding amendments to the Power River Basin rule. ODFW was concerned about the fish and wildlife in the south and north forks of the Burnt River. The agency recommended studies that should be performed prior to receiving storage water permits. Other comments were made for municipal corporation, species, and state agency roles. The resident trout in the South Fork Burnt River ecosystem was discussed.

Investigation Report on a Refraction Seismograph Survey of Ricco Damsite, North Fork Burnt River. 1994. USDA Soil Conservation Service (P.F. Pedone). [NRCS 1994a]

A preliminary geologic survey was conducted of the Ricco Dam site on the North Fork Burnt River in August 1994 by the Soil Conservation Service using a refraction seismograph. The seismograph can interpret energy waves to determine the probable types of materials and depths to the different materials. The site of this dam is about three miles west of Whitney. The valley bottom consists mostly of dredge tailings and a group of riparian shrubs. This document consisted of a lengthy description of each "line" that was produced by the seismograph. This document concludes with recommendations to use a rotary drilling rig for a detailed geologic investigation. There is a map of the plan and cross section of the dam, and the lines produced by the seismograph.

ENG – Ricco Dam, Preliminary Cost Estimate. 1994. Bright, R.E., USDA Soil Conservation Service. [NRCS 1994]

This letter is addressed to Robert Sampson, Area Engineer of SCS in Baker City. The State Conservation Engineer of SCS has recalculated the estimated cost of the Ricco

Dam using the same design and quantities as shown in the 1970 preliminary cost estimate [Burnt River SWCD 1970]. The estimated cost for an earth fill dam is $2 million. The estimated cost for a concrete dam is $3.75 million. Attachments include the list of quantities, cost, and volumes.

South Fork Burnt River Coordinated Resource Management Plan. 1992. Burnt River Soil and Water Conservation District. [Burnt River SWCD 1992]

The resource management emphasis in this plan is watershed function. The participants involved produced this document with a list of objectives (including multi-purpose reservoir, improve grazing management, control weeds) and a list of problems (not enough water storage, impaired watershed function). A RMS was created for specific items such as the watershed, wildlife, grazing, forestry, stream fisheries, reservoir fisheries, and others. The decisions and needs listed for each RMS discussed irrigation, vegetation, recreation, and other specific items relating to each RMS.

Unity Reservoir 1991 Sedimentation Survey. September 1992. Bureau of Reclamation, Technical Service Center, Sedimentation Section (R.L. Ferrari), Denver, CO. [Reclamation 1992]

This report discusses the results of the 1991 first extensive sedimentation survey of the Unity Reservoir after the construction of the dam (in 1938). There is a description of the Unity Dam height, width, elevation, and other measurements. The data gathered from this study will be able to develop the new reservoir topography, compute area-capacity relationships, and estimate storage depletion caused by sediment deposition since the dam was built. A total of 1,565 acre-feet of sediment has accumulated since the dam was built. The original total capacity of the reservoir was 25,800 acre-feet; this number has changed to 25,502 acre-feet, due to new bottom elevation. A new contour map was completed as a result of this survey.

North Fork Burnt River Coordinated Resource Plan. 1990. Burnt River Soil and Water Conservation District. [Burnt River SWCD 1990]

The resource management emphasis in this plan is to “maintain and improve watershed health while considering all resource uses.” The participants involved produced this document with a list of objectives (including restore riparian areas, decrease soil erosion) and a list of problems (improper forest harvest, lack of long-term grazing management plans). A RMS was created for specific items such as the watershed, wildlife, grazing, forestry, stream fisheries, reservoir fisheries, and others.

The decisions and needs listed for each RMS discussed irrigation, vegetation, recreation, and other specific items relating to each RMS. The project action items for each RMS item were given a responsible party and completion date.

Burnt River Project, Oregon, Dark Canyon Division, Wrap-up Report. July 1971. Bureau of Reclamation, Region 1, Boise, ID.

Relevant portions of this report focus on the effects of the Burnt River Project. Development of the Dark Canyon Division would have beneficial effects on fishery, water quality, recreation, and flood control, and would allow for either supplemental or full irrigation water supply. Included in this report are various tables and graphics.

Sites to be developed in the Dark Canyon Division include:

- Hardman dam and reservoir
- Dark Canyon dam and reservoir
- Chambeam Diversion dam and reservoir.

These structures will serve a multitude of functions (i.e., recreation, flood control irrigation).

Reservoir access and public use facilities are addressed in the plan by Fish and Wildlife. Public facilities include; vehicle parking, restrooms, and launching ramps. These services would be used by recreationalists, hunters, and fishermen.

The development of Dark Canyon Division would provide either full or supplemental irrigation water to 10,515 acres. Annual fishery benefits will amount to $64,100.

Due to dam and reservoir developments some big-game habitat will be inundated. Therefore, areas of new land have been designated for big game.

The Dark Canyon Division can be economically justified by benefits exceeding costs by a ratio of 1.21 to 1. Direct benefits have a ratio of 1.03 to 1. Water users and the Federal Columbia River Power system would repay 32% of all reimbursable costs.

Ricco Irrigation & Flood Control Dam. 1970. Burnt River Soil and Water Conservation District in cooperation with USDA Soil Conservation Service. [Burnt River SWCD 1970]

This report is a reconnaissance survey for the proposed dam and reservoir on the North Fork Burnt River prepared by the Soil Conservation Service for the Ricco group who own land along the river. The project area is about 22,000 acre watershed. The reservoir would store about 6,600 acre-feet. The multi-purpose dam would include flood control, irrigation, recreation, and fish. This report only researched

surface features, and a final site feasibility study is needed. A map of the location, dam, and profile of the dam is included.

***Memorandum, Burnt River Project, Dark Canyon Division, Oregon*.** 1967. Memorandum dated June 13, 1967 from US Fish and Wildlife Service (Portland, OR) to Bureau of Reclamation Regional Director, Boise, ID. [FWS 1967]

This memorandum is a detailed report on the effects of the Burnt River project upon fish and wildlife. The purpose of this project is to increase irrigation, water quality, flood control, fish and wildlife enhancement, and recreation. This would provide irrigation to 10,515 acres in the basin. The project would allow a more favorable habitat for the growth and survival of trout populations. Development of these areas would have no significant effect upon the wildlife populations. Discussion was given to a variety of enhancement features and their effects if included in the project. Enhancements include development of improved fisheries, eradication of non-game fish, public access to waters, sustained streamflows from the dam, and supplemental stocking of trout on an annual basis. Included in this document are tables of estimated angler use days and a summary of the project's costs associated with the fishery enhancements. Management plans and compensation for wildlife acres were also addressed in this document.

Thirteen recommendations were made by FWS addressing enhancement features, funding, language, recreation, compensation of wildlife area, minimum flows, and land management. Information in this report was supplied by the Fish Commission of Oregon, the Oregon State Game Commission, and the Snake River Development Office. Attached are letters from the Fish and Game Commissions of Oregon.

Ground-Water Reconnaissance in the Burnt River Valley, Baker County, Oregon (Open–file report). September 1964. US Geologic Survey (Don Price), Portland, OR; prepared in cooperation with Bureau of Reclamation. [USGS 1964]

Relevant portions of this report focus on the availability of water for irrigation in the Burnt River Valley. In review of geological data, it is concluded that most of the rocks in the Burnt River Valley are of such low permeability that most aquifers in the Valley are inadequate for irrigation purposes. There is indication that water is not suitable for irrigation due to high levels of boron, salinity, and sodium.

The most potential aquifer is that of the Columbia River Basalt. This aquifer runs beneath the valley floor and is roughly 10 miles east of Herford.

6. UPPER POWDER DRAINAGE AREA ABSTRACTS

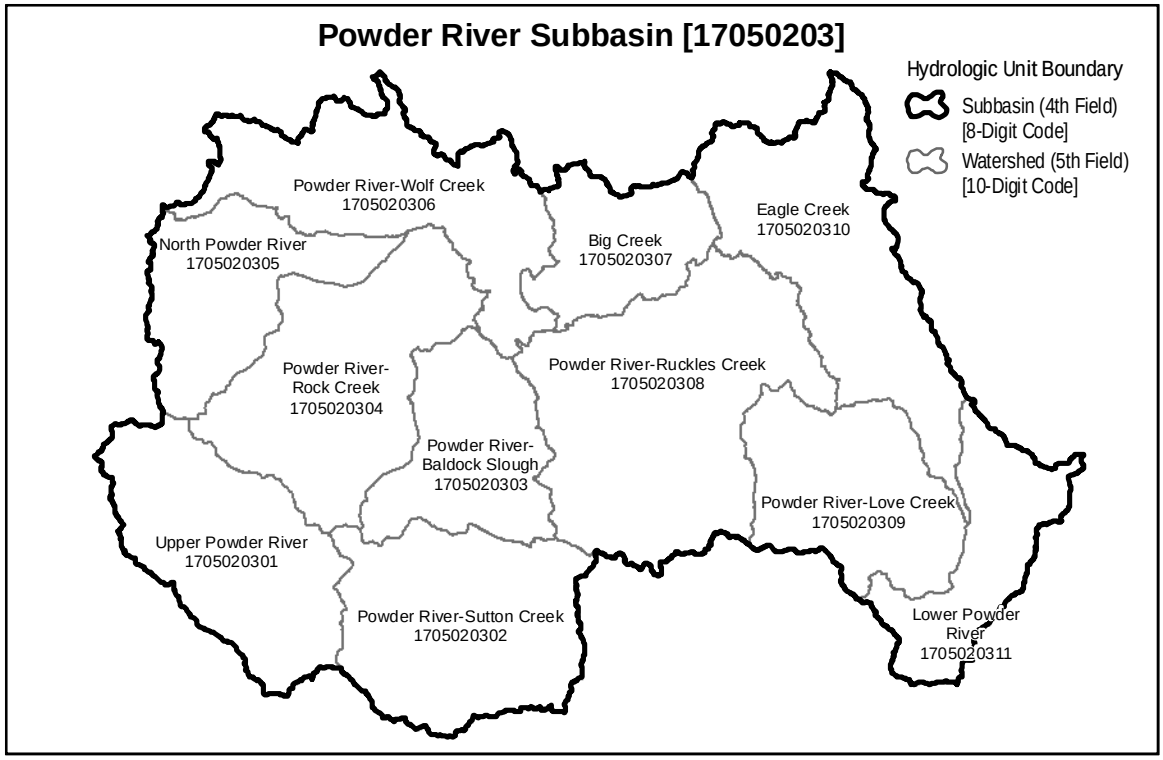


Figure 4. (Map) The Upper Powder River Drainage Area includes two watersheds: Upper Powder River and Powder River–Sutton Creek.

Upper Powder River Watershed Assessment. 2001. Powder Basin Watershed Council and Oregon Department of Fish and Wildlife, Baker City, OR. [Powder Basin WC and ODFW 2001]

This document provides an assessment of the Upper Powder River Watershed. The purpose of this assessment is to assist individual(s) who have a stake in the watershed(s) to develop a watershed action plan. This document addresses watershed health issues (i.e., water systems, recreational site developments, grazing, and water quality and rights) and their key findings. An overview of the Upper Powder River watershed is also provided addressing climate, geology, soils, water resources and quality, recreation, and water rights as well as social/cultural aspects of the community. The area's past and present economic aspects are also addressed. Included are various maps, tables, figures, and appendixes.

Initial Followup Report on the Fish and Wildlife Resources [of the Baker Project Upper Division]. October 1973. US Fish and Wildlife Service. [FWS 1973]

Relevant portions of this follow-up report focus on the actual effects of the Baker project (Upper Division) upon fisheries and wildlife. Previous reports concluded that the Powder River was undesirable for fishing due to low flow periods and an abundance of silt caused by gold dredging. Reports also stated that a change in water capacity of the Mason Reservoir from 53,000 to 100,000 acre-feet would have no positive effects upon fisheries, due to large irrigation draw downs. It was also indicated that, if measures were taken to provide a minimum flow of 10 cfs and diversion screens installed along the upper division, an annual fishery benefit of $14,800 could be assigned to the Powder River.

The actual effects of increasing the minimum pool requirements of Philips Lake have increased the stocking program. Presently, 300,000 fingerling Rainbow trout and 100,000 fingerling Coho salmon are stocked annually in the reservoir. In 1969, an angler program was introduced in order to track annual fish harvests at Philips Lake. It was suggested that fishing resources contributed approximately $100,000 to Oregon's economy in 1969 and $192,000 in 1970. Measures were never taken to provide a minimum flow of 10 cfs or diversion screens along the Powder River. Geological data indicate minimum flows occur periodically, thus decreasing the river's ability to allow for natural reproduction of game fish. A "put-and-take basis" was initiated by the Game commission.

Appendix D, Agricultural Economy Baker Project, Oregon Upper Division. 1964. Supporting "Baker Project, Oregon, Upper Division, Definite Plan Report" of December 1964. Bureau of Reclamation, Upper Columbia Development Office, Spokane, WA. [Reclamation 1964b].

Relevant portions of this addendum to the Baker Project (Upper Division) focus on the area's agricultural economy. Discussion includes such topics as anticipated crop distribution with or without project development, and agricultural farm production values as well as a summary of project payment capacities. Included in this addendum are various tables, illustrations, and farm budgets summarizing income and expenses with or without project development.

Land Ownership, Tenure and Water Supply are expanded upon emphasizing water requirements and distribution with regard to land classes and recordable contracts.

Previous reports indicate the project would have no effect on wildlife; gold dredging had already destroyed most of the area. Enhancement developments have increased wildlife occurrence. A wildlife habitat plan is being developed for Phillips Lake as well as the possible acquisition and development of land upstream from the Reservoir.

Based on recommendations from the US Bureau of Sport Fisheries and Wildlife (processor of the US Fish and Wildlife Service), there are 90 days of recreational use around the reservoir with no problems of access through private lands. BSFW also recommended a flow of not less then 10 cfs be provided at all times on the Powder River. Compliance was met in 1971, thus decreasing stocking rates.

Appendix A, Lands, Baker Project, Oregon Upper Division. 1964. Supporting "Baker Project, Oregon, Upper Division, Definite Plan Report" of December 1964. Bureau of Reclamation, Upper Columbia Development Office, Spokane, WA. [Reclamation 1964a]

Relevant portions of this Addendum to the Baker Project (Upper Division) focus on Lands. This appendix is an addition to the Definite Plan Report. Included in this document are various tables, maps, and illustrations. This report discusses the Division of Lands and its classification in accordance to various previous reports.

Letter from Secretary of the Interior, Upper Division, Baker Project, Oregon. 1962. 87th Congress, 2nd Session, January 1962, House Document No. 30. [Reclamation 1962]

This document transmits *Report of the Regional Director* (January 1961) about the Upper Division of Baker Project, Oregon. It provides a general description of the area including physical features, climate, settlement and development, population, industry, and land and water use. This document addresses Baker Valley's problems and needs. A large portion discusses irrigable lands in the upper division addressing soils, topography, drainage, erosion, water supply, and crop adaptability. Water rights, requirements, and quality were also addressed. Discussion was given to other project functions such as flood control, recreation, and fishery enhancement benefits. An overview is provided of the project's evolution, including development and repayment. A financial analysis was provided with economic justification. Benefits from the development exceed costs by a ratio of 1.28 to 1.00 over a 100-year period. Various tables and illustrations are included in this transmittal.

Baker Project, Oregon (Upper Division), Report of the Regional Director and Substantiating Materials. March 1953. Bureau of Reclamation, Region 1, Boise, ID.

This report focuses on the development of the Upper Division Baker Project, Oregon. The Upper Division lies in the upper portion of the Powder River. Agriculture drives Baker Valley socially and economically. Additional irrigation is needed to meet late season water shortages, and to assist with reclamation and prevention of alkali lands. Increased water supplies would in return increase forage production and grazing

capacities. Development of the project would decrease flood irrigation which directly influences alkaloid lands. Other benefits include flood protection for urban and rural areas as well as providing recreation and fishery improvements.

The construction of Mason Dam and reservoir were justified based upon economical and engineering data. An "annual benefit and cost analysis" (page 5) is outlined and concluded that water users could repay 29 percent of the reimbursable costs within a 40-year, interest-free repayment period.

It was recommended to authorize the construction of Mason Dam and Reservoir along with recreational facilities. Other recommendations include the United States retain operation of the reservoir, that the recreational portion be allocated to the USFS, and that water from the lake be sold to an irrigation district.

Operation Studies for Determination of Economic Capacity Mason Reservoir. January 1951. Appendix support "Reclamation 1953." Bureau of Reclamation, Hydrologic Studies Office, Boise, ID. [Reclamation 1951]

This memorandum is in response to a letter requesting a preliminary design and estimate on Mason Dam, Baker Project, Upper Division, Oregon. Six reservoir operation studies were conducted to determine the most feasible capacity for Mason Dam. Capacities varied from 43,000 acre-feet to 130,000 acre-feet. Included in the document are comparative cost estimates, capacity tables, and operation studies. It was determined that the economic capacity for Mason Dam was 100,000 acre-feet based on storage costs.

Included in the document are memoranda from US Fish and Wildlife Service.

Burnt River Investigations, Oregon. October 1934. E.B. Debler and L.J. Foster. Bureau of Reclamation. [Reclamation, 1934]

Relevant portions of this report focus on potential dam and reservoir sites on the Lower Powder River for the Baker project. Potential sites that were investigated include Bowen Dam, Boulder Gorge Dam, Hershel Dam, and Mason Dam. Geological data were collected and examined from the drilling of each site. Thus, the Boulder Gorge Dam site was preferred due to the area's geological conditions. This site allowed for the construction of a single arch dam.

Potential dam sites were investigated for the purpose of water management (storage and controlled flows of runoff and flooding). This report addresses the development of Baker Valley along with summary cost and annual cost comparisons.

7. NORTH POWDER DRAINAGE AREA ABSTRACTS

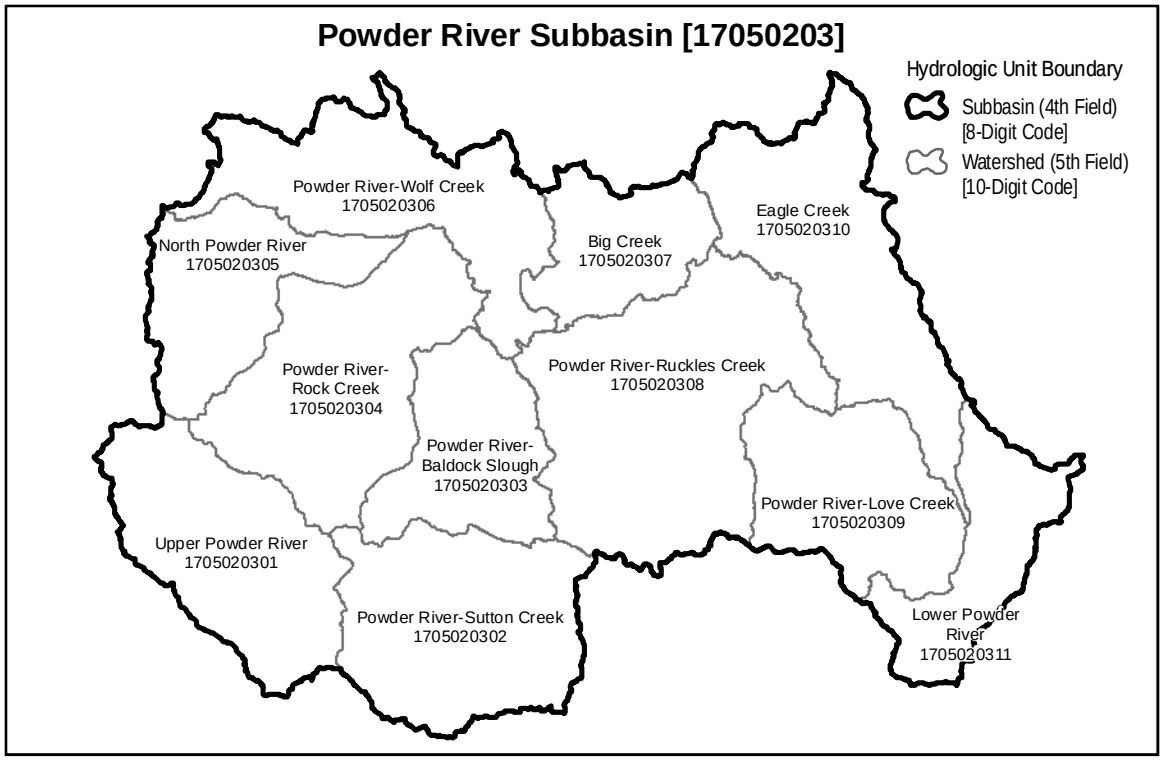


Figure 5. (Map) The North Powder River Drainage Area includes four watersheds. These are the Powder River–Baldock Slough, Powder River–Rock Creek, North Powder River, and Powder River–Wolf Creek. watersheds.

Powder River – Powder Valley Watershed Assessment Draft #3. 2004. Produced by Powder Basin Watershed Council Assessment Committee for Powder Valley Watershed Council. [Powder Basin WC 2004]

The purpose of this assessment was to identify existing issues about the current watershed condition. This report was highly contentious and a consensus was never reached to accept a final draft. This information will help determine which features and processes are working well and which are not working well. It is vital to help planners develop action plans for the most urgent issues. The assessment boundary included the Powder River Valley in Union and Baker counties, about 292,084 acres. The first part of the document discussed the climate and geology of the watershed. The vegetation topic covered items such as noxious weeds and endangered species. Wildlife found in the area was discussed in detail. The land use was detailed on a few maps. The transportation system was laid out and noted the extensive road system. General information about the area's agriculture and forest management was

discussed. Mining, recreation, and municipal water supplies data were included as well.

The second part of the document characterized the water of the watershed. The major surface water resources such as streams, lakes, reservoirs, and springs were itemized on a table. Reasons for the resulting channel changes were discussed. Streamflow included a large discussion in this document due to the concerns of dewatering. Fish and fish habitat discussed the concerned species distribution and recovery. Many maps were included to display the fish resources. Water use and irrigation water rights were outlined in this document. The irrigation systems and reservoirs were discussed in the surface water portion. Groundwater is explained as being monitored by selected wells. The riparian areas and resources such as wetlands were described. The stream systems were displayed on maps and discussed in detail. The water quality, such as 303(d) list, of streams were discussed with topics such as stream temperature. This assessment seemed to encompass mostly all of the current information about the watershed.

Feasibility Design Report – Revision 1– P and P1 Pipeline (Draft). 2003. USDA Natural Resources Conservation Service, Spokane Regional Design Team, Spokane, WA. [NRCS 2003]

This report focuses on the P and P1 Pipelines for the Wolf Creek Watershed project. This report contains only the feasibility design, later revisions will include:

- Soil Mechanical Design
- Structural Design
- Appurtenance
- Construction Specifications
- Construction Schedule
- Operation & Maintenance Plan

The P and P1 pipelines are supplemental measures to increase efficiencies, save water, conserve energy, and reduce the need for weed control along ditches. Lengthy discussion is given to design objectives, basis for design, hydraulics, and cost estimates. An estimated total cost for the pipelines is $3,021,015.

The P line delivers water from an existing south irrigation outlet to the P2 Pipeline inlet. This mainline provides approximately 1,966 acres with pressurized delivery of irrigation water. This pipeline replaces the north portion of the existing Mahary-Belvis ditch.

The P1 pipeline converts surface ditch water into a pressurized pipeline. This line includes fifteen delivery outlets that service 2,405 acres of cropland.

In conjunction with each other, these pipelines will save water and will eliminate the need to maintain bypass water at the P2 inlet.

This report contains various figures, cost tables, and appendices.

Reservoir Increase at Thief Valley Dam, Oregon. December 2001. Bureau of Reclamation, Denver, CO. "Appraisal Report TVD-RVI-APPRAISAL-2002-1" [Reclamation 2001b]

The following excerpt was taken from the Executive Summary of the document:

The study developed "appraisal level costs to install a rubber dam (a bladder) in the spillway at Thief Valley Dam to increase the storage capacity by 5,000 acre-feet to recover lost storage from sedimentation. A sedimentation study [Reclamation 1992] determined that the Thief Valley Dam reservoir has reduced about 4,100 acre-feet in storage capacity from 17,400 acre-feet to 13,300 acre-feet and possibly an additional 500 acre-feet since 1992."

"The rubber dam would be inflated after peak flow passed in the spring and would store the recession of the hydrograph peak. After irrigation releases through the outlets reduced the reservoir level below the original spillway level, the rubber dam would be deflated until needed the next year."

"Operation of the rubber dam can be automatic, manual at the site, or remote. Remote operation is recommended at Thief Valley because of the difficulty and length of time to get to the site. The required controls and equipment for remote operation are included as part of the rubber dam installation."

Appraisal costs for the rubber dam installation was $895,000, which did not include costs for data collection, design, project coordination, contract administration, construction management and permits. Additionally, the picnic area may need to be modified due to the increased water level; the cost was estimated to be about $250,000.

Background was given as to the dam's location and its structural statistics. These included the fact that the reservoir is at 3,133 feet elevation and has a volume of 17,600 acre-feet with a surface area of 740 acres. The only minimum downstream flow requirements are "to keep the river alive." A recommendation was made that it would be "well advised" to perform an updated seismic analysis of the dam and foundation. When a "Comprehensive Facility Review" was completed in 1998, the dam was judged to be "basically in good condition" and there were "no signs of structural distress and the dam has a good history of performance."

The bladder required for Thief Valley Dam would be 267' 10" long, 6' 4" tall, and weigh 35,000 lbs. Bladders have a 30-50 year life span.

Recommendations for future studies are:

1. The effect of changes in dam operations on the reservoir's fill and release.
2. An environmental analysis (estimate $100,000).
3. Pullout tests of anchor bars on the crest of the spillway.
4. The need for a downstream warning system when rubber dam is deflated.

Thief Valley Reservoir 1992 Sedimentation Survey. Bureau of Reclamation, TSC Sedimentation Section (R.L. Ferrari), Denver, CO. [Reclamation 1994]

In June of 1992, Thief Valley Reservoir was surveyed to collect data for the development of a topographic map, and to determine the relationship between storage and elevation. The reservoir's sediment volume was also determined from collected data. The Bathymetric survey used sonic depth recording equipment interfaced with a microwave positioning unit, which allowed continuous recording of reservoir depths and horizontal coordinates. Water surface elevations were used to convert sonic depth measurements to give true lake elevations. The above-water reservoir was determined from aerial photography.

According to the 1992 survey, Thief Valley Reservoir's spillway crest elevation was 3,133 feet with 685.1 acres of surface area and a capacity of 13,307 acre-feet. Since February 1932, 1,798 acre-feet of sediment has accumulated in Thief Valley Reservoir. Calculations show sediment accumulation increases 30.1 acre-feet annually. Reservoir capacity has decreased 11.9 percent.

Archeological Investigation Pilcher Creek Dam, Wolf Creek Watershed, Union County, Oregon. USDA Soil Conservation Service, West Technical Service Center (Rechendorf, F.; Gelburd, D.; and Scott, C.), Portland, OR. [NRCS 1982]

This archeological investigation first provided a brief overview description of the Pilcher Creek subwatershed including: general location, land use, climate, vegetation, fauna, regional geology, reservoir area geology, geomorphology, and soils. Three main locations of study were identified along with methodology for obtaining data, conclusions, and recommendations. There were pictures included which showed the artifacts that had been found, discussion pertaining to scatter direction and soil erosion in the area, and that the artifacts were generally located in a fairly predictable pattern.

The researchers concluded that the site had been revisited over a long period of time, Pre-Mazama to Post-Mazama. It was recommended that the site undergo further study when funds were available, but inundation of water would not significantly

affect artifacts. Therefore, the reservoir could be constructed without further archeological review.

Final Design North Powder Reservoir. 1979. Produced by CH2M Hill, Inc. for USDA Soil Conservation Service, Portland, OR. [CH2M Hill 1979]

This report summarizes past design efforts and future considerations for the construction and operation of the North Powder Reservoir. This report includes the following information:

- Summary of total project design
- Exploration/design recommendations
- Review of construction alternatives
- Reference tool for supervisors.
- Guide for operation and maintenance.

Topics of discussion include Final Design, Additional Field Explorations, Construction, Contracts, and Operation and Maintenance. A cost estimate was not included in this report. Appendixes contain: Model reports, Correspondence, and Review meeting notes and references. Periodic reviews of the project were conducted under the SCS contract, and earlier reports are heavily referenced.

Geotechnical Report for North Powder Reservoir and Antelope Canal. 1977. Produced by CH2M-HILL, Inc. for USDA Soil Conservation Service, Portland, OR. [CH2M Hill 1977]

This report provides information on subsurface conditions for the development of the North Powder Reservoir and Antelope Canal. Sites visited and tested are the spillway inlet, stilling basin, upstream portal of tunnel, and the accessibility of granular borrow materials. Nine test holes were drilled in the above-mentioned locations and sixteen test pits were dug to examine granular borrow. Twelve samples were taken from the pits and analyzed for grain size and selected for “Atterberg Limits” (a measure of suitability for use in construction). About 2.4 million cubic yards of granular materials were found to be available. No subsurface problems were encountered except for the tunnel portal area. Included in this report are figures, field logs, and laboratory data.

***Watershed Work Plan North Powder River Watershed, Baker County, Oregon*.** 1967. Produced by Baker Valley Soil and Water Conservation District and Powder Valley Water Control District with assistance from USDA Soil Conservation Service. [Baker and Powder 1967]

This document outlines a watershed work plan for the North Powder River. The North Powder River Watershed is located in northeastern Oregon in Baker County. This area covers approximately 117,800 acres of which 58% is forest land, 3% is range, 33% is cropland, and 6% urban. Average annual precipitation for this area is 23.3" of which 24% of this moisture occurs during the growing season.

The project's objectives are to provide valuable land treatment on watershed lands, flood protection for crop lands and structures along North Powder River and Willow Creek, improve existing usages of water supplies, provide supplemental irrigation, and provide reservoir fishery habitat and recreation facilities.

This document provides physical and economical data for the North Powder area. Problems of great importance include flooding of croplands, insufficient supply of irrigation during growing season, outdated delivery systems with excessive operation and maintenance costs, and an ever increasing recreational population into outdated facilities. Other problems bearing upon the project include watershed erosion, poor irrigation management, and poor fishery habitat.

Measures to be addressed include land and structural treatments. Land treatment measures consist of practices for watershed protection, flood control, land enhancement, irrigation management, and a decrease in sediment. It is the responsibility of the landowners/operators to install and maintain these measures with the assistance of the Soil Conservation Service and the State Forestry Department.

Structural treatments include two multi-purpose reservoirs with recreational facilities, a main-line irrigation canal, and stream channel improvements. One is the North Powder Reservoir; the capacity at full pool is 19,500 acre-feet with a 200 foot dam height. The second is the Muddy Creek Reservoir with a capacity of 1,035 acre-feet at full pool and a 39.5-foot-high dam. Other treatments to be included are delivery lines, diversion dams, structures for water measurement and regulation.

Developments will occur over an eight year period with an estimated cost of $4,821,980. The ratios of benefits to cost are 1.6 to 1.0. Installation costs will be shared with Public Law 566 fund and other funds.

Included in this document is an investigations and analysis section. Various tables, graphs, figures, and maps are contained in this document.

Watershed Work Plan Wolf Creek Watershed, Union County, Oregon. 1966. USDA Soil Conservation Service (Watershed Protection and Flood Prevention Act), Union County, OR. [NRCS 1966]

This document outlines a watershed work plan for the Wolf Creek area. Wolf Creek is located in northeast Oregon approximately 15 miles from La Grande and about 19 miles from Baker. The area covers approximately 106,204 acres with 36% forest, 40% range, 21% cropland, and 3% urban. Average annual precipitation is less than 10'' on most cropland of which 24% of this moisture is received during the growing season.

The objective of the watershed is to provide flood protection for agricultural land along Wolf Creek, to improve consumption of water supplies, develop a reservoir which will provide fishery and facilities for recreation, and to supply supplemental irrigation.

This document provides physical and economical data for the Wolf Creek area. It also addresses the area's watershed problems.

Measures to be addressed include land treatment structural measures. Land treatment measures included practices for watershed protection, flood control, land improvements, and irrigation water management. It is the responsibility of the landowners or operators to install and maintain these measures with the assistance of Soil Conservation Service. Powder Valley Water Control District will be responsible for installation, operation, maintenance, and replacement of all structural measures.

The developments will occur over an 8-year period with an estimated cost of $4,329,680. The ratios of benefits to cost are 1.5 to 1. Installation costs will be shared with Public Law 566 funds and other bearing funds.

Included in this document is an investigations and analysis section. Various tables, graphs, figures, and maps are contained in this document.

Baker Project, Wolf Creek Division, Water Supply and Requirements Supporting Data (draft). May 1959. Bureau of Reclamation, Snake River Development Office, Boise, ID. [Reclamation 1959]

Relevant portions of this document focus on the Wolf Creek Division for the Baker Project. Wolf Creek is located near the town of North Powder and provides irrigators in the area with a natural flow of water. Wolf Creek supports approximately 5,600 acres of crop land and natural streamflow is sufficient to supply all water rights until the first part of June each year. Principle crops grown in the project area include hay and grain with no expectation of change. Supplemental water is needed to reduce shortages in critical years.

It is proposed to build a storage reservoir with a capacity of 17,800 acre-feet; 1,400 acre-feet of that would be designated dead storage for diversion purposes. Water requirements for the project were based on climatological data and requirements of anticipated crops.

8. PINE CREEK WATERSHED ABSTRACTS

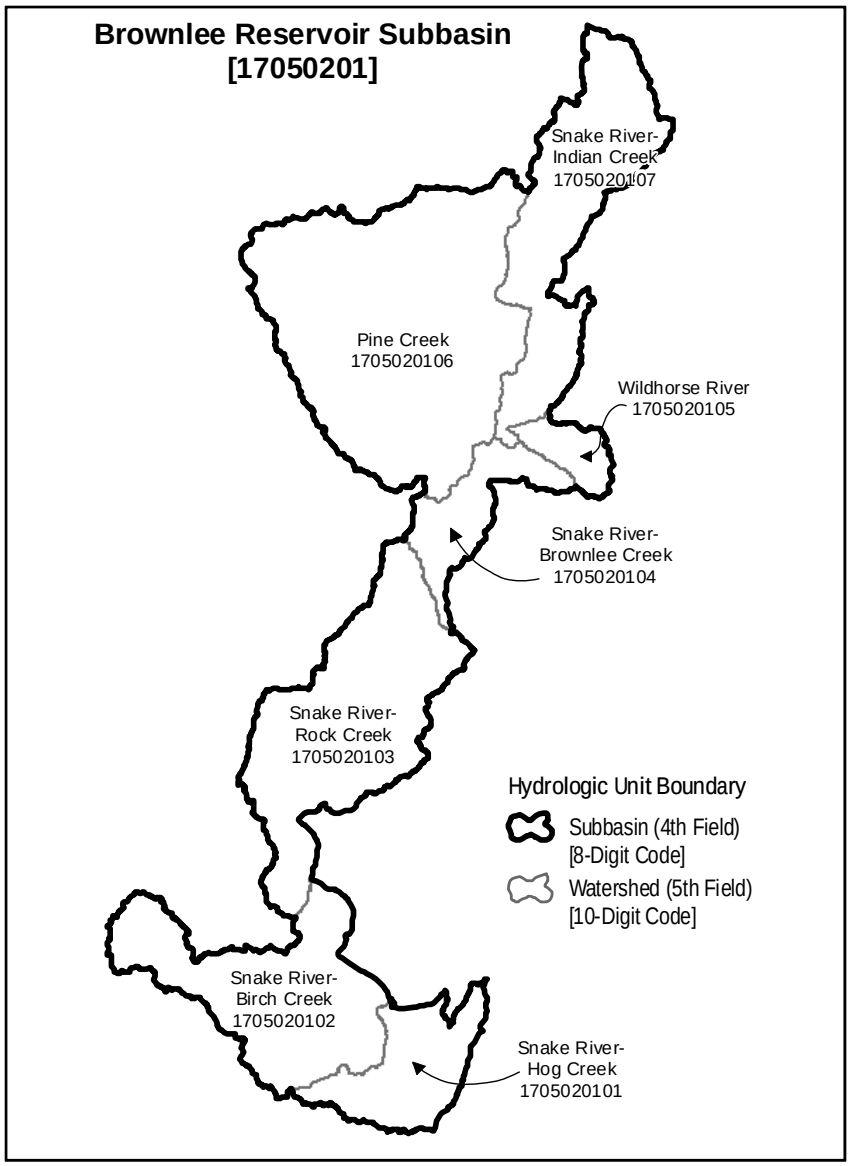


Figure 6. (Map) Pine Creek is the only watershed in the Brownlee Reservoir Subbasin that was reviewed in this report.

Pine Creek Watershed Action Plan. 2003. Powder Basin Watershed Council, Baker City, OR. [Powder Basin WC 2003].

This assessment of the Pine Creek Watershed focused on describing the issues and information needs, the process to prioritize work, and short- and long-term strategies. The basis for the project design was to assess the natural and human resources in each watershed, prioritize environmental needs, and develop an action plan. Fourteen

issues were identified. The short-term goals were to communicate with the public, recruit partners, and acquire funding and other support to implement high priority items. Long-term goals set were to review priorities, identify new issues and information needs, and set long-term goals to improve watershed. Action items included increase water availability, and updated working database serves as basis for planning of water management, fish screens, and bull trout.

Pine Creek Watershed Assessment Volume 1 – Report. 2000. Powder Basin Watershed Council, Baker City, OR. [Powder Basin WC 2000]

This document assesses the Pine Creek Watershed and provides the basis for the development of the Action plan. Volume 1 includes information on basic resources within the watershed and existing health issues.

Included is an overview of Pine Creek Watershed, health issues, and key findings. Discussion is given to climate, geology, soils, water quality, water rights, recreation, biology, economic aspects, hydrology, and subbasin watersheds.

Health issues are addressed from the standpoint of a council's basin-wide list, assessment committee, and others.

Issues of discussion, but not limited to, include:

- Water quality impaired streams
- Bull trout
- Fish screens
- Noxious weeds
- Over appropriation of water from streams
- Unauthorized water use.
- Soil productivity
- Hydrologic function
- Riparian area
- Reservation of surface water for future economic development
- Effects of uncontrolled run off.

This document also provides a list of information that was unavailable but could be potentially essential for the development of the action plan.

East Pine Creek Reservoir Impact Survey Report (NEPA). 1972. Wallowa-Whitman National Forest, Pine Ranger District (R.F. Pierce). [USFS 1972]

This document analyzed the East Pine Creek Reservoir relationship with the resources and management of the Wallowa-Whitman National Forest in accordance with NEPA requirements. The introduction was a chronological description of the development of the East Pine Reservoir from 1954 to the time this document was written. This document then generally describes the project and land ownership within the project boundary. The majority of the land within the project boundary is owned by the USFS.

A large portion of the document discussed the resource values such as recreation, range, timber, water, soil, wildlife, fish, etc. Campgrounds will be developed away from water features, and about 950,000 board feet of timber is calculated within the project area on USFS land. A fish ladder would be required due to the trout within the creek. Forest administration and protection such as transportation system and fire protection were discussed. The environmental summary states that "no resource would be adversely affected to a great extent … if properly designed." Included in this document is a table of the cost estimate of minimum recreation facilities, road relocation, and services. The maps included are boundaries, land use, recreation, new diversion canal, range types, and geologic types.

Watershed Work Plan Pine Valley. 1968. Produced by Eagle Valley Soil and Water Conservation District (Richland, OR) and Pine Valley Water Control District (Halfway, OR) with assistance from USDA Soil Conservation Service and USDA Forest Service, Baker City, OR. [Eagle and Pine 1968]

This document outlined ways to prevent the main watershed problems of flooding, inadequate water supply, inefficient irrigation systems, and increasing number of recreationists. One goal of this project included effective land treatment measures such as practices for watershed protection, flood prevention, irrigation management, and sediment reduction for the entire watershed. The main solution was a 177-foot-high dam impounding a multipurpose reservoir with a capacity of 17,200 acre-feet, and a surface area of 266 acres,. Other solutions included a new diversion canal, main line, and pipelines. The estimated cost was over $2 million.

The geology, soils, and hydrology of the watershed were discussed as well as the needs of recreation and wildlife.

The cost estimate of construction and installation was itemized and discussed. Cost benefits to the new reservoir included damage reductions due to fewer floods.

Onsite investigations have been completed for the proposed reservoir. This included hydrology by using stream gauges, climatologic records, and snow measurements.

Geology investigations of the surface, subsurface, foundation by pressure tests, and ground water were accomplished. Irrigation studies were intense to determine the requirements of the reservoir. Topographic surveys of the reservoir were completed. A land-use map with annual precipitation and irrigation, geology and soils map, topographic reservoir with planned recreation sites map, cross-section of the dam, and a project map are included in this document.

9. RELATED REGIONAL ABSTRACTS

***Ecology of the Columbia Spotted Frog in Northeastern Oregon*.** 2005. USDA Forest Service, Pacific Northwest Research Station (Evelyn L. Bull), La Grande, OR. [USFS 2005]

This document explores the population decline of the spotted frog *(Rana luteiventris)* in northeast Oregon. Ten study sites were observed for eight years starting in 1997 and ending in 2004. Observations included breeding, post-breeding, over-wintering, habitat, and ecology.

The spotted frog is found in permanent waters such as lakes, streams and ponds where continuous flows occur. Populations are small with a male to female ratio of 1 to 2.8. They over-winter in areas with ice cover, and flies make up 50 percent of their diet. No evidence was found that an area of grazing or ungrazed was relevant.

A longer period of observation is needed to determine the overall health and influences affecting the spotted frog.

Endangered and Threatened Wildlife and Plants: Designation of Critical habitat for the Bull Trout, Final Rule. 2005. US Fish and Wildlife Service. Federal Register, Vol. 70, No. 85, Monday, September 26, 2005; pp 56212-56311. See at http://www.fws.gov/pacific/bulltrout/ then link to "Final Rule". [FWS 2005]

This notice is the critical habitat final rule for Endangered and Threatened Wildlife and Plants (i.e., bull trout) in the Klamath River, Columbia River, Jarbridge River Coastal-Puget Sound, and Saint Mary-Belly River. This final rule amends the Endangered Species Act of 1973 and became effective on October 26, 2005.

The area defined as critical habitat encompasses approximately 3,828 miles of streams; 143,218 acres of lakes in Idaho, Montana, Oregon and Washington.

Data and comments were solicited from all sectors of the public.

This notice defines the role of critical habitat and provides supplemental and background information on bull trout. Also included are numerous summaries and recommendations.

Operations Description for Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir. February 2004, revised May 2004. Bureau of Reclamation, Snake River Area Office, Boise, ID. [Reclamation 2004a]

This document provides an overview of various projects in the upper Snake River basin, from the headwaters to Brownlee Dam.

The Snake River begins in Wyoming, flowing through parts of Idaho and Oregon. Due to the river's extensive coverage, water rights are administered by the above-mentioned states. In 1949, the Snake River Compact was signed between Idaho and Wyoming allocating water rights from the Snake River (96% to Idaho and 4% to Wyoming) for storage and/or diversion. Oregon issues water rights for storage and for use. Natural flows involve the right of use. Storage rights, however, involve two water rights- the right of storage and the right for usage. Permits are allocated for the appropriation of water.

Relevant portions of this report focus on a variety of factors (i.e., legal requirements) influencing the following projects:

- Minidoka Project
- Boise Project
- Vale Project
- Mann Creek Project
- Burnt River Project
- Baker Project
- Palisades Project
- Ririe Project
- Michaud Project
- Little Wood Project
- Owyhee Project.

Project information includes: general information, development history, project authorization, facilities, cost allocation, contracts, water rights, reservoir operations, irrigation, and flood control, as well as reservoir storage and outflows.

It is the responsibility of Reclamation to provide a "SOP" (standing operating procedures) for each project. These procedures provide information pertinent for the operation of a dam and reservoir. SOPs include:

- Communications listings
- Facility information
- Structural, electrical, and mechanical data
- Manuals for instruments
- Operating procedures.
- Emergency action plans

Relationship of Shade and Maximum Stream Temperatures on Three Northeastern Oregon Streams. 2003. *Range Field Day Progress Report on Environmental and Management Impact on Stream Temperature, July 1, 2003, Unity, OR.* Oregon State University (Krueger, W.C.; Williams, J.; Borman, M.; and Larson, L.), Corvallis, OR. pp. 30-34. [Krueger et al. 2003]

This study was initiated due to the assumption that there is a strong correlation between the percent cover of a stream and the streams maximum daily temperature. Therefore, the question was addressed: "Is there a measurable correlation between the percent cover of a stream and its maximum daily temperature?" For this study, three Rosgen Type-B streams in northeastern Oregon were chosen; all had base flows from 0.05 cfs to 1.1 cfs.

At the time the study was summarized for the Range Field Day data analysis and interpretation were ongoing and the findings were preliminary. However, preliminary findings were: the study provided no "evidence that shade is a driving force in temperature change on these [types] of streams."

A Case Study of River Temperature Response to Agricultural Land Use and Environmental Thermal Patterns. 2003. Borman, M. and Larson, L. in *Journal of Soil and Water Conservation* 58(1): 8-12. Corvallis, OR. [Borman and Larson 2003]

An evaluation was done on the relationship between river temperature patterns, existing agricultural land-use patterns, and the thermal equilibrium condition of the surrounding environment (ex: air and soil temperatures). It was found that when temperatures approached equilibrium (soils, water, ambient air), the most influential factor was weather conditions. Existing agricultural land uses were not an influencing factor to water temperature along the studied stream reach, and therefore in areas with similar characteristics to the study area.

Chapter 13, Hells Canyon Complex Recovery Unit, Oregon. Draft Recovery Plan. 2002. US Fish and Wildlife Service. Portland, OR. [FWS 2002]

This document provides a detailed discussion of the bull trout (*Salvelinus confluentus*) specific to the Hells Canyon Complex Recovery Unit. The Hells Canyon Complex consists of Basins in Idaho and Oregon and their associated reservoirs, that drain into the Snake River. The Hells Canyon complex consists of three reservoirs: Hells Canyon, Oxbow, and Brownlee. Major watersheds found within the complex include Pine Creek, Powder River, and Burnt River in Oregon, and the Indian Creek and Wildhorse River drainages in Idaho.

This document discusses goals, objectives, recovery criteria, estimated costs, and period of recovery for the unit. Limiting factors directly affecting the bull trout are fragmentation and degradation. Due to a lack of fish passage, the bull trout have been isolated to the above mentioned basins, watersheds, and rivers. Various land management activities (i.e., mining, timber, harvesting, irrigation diversions, etc.) have directly altered streamflows and riparian vegetation.

The estimated cost of the bull trout recovery is $9 million allocated over a 25-year period. This excludes capital improvements for fish passage and protection. Recovery and delisting of the bull trout may take up to 25 years, depending on the reduction of identified threats.

The overall goal is to create a persistent, sustainable bull trout population distributed across the species native range, thus delisting the species.

Reservoirs of Opportunity/Final Report. 1999. U.S. Department of Interior, National Recreation Lakes Study Commission (Bob Armstrong, chairman). [Armstrong 1999]

This report provides an analysis from a commission on our nation's federal lakes and their place within society. The commission's purpose was to provide information on current recreational demands and to develop alternatives for enhanced recreation. Scope of study included literature reviews, meetings, and surveys in both private and public sectors. The commission addressed six principles to guide its review and make recommendations. These include environmental protection; encourage private and public involvement; reaffirm federal responsibility; increase management flexibility, and support and recognize management; attract private and public partners; and optimize water use.

Federal lakes were created to help drain watersheds in basins providing jobs, flood control, supplemental irrigation, navigation and aid in the generation of power. However, and most important, federal lakes are an authorized purpose (recreation). Federal lakes host approximately 900 million visits per year with a 2% annual growth. Federal lake recreation is a significant national recreation contributing to local, state, and national economics. Currently, there are 1,782 lakes with approximately 50 acre-feet of water. Of these, 70 are in Oregon (i.e., Unity Reservoir & Phillips Reservoir). Over the years, our lakes and facilities have deteriorated due to a multitude of deficiencies leaving several concerns.

- Facilities poorly maintained
- Poor water quality
- Policy
- Management

- Federal and local barriers.

Currently, eleven agencies manage national lakes and with shrinking appropriations this leaves little room for maintenance and growth. In order to address these concerns, constructive measures will need to be taken.

Commission measures and recommendations are:

- Establish federal lake as a priority (authorized purpose).
- Energize and focus federal leadership.
- Advance federal lake recreation through demonstration and reinvention.
- Create an environment for success.
- Identify and close the gaps between needs and services.

The Commission suggested a pilot program establishing a national recreational lakes system. Pilot lakes would be selected for the program and monitored for three to five years allowing time to find new economic resources, management practices, and methods to resolve conflicts. An analysis would be conducted on the program's failures and successes. Included in this document are various maps, tables, figures, and appendices.

Endangered and Threatened Wildlife species, Determination of Threatened Status for the Klamath River and Columbia River Delisting of several Evolutionarily Significant Units (ESUs) of West Coast steelhead. Final rule. US Fish and Wildlife Service. Federal Register, Vol. 63, No. 111, Wednesday, June 10, 1998. pp. 31647-31674. [FWS 1998b]

This final rule explains the role of the Fish and Wildlife Service with regard to the Endangered and Threatened Species Act of 1973 as amended.

FWS has determined the status of the bull trout in the Klamath and Columbia Basins to be threatened and not endangered. Habitat degradation, fragmentation and blockage of passageways, and non-native species have lead to a significant decline in population. A 5-year status review completed in April 2008 confirmed the threatened status (FWS 2008).

Bull Trout Life History, Genetics, Habitat Needs, and Limiting Factors in Central and Northeast Oregon Annual Report. 1998. Oregon Department of Fish and Wildlife, Portland, OR. [ODFW 1998]

This report focuses on the work accomplished in 1998, addressing distribution of immature and mature bull trout and habits associated with distribution, fluvial and

inhabitant bull trout life history patterns, interactions, and spawning. Areas of study were the Grand Ronde, Walla Walla, and John Day river basins.

Radio telemetry was used to describe seasonal movement of the bull trout and traps were used to collect biological information. Two groups of bull trout were determined, those caught for the first time and those recaptured. Bull trout that were recaptured were marked.

Twenty-five bull trout were implanted with radio transmitters and PIT tags from the Grande Ronde subbasin.

To observe interactions between species eight enclosures were built upon which experimental animals were introduced, then monitored for behavioral patterns or changes. A total of 238 fish were observed for 14 days. Results indicated feeding positions of fish were similar. Brook trout instigated 88% of the interactions and 87% of those interactions were size dominant. Bull trout predominantly decreased in weight over the duration. An overview is provided for each basin containing historical and current data, life history with limiting factors, management considerations, and current status.

Status of Oregon's Bull Trout, Distribution, Life History, Limiting Factors, Management Considerations, and Status. 1997a. Oregon Department of Fish and Wildlife, Portland, OR. [ODFW 1997a]

Relevant portions of this document focus on the bull trout's existence in eastern Oregon. Drainages of relevance include Grande Ronde, Imnaha, Pine Creek, and Powder River. Table 2 examines each basin's bull trout status in 1991 and 1996, thus determining any status change. Overall status change is primarily due to additional monitoring and/or field surveys of the bull trout. Data show extensions of bull trout distribution in Indian Creek (Grande Ronde subbasin). A reintroduction project has resulted in bull trout being returned to Wallowa Lake (Grande Ronde subbasin).

Bull Trout Life History, Genetics, Habitat Needs, and Limiting Factors in Central and Northeast Oregon Annual Report. 1997b. Oregon Department of Fish and Wildlife, Portland, OR. [ODFW 1997b]

This report focuses on movement, life history, distribution, habitat, and interactions of the bull trout in the Grande Ronde, Walla Walla, and John Day subbasins. Objectives were to determine the distribution of immature and mature bull trout and habits associated with distribution; determine fluvial and inhabitant bull trout life history patterns; identity habitat characteristics; and, determine possible competition between species. Populations of study were performed in the Grande Ronde, Walla

Walla, and John Day subbasins. Methods of study include radio telemetry, barbless hook lures, traps, and a systematic sampling strategy.

A total of 102 bull trout were tagged in the Grande Ronde subbasin. It was determined that there is a distinct distribution pattern between bull trout and brook trout. Three different zones occur, one where allopatric bull trout exist upstream, one with allopatric brook trout, and a zone of sympatry between them. It was also found that in all treatments bull trout experienced weight loss when interacting with brook trout.

Estimated Water Use and General Hydrologic Conditions for Oregon, 1985 and 1990. 1996. US Geologic Survey (Broad, T.M. and Collins, C.A.), Water-Resources Investigations Report 96-4080. [USGS 1996]

This document was a general summary of water use for Oregon in 1985 and 1990 in the Powder, Burnt, and Grande Ronde subbasin river subbasins. Together, these subbasins were called the "Northeast Region." For example, the water use in the Northeast Region was approximately 500-999 millions of gallons per day, with most using surface water. The water withdrawals for public supply in the Northeast Region were 3-9 millions of gallons per day with most using groundwater. There were additional charts and figures summarizing commercial, industrial, mining, hydroelectric power, livestock, irrigation, reservoir evaporation, and wastewater treatment. The irrigation water withdrawals for the northeast region were 500-999 millions of gallons per day. There are approximately 440,000 acres of cropland within the Northeast Region. About 250,000 acres are irrigated with an average rate of application of 3.9 acre-feet per acre, using 96% surface water. Pages 161-172 list detailed tables of the data compiled to create the summaries listed above

Bull Trout Life History, Genetics, Habitat Needs, and Limiting Factors in Central and Northeast Oregon 1996 Annual Report. October 1997. Prepared for Bonneville Power Administration, Environment Fish and Wildlife Program (Portland, OR) by Oregon Department of Fish and Wildlife (Portland, OR) and USFS North Fork John Day Ranger District (Ukiah, OR). [BPA 1997]
http://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=34342-2

This report covers the activities of the bull trout project for 1996.

Included in this report are work plan objectives with results and analysis for five areas. The Oregon bull trout belongs to three major lineages: Coastal, Klamath, and Inland. This was determined with analysis of DNA, in combination with previous genetic studies. It was concluded that there was little genetic variability within populations.

Three distinct zones of distribution were revealed through distribution surveys of brook trout and bull trout. Distribution and multiple spawning surveys were conducted. Spawning surveys were conducted on the Mill Creek, Little Minam River, and Silver Creek. It was determined that the Little Minam River and Silver Creek both have populations of resident bull trout. Populations peaked in September and October, with bull trout producing smaller redband trout than fluvial populations found in Mill Creek.

Trap catches took place on the Grande Ronde subbasin. It was established that two runs occur: one in April and May, composed of 2-3 year old fish, and one in September and October, composed of 3-4 year old fish. It appears as though the runs are separated by flow periods. High spring flows are associated with the spring run, and when the water begins to cool the fall run begins.

***Magnitude and Frequency of Floods in Eastern Oregon*.** 1982. US Geologic Survey Water-Resources Investigations Report 82-4078 (Harris, D.D. and Hubbard, L.E.), Portland, OR. [USGS 1982]

The focus of this report was to establish a method for determining the magnitude and frequency of floods on unregulated streams in eastern Oregon. This report contains a general description of the area, a multiple-regression analysis, and methods for estimating frequency of floods.

To better define flood characteristics, eastern Oregon was divided into four geographical regions: Southeast, Northeast, North Central, and Eastern Cascades. Each region has separate equations. Data are included for all regions. The following characteristics influence the magnitude of a flood: basin size, climate, topography, geography, soils, and vegetation. Included in this document are various illustrations, tables, and a conversion chart.

10. RECOMMENDATIONS

Upon reviewing the available documents pertaining to the Powder Basin and the drainage areas, it is evident that there is a need to address the specific area. The topics are

- endangered species,
- climatological data (which influences the timing and intensity of snow melt and runoff periods)
- water usage projections
- hydrology and streamflow
- economic/industry impacts
- estimated costs of specific projects.

No information was available pertaining to underground water storage. This potential opportunity should not be ruled out as an option; thus, there should be a study done to identify potential sites.

When addressing a specific project, some of the information contained within this Literature Review will be an excellent resource. On many of the existing potential sites there is likely adequate geologic and topographic data available and no future studies pertaining to those topics would be required.

Studies answer specific questions such as:

1. Is there a topographic and geologic location adequate for water storage above or below ground?
2. Is there enough snowmelt available to fill a reservoir of a specific size and how often will it fill? A hydrologic study will address that question.
3. Is the project feasible – do the benefits outweigh the costs?

11. TABLE OF REFERENCES AND CONTENT ANALYSES

Areas: BRS = Burnt River Subbasin; NPDA = North Powder Drainage Area; PB = Powder Basin; PCW = Pine Creek Watershed; PRS = Powder River Subbasin; Reg. = regional; UPDA = Upper Powder Drainage Area

In Text	Full Citation	Area	Geol-ogy	Hydro-logy	Topo-graphy	Biology	Climato-logical Data	Stream-flow	Stream Temp.	Water Use	Water usage project-ions	Irriga-tion	Water Rights	Recrea-tion	Econ-omy	Industry & Commerce	Est. Cost	Land Use/ Owner-ship	Peer review
Armstrong 1999	National Recreation Lakes Study Commission. June 1999. *Reservoirs of Opportunity, Final Report.* Bob Armstrong, commission chairman, Washington, DC.	Reg.				x	x			x	x		x	x	x	x			
Baker and Powder 1967	Baker Valley Soil and Water Conservation District (Bakery City, OR) and the Powder Valley Water Control District (North Powder, OR). 1967. *Watershed Work Plan North Powder River Watershed Baker County, Oregon*. With assistant from the USDA Soil Conservation Service, Baker City, OR.	NPDA	x	x	x					x				x	x	x			
Baker County 1995	Baker County Planning Department. 1995. *Baker County Water Resources (Draft),* Baker City, OR.	PB	x	x			x	x		x	x	x	x	x	x				
Baker County ACD 2004	Baker County Association of Conservation Districts. November 2004. *Supplement to the Powder and Burnt Subbasin Plans.* Baker City, OR. 8 pp.																		
Borman and Larson 2003	Borman, M. and Larson, L. 2003. "A Case Study of River Temperature Response to Agricultural Land Use and Environmental Thermal Patterns" in *Journal of Soil & Water Conservation* 58(1): 8-12. Corvallis, OR.	Reg.	x	x		x		x	x		x						x		
BPA 1997	Bonneville Power Administration. October 1997. *Bull Trout Life History, Genetics, Habitat Needs, and Limiting Factors in Central and Northeast Oregon 1996 Annual Report.* Prepared for Bonneville Power Administration, Environment Fish and Wildlife Program (Portland, OR) by Oregon Department of Fish and Wildlife (Portland, OR) and USFS North Fork John Day Ranger District (Ukiah, OR). http://pisces.bpa.gov/release/documents/documentviewer.aspx?doc=34342-2	Reg.	x	x		x													
Burnt River HC 2007	Burnt River Heritage Center. 2007. *Lest We Forget – Remembrances of Upper Burnt River in Baker County Oregon.* Compiled & edited by Members of the Burnt River History Group.	BRS		x						x			x		x	x	x		
Burnt River I.D. 2002	Burnt River Irrigation District. 2002. *Request for Appraisal Study.* Letter regarding Bureau of Reclamation to U.S. Representative Walden (February 20, 2002) from Burnt River I.D., Baker City, OR. Supported by letter to Rep. Walden from Oregon Sen. Ferrioli (February 28, 2002).	BRS						x	x		x		x	x				Rec.	
Burnt River LAC 2003	Burnt River Local Advisory Committee. 2003. *Burnt River Agriculture Water Quality Management Area Plan*. In cooperation with Oregon Department of Agriculture and Burnt River Soil and Water Conservation District.	BRS							x										
Burnt River SWCD 1970	Burnt River Soil and Water Conservation District. 1970. *Ricco Irrigation & Flood Control Dam*. In cooperation with Soil Conservation Service.	BRS									x		x					NRCS [SCS]	
Burnt River SWCD 1990	Burnt River Soil and Water Conservation District. 1990. *North Fork Burnt River Coordinated Resource Plan*.	BRS		x		x				x	x		x					SWCD	

In Text	Full Citation	Area	Geol-ogy	Hydro-logy	Topo-graphy	Biology	Climato-logical Data	Stream-flow	Stream Temp.	Water Use	Water usage project-ions	Irriga-tion	Water Rights	Recrea-tion	Econ-omy	Industry & Commerce	Est. Cost	Land Use/ Owner-ship	Peer review
Burnt River SWCD 1992	Burnt River Soil and Water Conservation District. 1992. *South Fork Burnt River Coordinated Resource Management Plan*.	BRS		x		x				x	x		x					SWCD	
Burnt River SWCD 2000	Burnt River Soil and Water Conservation District. 2000. *Middle Burnt River Coordinated Resource Management Plan*. Hereford, OR.	BRS								x	x		x	x					
CH2M 1977	CH2M-HILL, Inc. 1977. *Geotechnical Report for North Powder Reservoir and Antelope Canal.* Produced for USDA Soil Conservation Service, Portland, OR.	NPDA	x														x	SWS	
CH2M 1979	CH2M HILL, Inc. 1979. *Final Design North Powder Reservoir.* Produced for USDA Soil Conservation Service, Portland, OR.	NPDA	x														x		
Ducret and Anderson 1965	Ducret, G.L. Jr. and Anderson, D.B. 1965. *Records of Wells, Water Levels and Chemical Quality of Water in Baker Valley, Baker County, Oregon.* US Geological Survey, Salem, OR.	PB	x		x	x			x	x	x							Recl.	
Duncan 2002	David Duncan & Associates. 2002. *Burnt River Water Temperature Study Steering Committee Final Report.* Produced for Burnt River Steering Committee.	BRS		x			x	x	x						x			ODA	
Eagle and Pine 1968	Eagle Valley Soil and Water Conservation District (Richland, OR) and Pine Valley Water Control District (Halfway, OR). 1968. *Watershed Work Plan Pine Valley*. with assistance from USDA Soil Conservation Service and USDA Forest Service, Baker City, OR.	PCW	x	x	x	x		x		x	x			x		x		NRCS [SCS], USFS	
Franke 2007	Jerry Franke, manager of the Burnt River Irrigation District, Hereford, OR. 2007. Personal communication.	BRS																	
FWS 1967	Fish and Wildlife Service. 1967. *Memorandum, Burnt River Project, Dark Canyon Division, Oregon*. 1967. Memorandum dated June 13, 1967 from Fish and Wildlife Service (Portland, OR) to Bureau of Reclamation Regional Director, Boise, ID.	BRS																	
FWS 1973	US Fish and Wildlife Service. 1973. *Initial Followup Report on the Fish and Wildlife Resources* [of the Baker Project Upper Division].	UPDA	x			x		x	x		x			x				ODFW	
FWS 1998a	US Fish and Wildlife Service. 1998a. *A Framework to Assist in Making Endangered Species Act Determinations of Effect for Individual or Grouped Actions at the Bull Trout Subpopulation Watershed Scale*, February 1998.	Reg.																	
FWS 1998b	US Fish and Wildlife Service. 1998b. *Endangered and Threatened Wildlife species, Determination of Threatened Status for the Klamath River and Columbia River Delisting of several Evolutionarily Significant Units (ESUs) of West Coast steelhead. Final rule.* Federal Register, Vol. 63, No. 111, Wednesday, June 10, 1998. pp. 31647-31674.	Reg.																	
FWS 2005	US Fish and Wildlife Service. 2005. *Endangered and Threatened Wildlife and Plants; Designation of Critical habitat for the Bull Trout. Final Rule.* Federal Register, Vol. 70, No. 185, Monday, September 26, 2005. pp 56212-56311. http://www.fws.gov/policy/library/05-18880.html (as April 2008)	Reg.																	
FWS 2008	US Fish and Wildlife Service. April 2008. *Bull Trout (Salvelinus confluentus) 5-Year Review: Summary and Evaluation.* Portland, OR. http://www.fws.gov/pacific/bulltrout/5yrreview.html	Reg.																	

In Text	Full Citation	Area	Geol-ogy	Hydro-logy	Topo-graphy	Biology	Climato-logical Data	Stream-flow	Stream Temp.	Water Use	Water usage project-ions	Irriga-tion	Water Rights	Recrea-tion	Econ-omy	Industry & Commerce	Est. Cost	Land Use/ Owner-ship	Peer review
Geriz 1997a	Geriz, A.J. 1997a. *Highly Erodible Land and Wetland Conservation Determination for Tract 4407.* USDA Natural Resources Conservation Service.	BRS		x														NRCS	
Geriz 1997b	Geriz, A.J. 1997b. *Highly Erodible Land and Wetland Conservation Determination for Tract 4408.* USDA Natural Resources Conservation Service.	BRS		x														NRCS	
Geriz 1997c	Geriz, A.J. 1997c. *Highly Erodible Land and Wetland Conservation Determination for Tract 4409.* USDA Natural Resources Conservation Service.	BRS		x														NRCS	
Geriz 1997d	Geriz, A.J. 1997d. *Highly Erodible Land and Wetland Conservation Determination for Tract 4410.* USDA Natural Resources Conservation Service.	BRS		x														NRCS	
Hutchinson and Fortune 1967	Hutchison, J.M. and Fortune, J.P. Jr. 1967. *The Fish & Wildlife Resources of the Powder Basin and their Water Requirements.* Oregon State Game Commission A report with recommendations to the Oregon State Water Resources Board; "Federal Aid to Fish Project F-69-R-5." Portland, OR.	PB		x		x	x	x	x				x					ODFW	
Kerns 2007	Mac Kerns, retired rancher and chairman of the Powder Basin Water and Stream Health (WASH) Committee. 2007. Personal communication.	PB																	
Kraynick and Shevener, 1981	*An Economic Study of Three Small Watershed Projects in Midlife*. 1981. R.G. Kraynick and H.H. Shevener, Department of Agriculture, Oregon State University, Corvallis, OR.	NPDA								x	x		x					NRCS [SCS]	
Krueger et al. 2003	Krueger, W.C.; Williams, J.; Borman, M.; and Larson, L. 2003. "Relationship of Shade and Maximum Stream Temperatures on Three Northeastern Oregon Streams" in *Range Field Day Progress Report on Environmental and Management Impact on Stream Temperature, July 1, 2003, Unity, OR.* pp. 30-34. Oregon State University, Corvallis, OR.	Reg.	x	x	x			x	x										
Larson and Borman 1999	Larson, L. and M. Borman. 1999. *Burnt River – Shade, Soil Temperature, and Groundwater Recharge Estimates, A First Approximation.* Rangeland Resources Department, Oregon State University, Corvallis, OR.	BRS					x		x									OSU	
Larson and Borman 2000	Larson, L. and M. Borman. 2000. *Use Attainability Assessment (Temperature Standard) – Burnt River Watershed.* Rangeland Resources Department, Oregon State University, Corvallis, OR.	BRS					x		x									OSU	
Meays 2000	Meays, C.L. 2000. *Appendix B Elevation, Thermal Environment, and Stream Temperature on Headwater Streams in Northeastern Oregon (Thesis).* Oregon State University. Corvallis, OR.	BRS			x		x	x	x										
Newton 2001	Newton Consultants, Inc. 2001. *Hardman & Ricco Reservoir Projects – Key Issues & Feasibility Evaluation Process*. Produced for Burnt River Irrigation District, Hereford, OR.	BRS																Burnt River I.D.	
Nowak 2004a	Nowak, M. Cathy. May 2004a. *Burnt River Subbasin Plan, DRAFT.* Cat Tracks Wildlife Consulting. Prepared for Northwest Power and Conservation Council; http://www.nwcouncil.org/fw/subbasinplanning (as of April 2008)	BRS																	

In Text	Full Citation	Area	Geol-ogy	Hydro-logy	Topo-graphy	Biology	Climato-logical Data	Stream-flow	Stream Temp.	Water Use	Water usage project-ions	Irriga-tion	Water Rights	Recrea-tion	Econ-omy	Industry & Commerce	Est. Cost	Land Use/ Owner-ship	Peer review
Nowak 2004b	Nowak, M. Cathy. May 2004b. *Powder River Subbasin Plan.* Cat Tracks Wildlife Consulting. Prepared for Northwest Power and Conservation Council; http://www.nwcouncil.org/fw/subbasinplanning (as of April 2008)	PRS																	
NRCS 1966	Soil Conservation Service. 1966. *Watershed Work Plan, Wolf Creek Watershed, Union County Oregon.* US Department of Agriculture, Union County, OR. For P.L. 566 (Watershed Protection & Flood Prevention Act)	NPDA	x	x	x		x			x	x	x	x	x	x	x			
NRCS 1982	Natural Resources Conservation Service. 1982. *Archeological Investigation Pilcher Creek Dam, Wolf Creek Watershed, Union County, Oregon*. USDA Soils Conservation Service, West Technical Service Center (Rechendorf F., Gelburd, D., and Scott, C.) Portland, OR.	NPDA	x			x	x											NRCS	
NRCS 1994a	USDA Soil Conservation Service. 1994. *Investigation Report on a Refraction Seismograph Survey of Ricco Damsite, North Fork Burnt River*. USDA Soil Conservation Service (Pedone, P.F.)	BRS	x															NRCS [SCS]	
NRCS 1994b	USDA Soil Conservation Service. 1994. *ENG – Ricco Dam, Preliminary Cost Estimate*. Letter from R.E. Bright to Robert Sampson.	BRS														x		NRCS [SCS]	
NRCS 1997a	Natural Resources Conservation Service. 1997a. *Hardman Proposed Reservation – Wetland Conservation Determination for Forest Service*. (Bradford, C.A.)	BRS		x														NRCS	
NRCS 1997b	Natural Resources Conservation Service. 1997. *Ricco Proposed Reservation – Wetland Conservation Determination for Forest Service.* (Bradford, C.A)	BRS																	
NRCS 2003	Natural Resources Conservation Service. 2003. *Feasibility Design Report – Revision 1 P and P1 Pipeline.* Spokane Regional Design Team, Spokane, WA.	NPDA									x					x			
NRCS 2006	Natural Resources Conservation Service. 2006. *Burnt River – 17050202 – 8-Digit Hydrologic Unit Profile*. Water Resources Planning Team.	BRS				x	x		x	x		x	x					x	
ODA 2007	Oregon Department of Agriculture website: http://www.oregon.gov/ODA/	BRS PBS																	
ODFW 1967a BRS	Oregon Department of Fish and Wildlife. 1967a. *Annual Report Fishery Division.* (Sayer, R.C.)	BRS				x				x	x								
ODFW 1967b PB	Oregon Department of Fish and Wildlife. 1967b. *Annual Report Fishery Division.* (Sayer, R.C.)	PB		x	x	x													
ODFW 1996	Oregon Department of Fish and Wildlife. 1996. *Proposed Amendments to the Powder River Basin*. Letter from Zarnowitz, J.	BRS				x												ODFW	
ODFW 1997a	Oregon Department of Fish and Wildlife. 1997a. *Status of Oregon's Bull Trout, Distribution, Life History, Limiting Factors, Management Considerations, and Status.* Oregon Department of Fish & Wildlife. Portland, OR	Reg.			x	x													
ODFW 1997b	Oregon Department of Fish and Wildlife. October 1997b. *Bull Trout Life History, Genetics, Habitat Needs, and Limiting Factors in Central and Northeast Oregon, 1996 Annual Report.* Portland, OR.	Reg.	x		x	x													

In Text	Full Citation	Area	Geol-ogy	Hydro-logy	Topo-graphy	Biology	Climato-logical Data	Stream-flow	Stream Temp.	Water Use	Water usage project-ions	Irriga-tion	Water Rights	Recrea-tion	Econ-omy	Industry & Commerce	Est. Cost	Land Use/ Owner-ship	Peer review
ODFW 1998a	Oregon Department of Fish and Wildlife. 1998a. *Bull Trout Life History, Genetics, Habitat Needs, and Limiting Factors in Central and Northeast Oregon Annual Report*. Oregon Department of Fish and Wildlife, Portland, OR.	Reg.	x		x	x													
ODFW 1998b	Oregon Department of Fish and Wildlife. 1998b. *Request for Department Stand on Water Storage Reservoirs, North and South Forks of the Burnt River.* Letter from Zarnowitz, J.E.	BRS																	
ODFW 2006	Oregon Department of Fish and Wildlife. 2006. *Draft Elkhorn Wildlife Area Long Range Management Plan*. Oregon Department of Fish and Wildlife.	PB			x		x		x	x		x	x					ODFW	
OSU 1979	Oregon State University. 1979. *A resource survey of river energy and low-head hydrologic power potential in Oregon. Appendix 9; Powder Basin.* Corvallis, OR.	PB																	
OWRD 1965	Oregon State Water Resources Board. 1965. *Powder River Drainage Basin Survey of Literature.*	PB	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
OWRD 2007	Oregon Water Resources Department. 2007. The Oregon Administrative Rules contain *OAR Division 509 Powder Basin Program.* http://arcweb.sos.state.or.us/rules/OARS_600/OAR_690/690_509.html (April 2008)	PB								x	x								
OWRD and USDA 1966	Oregon State Water Resources Board of Oregon and US Department of Agriculture. 1966. *USDA Report on Water and Related Land Resources Powder Drainage Basin Oregon*. Salem, OR.	PB	x	x						x	x		x	x	x				
Powder Basin WC 2000	Powder Basin Watershed Council. August 2000. *Pine Creek Watershed Assessment Volume 1 – Report; Volume 2 – Appendices.* Baker City, OR.	PCW																	
Powder Basin WC 2003	Powder Basin Watershed Council. 2003. *Pine Creek Watershed Action Plan*. Baker City, OR.	PCW																	
Powder Basin WC 2004	Powder Basin Watershed Council. 2004. *Powder River – Powder Valley Watershed Assessment Draft #3.* Produced by Powder Basin Watershed Council Assessment Committee, Baker City, OR.	NPDA	x	x	x	x	x	x	x	x	x	x	x					Water-shed council	
Powder Basin WC and ODFW 2001	Powder Basin Watershed Council and Oregon Department of Fish and Wildlife. September 2001. *Upper Powder River Watershed Assessment.* Baker City, OR.	UPDA	x		x		x			x	x	x	x	x	x				
Powder/ Brownlee LAC 2007	Powder/Brownlee Local Advisory Committee. 2007. *Powder/Brownlee Agricultural Water Quality Management Area Plan.* With assistance from Oregon Department of Agriculture and Baker Valley, Eagle Valley, and Keating Soil and Water Conservation Districts. Adopted December 2003; revised January 2007.	PCW																	
Reclamation 1934	Bureau of Reclamation. October 1934. *Baker Project Investigations Oregon.* Debler, E.B. and Foster, L.J.	UPDA	x	x	x											x		Recl.	
Reclamation 1951 (BRS)	Bureau of Reclamation. January 1951. *Operation Studies for Determination of Economic Capacity, Mason Reservoir, Upper Division, Baker Project, Oregon.* [Appendix supporting Reclamation, 1953. Bureau of Reclamation, Hydrologic Studies Office, Boise, ID.	BRS		x															

In Text	Full Citation	Area	Geol-ogy	Hydro-logy	Topo-graphy	Biology	Climato-logical Data	Stream-flow	Stream Temp.	Water Use	Water usage project-ions	Irriga-tion	Water Rights	Recrea-tion	Econ-omy	Industry & Commerce	Est. Cost	Land Use/ Owner-ship	Peer review
Reclamation 1951 (UPDA)	Bureau of Reclamation. January 1951. *Operation Studies for Determination of Economic Capacity, Mason Reservoir, Upper Division, Baker Project, Oregon.* [Appendix supporting Reclamation, 1953. Bureau of Reclamation, Hydrologic Studies Office, Boise, ID.	UPDA	x	x			x			x	x	x	x	x	x	x		Recl.	
Reclamation 1953	Bureau of Reclamation. March 1953. *Baker Project Oregon (Upper Division) Report of the Regional Director and Substantiating Materials.* Region 1, Boise, ID. "Proposed report for official review only subject to revision."	UPDA		x							x					x			
Reclamation 1959	Bureau of Reclamation. 1959. *Baker Project, Wolf Creek Division, Water Supply and Requirements Supporting Data.* Snake River Development Office, Boise, ID.	NPDA					x	x		x	x	x							
Reclamation 1962	Bureau of Reclamation. 1962. *Letter from Secretary of the Interior, Upper Division, Baker Project, Oregon.* 87th Congress, 2nd Session, January 1962, House Document No. 30. Washington, DC. Transmits *Report of the Regional Director* (January 1961)	UPDA	x		x						x	x	x	x	x	x		Recl.	
Reclamation 1964a	Bureau of Reclamation. November 1964a. *Appendix A, Lands* [supporting *Baker Project, Oregon Upper Division, Definite Plan Report* of December 1964]. Upper Columbia Development Office, Spokane, WA.	UPDA																	
Reclamation 1964b	Bureau of Reclamation. 1964b. *Appendix D, Agricultural Economy* [supporting *Baker Project, Oregon, Upper Division, Definite Plan Report* of December 1964]. Upper Columbia Development Office, Spokane, WA.	UPDA								x	x			x	x			Recl.	
Reclamation 1971	Bureau of Reclamation. July 1971. *Burnt River Project, Oregon, Dark Canyon Division, Wrap-up Report.* Region 1, Boise, ID.	BRS	x		x	x				x	x		x			x			
Reclamation 1992	Bureau of Reclamation. September 1992. *Unity Reservoir 1991 Sedimentation Survey*. Technical Service Center, Sedimentation Section (R.L. Ferrari), Denver, CO.	BRS			x													Recl.	
Reclamation 1994	Bureau of Reclamation. March 1994. *Thief Valley Reservoir 1992 Sedimentation Survey*. Technical Service Center, Sedimentation Section (Ferrari, R.L.), Denver, CO.	NPDA	x	x		x					x							Recl.	
Reclamation 2001a	Bureau of Reclamation. 2001. *Burnt River Basin Water Temperature Modeling, Final Report.* Technical Service Center, Water Quality and Land Suitability Group (Mangelson, K.A.), Denver, CO.	BRS		x			x	x	x										
Reclamation 2001b	Bureau of Reclamation. December 2001. *Reservoir Increase at Thief Valley Dam, Oregon*. "Appraisal Report TVD-RVI-APPRAISAL-2002-1." Denver, CO.	NPDA	x		x			x		x	x	x				x		Recl.	
Reclamation 2004a	Bureau of Reclamation. 2004. *Operations Description for Bureau of Reclamation Projects in the Snake River Basin above Brownlee Reservoir*. Snake River Area Office, Boise, ID.	Reg.		x			x				x							Recl.	
Reclamation 2004b	Bureau of Reclamation. October 2004b. *Reclamation, Partners Reach Minimum Streamflow Agreement for Powder River*. Pacific Northwest Region, Boise, ID. News released dated October 26, 2004.	PB				x				x		x	x					Recl.	
Reclamation 2004c	*Powder River-Powder Valley Watershed Assessment, Draft 4*, December 2004, prepared for the Powder Basin Watershed Council, Baker City OR by Pacific Northwest Region, Boise, ID.	PB																	

In Text	Full Citation	Area	Geol-ogy	Hydro-logy	Topo-graphy	Biology	Climato-logical Data	Stream-flow	Stream Temp.	Water Use	Water usage project-ions	Irriga-tion	Water Rights	Recrea-tion	Econ-omy	Industry & Commerce	Est. Cost	Land Use/ Owner-ship	Peer review
Reclamation 2008	*Literature Review of the Powder Basin, Oregon, Stream systems, water storage, and stream health as they pertain to the basin and water science.* May 2008, Bureau of Reclamation, Snake River Area Office, Boise, ID. Prepared by Browne Consulting, LLC, Baker City, OR, in cooperation with Powder Basin Water and Stream Health Committee, Baker City, OR. [this document]	PB																	
Sorte et al. 2004	Sorte, B.; Carr, J.; and Tanaka, J. 2004. *Potential Impacts of the Proposed Designation of Bull Trout Critical Habitat in the Hells Canyon Complex/Baker County: A Regional Economic Analysis.* Oregon State University, Corvallis, OR.	PB												x	x	x	x	OSU	
Streamnet 2007	Streamnet website. 2007. http://www.streamnet.org/. StreamNet is a cooperative venture of the Pacific Northwest's fish and wildlife agencies and tribes and is administered by the Pacific States Marine Fisheries Commission.	Reg.																	
USFS 1972	US Forest Service. 1972. *East Pine Creek Reservoir Impact Survey Report (NEPA).* Wallowa-Whitman National Forest, Pine Ranger District (Pierce, R.F.), Baker City, OR.	PCW				x					x		x			x		USFS	
USFS 2005	US Forest Service. 2005. *Ecology of the Columbia Spotted Frog in Northeastern Oregon.* USDA Forest Service Pacific Northwest Research Station (Bull, Evelyn L.), La Grande, OR.	PB																	
USGS 1964	US Geologic Service. 1964. *Ground Water Reconnaissance in the Burnt River Valley, Baker County, Oregon (Open-file report)* Don Price, Portland, OR in cooperation with the Bureau of Reclamation.	BRS	x	x											x			Many	
USGS 1982	*Magnitude and Frequency of Floods in Eastern Oregon.* 1982. US Geologic Survey Water-Resources Investigations Report 82-4078 (Harris, D.D. and Hubbard, L.E.), Portland, OR.	Reg.	x		x	x	x												
USGS 1984	Seaber, P.R., Kapinos, F.P., and Knapp, G.L. 1984. State hydrologic unit maps. US Geological Survey Open File Report 84-708, 198 p.	PB																	
USGS 1996	US Geological Survey. 1996. *Estimated Water Use and General Hydrologic Conditions for Oregon, 1985 and 1990.* US Geologic Survey (Broad, T.M. and Collins, C.A.), Water-Resources Investigations Report 96-4080.	PB		x						x	x							USGS OWRD	
Van Staveren 1997	Van Staveren, J. 1997. *Fatal Flaw Analysis – Meeting material*. Pacific Habitat Services, Inc.	BRS		x		x												Burnt River I.D.	

12. ANALYSES OF DOCUMENT CONTENTS BY TOPIC IN TABULAR AND GRAPHIC FORM

12.1 ALL DOCUMENTS

Table 3. All Documents – Timeframe of Relevant Topics

Year	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Biology	Climato-logical Data	Economy & Industry	Est. Cost
2007		x		x			x	x
2007				x				
2006			x	x		x		
2006				x	x			
2005					x			
2005					x			
2004		x			x			
2004		x		x		x		
2004							x	x
2004	x	x	x	x	x	x		
2004				x	x			
2003	x	x	x	x		x		
2003	x	x		x	x			
2003				x				
2003				x				x
2002		x			x			x
2002		x				x		
2002		x		x			x	
2002		x		x		x	x	
2001				x				
2001	x	x	x	x				x
2001	x		x	x		x	x	
2000								
2000						x		
2000				x		x	x	
2000		x	x	x				
1999				x		x	x	x
1999						x		
1998					x			
1998	x		x	x	x			
1998					x			
1997			x		x			

Year	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Biology	Climato-logical Data	Economy & Industry	Est. Cost
1997	x		x		x			
1997		x			x			
1997		x						
1997		x						
1997		x						
1997		x						
1997		x						
1997		x						
1996		x		x				
1996	x	x			x			
1996					x			
1995	x	x		x		x	x	
1994	x	x		x	x			
1994								x
1994	x							
1992		x		x	x			
1992			x					
1990		x		x	x			
1982	x				x	x		
1981				x				
1979		x						
1979	x		x		x	x		
1979	x							
1977	x							
1973	x			x	x		x	
1972				x	x			x
1971	x		x	x	x			x
1970				x				
1968	x	x	x	x	x		x	x
1967		x		x	x	x		
1967	x	x	x	x			x	x
1967				x	x			
1967		x	x		x			
1966	x	x		x			x	
1966	x	x	x	x		x	x	x
1965	x	x	x	x	x	x	x	x
1965	x		x	x	x			
1964				x				
1964				x			x	

Year	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Biology	Climato-logical Data	Economy & Industry	Est. Cost
1964	x	x					x	
1962	x		x	x			x	x
1959		x		x		x		
1951		x		x				x
1951	x	x		x		x	x	x
1951		x						
1934	x	x	x					x

Table 4. All Documents – Percentage of Relevant Topics Within Timeframe.

	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Biology	Climato-logical Data	Economy & Industry	Est. Cost
	35	50	26	56	38	24	23	22

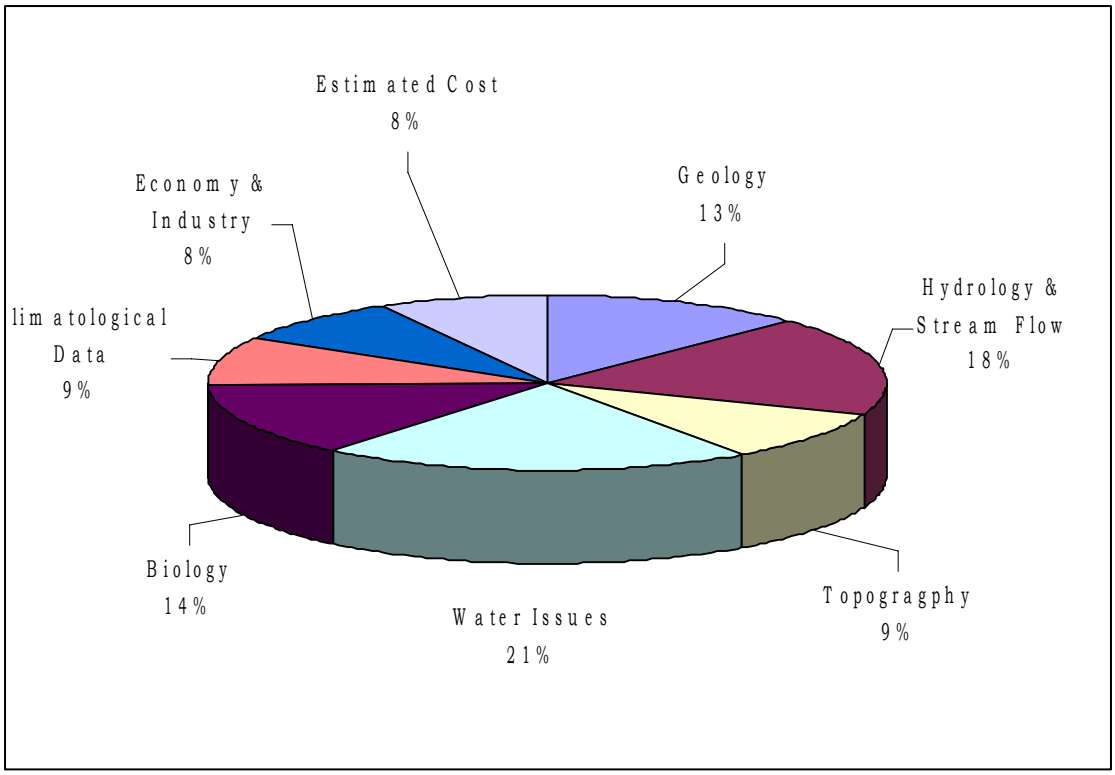


Figure 7. All Documents – Percentage of Relevant Topics Addressed.

12.2 POWDER BASIN [SUBREGION] DOCUMENTS

Table 5. Powder Basin – Timeframe of Relevant Topics.

Years	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Biology	Climato-logical Data	Economy & Industry	Est. Cost
2007				x				
2006			x	x		x		
2004			x		x		x	
2004				x	x		x	
2004								
1995	x	x		x		x	x	
1981				x				
1967		x	x		x			
1967		x		x	x	x		
1965	x	x	x	x	x	x	x	x
1965	x		x	x	x			
1964				x			x	

Table 6. Powder Basin – Percentage of Relevant Topics within Timeframe.

	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Biology	Climato-logical Data	Economy & Industry	Est. Cost
	25	33	42	75	50	33	42	8

Table 7. Powder Basin – Timeframe of Relevant Topics.

	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Biology	Climato-logical Data	Economy & Industry	Est. Cost
				2000	2000	2000	2000	
	1990	1990				1990	1990	
	1960	1960	1960	1960	1960	1960	1960	1960
			1950					

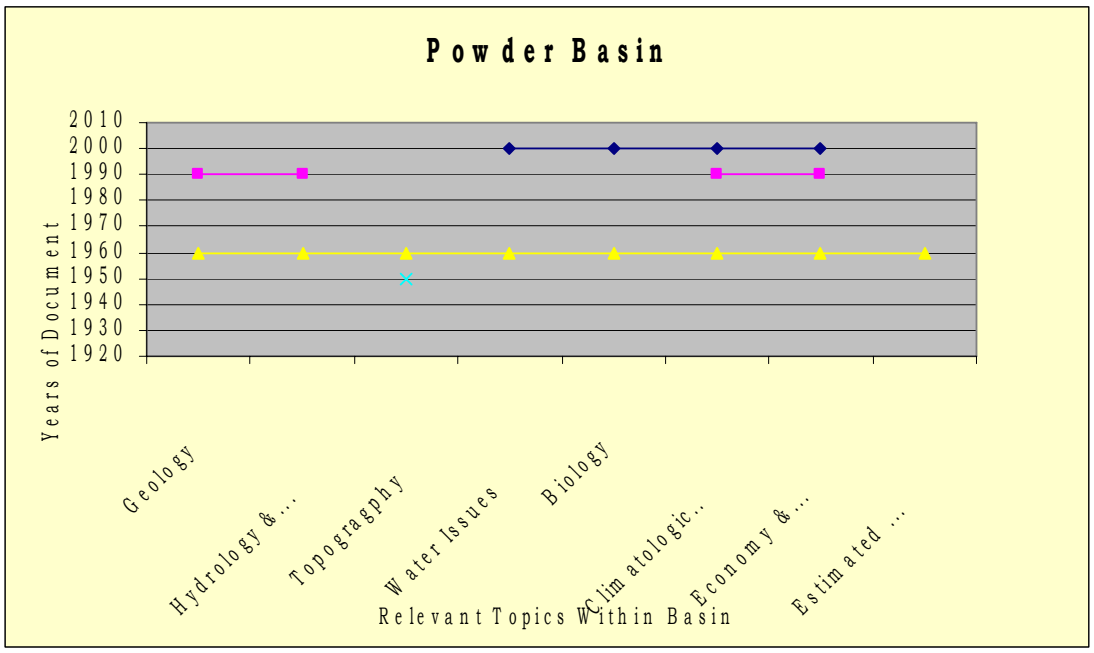


Figure 8. Powder Basin – Timeframe of Relevant Topics

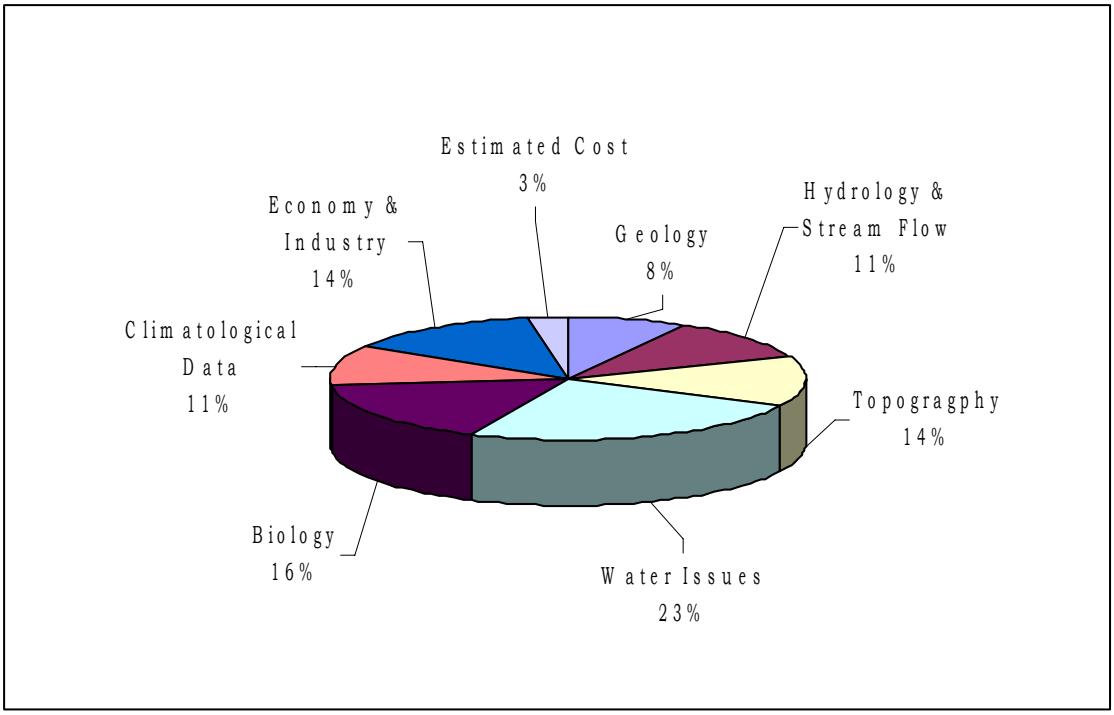


Figure 9. Powder Basin – Percentage of Relevant Topics Addressed.

12.3 ANALYSES OF BURNT RIVER SUBBASIN DOCUMENTS

Table 8. Burnt River Subbasin – Timeframe of Relevant Topics.

Years	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Biology	Climato-logical Data	Economy & Industry	Est. Cost
2007		x		x			x	x
2006				x	x	x		
2004				x			x	x
2003								
2002		x				x		
2002		x		x			x	
2002		x				x	x	
2001								
2000						x		
2000				x			x	
2000		x	x			x		
1999						x		
1998					x			
1997		x			x			
1997		x						
1997		x						
1997		x						
1997		x						
1997		x						
1997		x						
1996					x			
1994								x
1994	x							
1992		x		x	x			
1992			x					
1990		x		x	x			
1971	x		x	x	x			x
1967				x	x			
1964	x	x					x	
1951		x						
1970				x				

Table 9. Burnt River Subbasin – Percentage of Relevant Topics within Timeframe.

	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Biology	Climato-logical Data	Economy & Industry	Est. Cost
	9.67	52	10	32	26	19	19	13

Table 10. Burnt River Subbasin – Timeframe of Relevant Topics.

	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Biology	Climato-logical Data	Economy & Industry	Est. Cost
		2000	2000	2000	2000	2000	2000	2000
	1990	1990	1990	1990	1990	1990		1990
			1970	1970	1970			1970
	1960	1960		1960	1960		1960	
		1950						

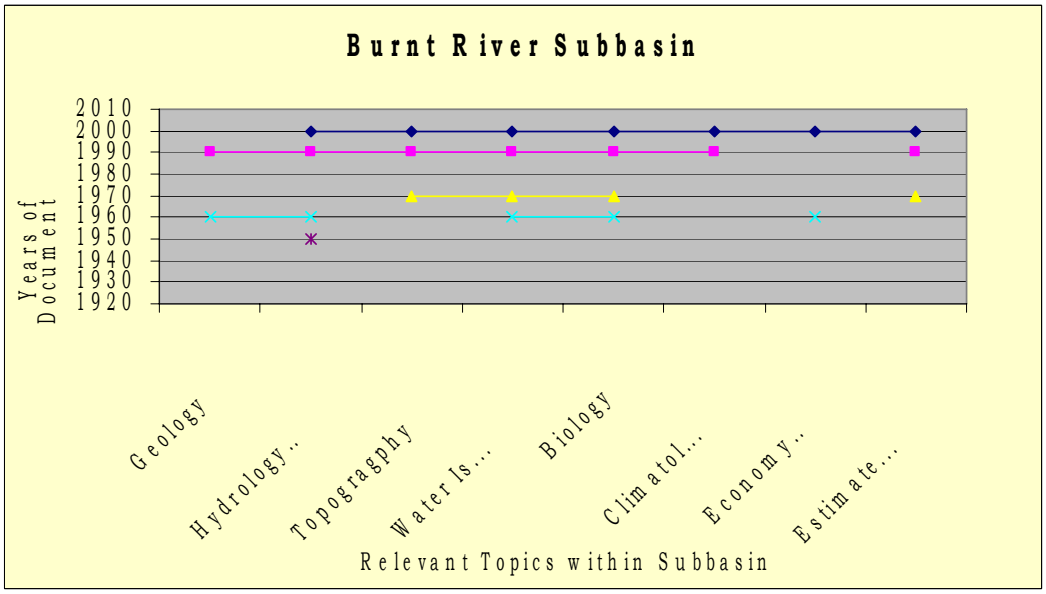


Figure 10 . Burnt River Subbasin– Timeframe of Relevant Topics.

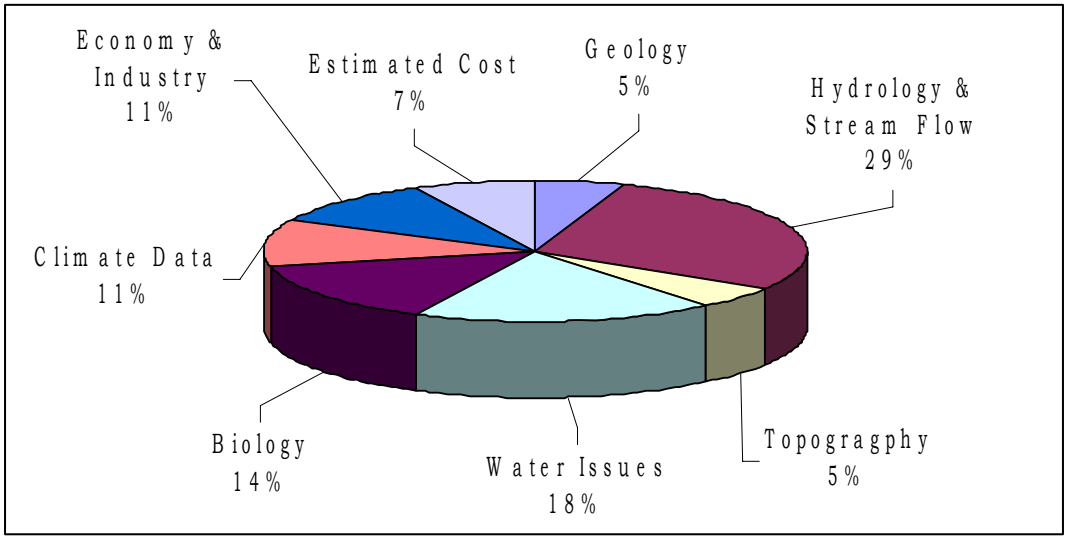


Figure 11. Burnt River Subbasin – Percentage of Relevant Topics Within Timeframe.

12.4 UPPER POWDER RIVER DRAINAGE DOCUMENTS

Table 11. Upper Powder Drainage Area – Timeframe of Relevant Topics.

Years	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Biology	Climato-logical Data	Economy & Industry	Est. Cost
2001	x		x	x		x	x	
1973	x	x		x	x		x	
1964								
1964				x			x	
1962	x		x	x			x	x
1951		x		x				x
1951	x	x	x	x		x		x
1934	x	x	x					x

Table 12. Upper Powder River Drainage Area – Percentage of Relevant Topics Within Timeframe .

	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Biology	Climato-logical Data	Economy & Industry	Est. Cost
	63%	50%	50%	88%	13%	25%	50%	50%

Table 13. Upper Powder River Drainage Area – Timeframe of Relevant Topics

	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Biology	Climato-logical Data	Economy & Industry	Est. Cost
			2000	2000		2000	2000	
	1970	1970			1970		1970	
	1960			1960			1960	1960
	1950	1950		1950		1950		1950
	1930	1930	1930	1930				1930

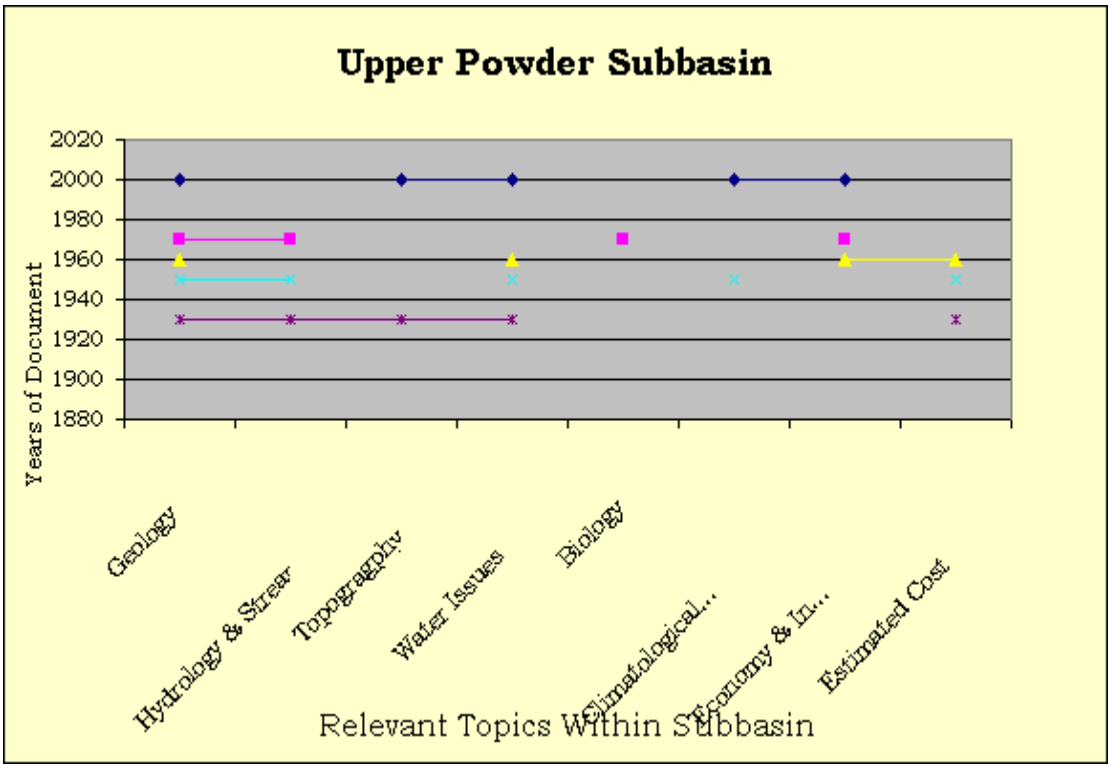


Figure 12. Upper Powder River Drainage Area – Timeframe of Relevant Topics.

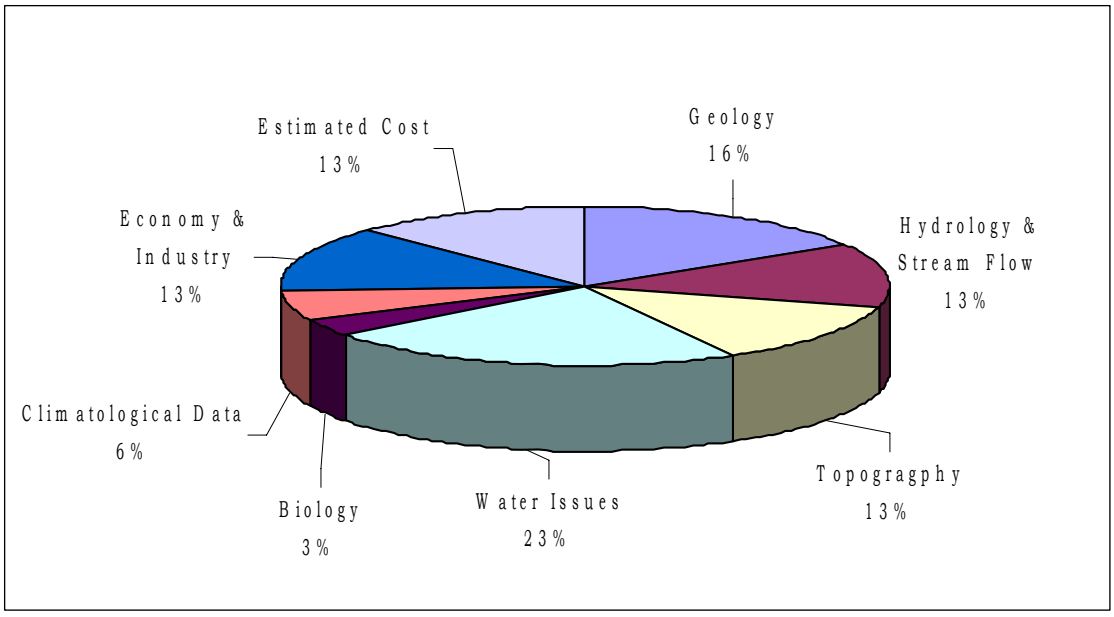


Figure 13. Upper Powder River Drainage Area – Percentage of Relevant Topics Within Timeframe.

12.5 NORTH POWDER RIVER DRAINAGE DOCUMENTS

Table 14. North Powder River Drainage Area – Timeframe of Relevant Topics.

Year	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Biology	Climato-logical Data	Economy & Industry	Est. Cost
2004	x	x	x	x	x	x		
2003				x				x
2001	x		x	x		x	x	
1994	x	x		x	x			
1982	x				x	x		
1979	x							
1977	x							
1967	x	x	x	x			x	x
1966	x	x		x			x	
1966	x	x	x	x		x	x	x
1959		x		x		x		

Table 15. North Powder Drainage Area – Percentage of Relevant Topics Within Timeframe.

	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Biology	Climato-logical Data	Economy & Industry	Est. Cost
	82%	55%	36%	73%	27%	45%	36%	27%

Table 16. North Powder Drainage Area – Timeframe of Relevant Topics.

	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Biology	Climato-logical Data	Economy & Industry	Est. Cost
	2000	2000	2000	2000	2000	2000	2000	2000
	1990	1990		1990	1990			
	1980				1980	1980		
	1970							
	1960	1960	1960	1960		1960	1960	1960
		1950		1950		1950		

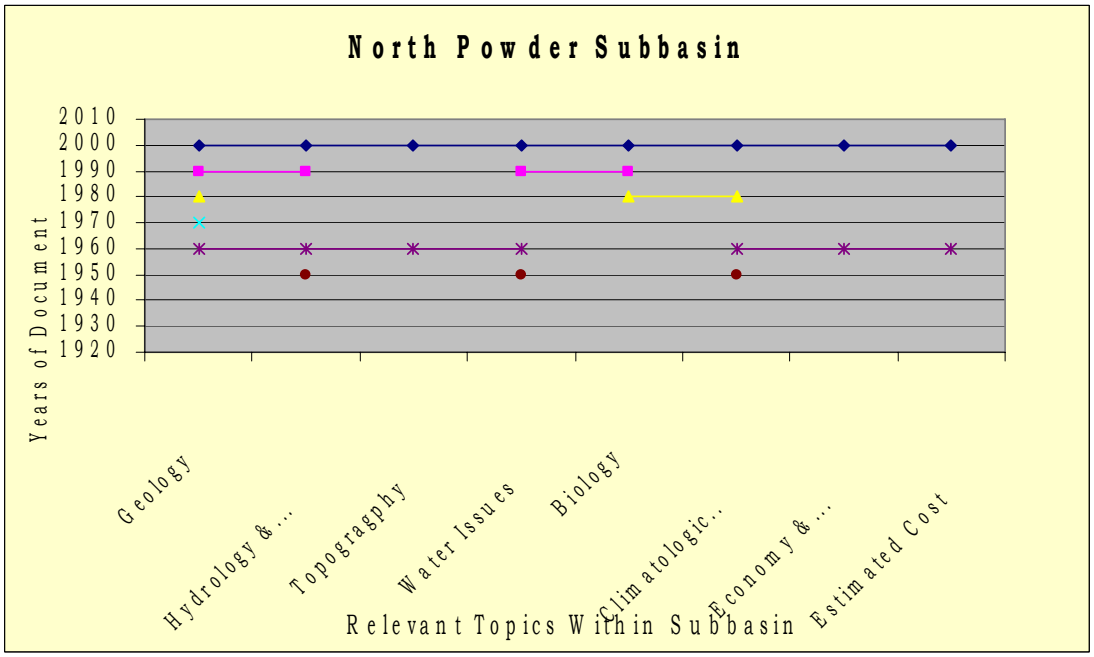


Figure 14. North Powder River Drainage Area – Timeframe of Relevant Topics

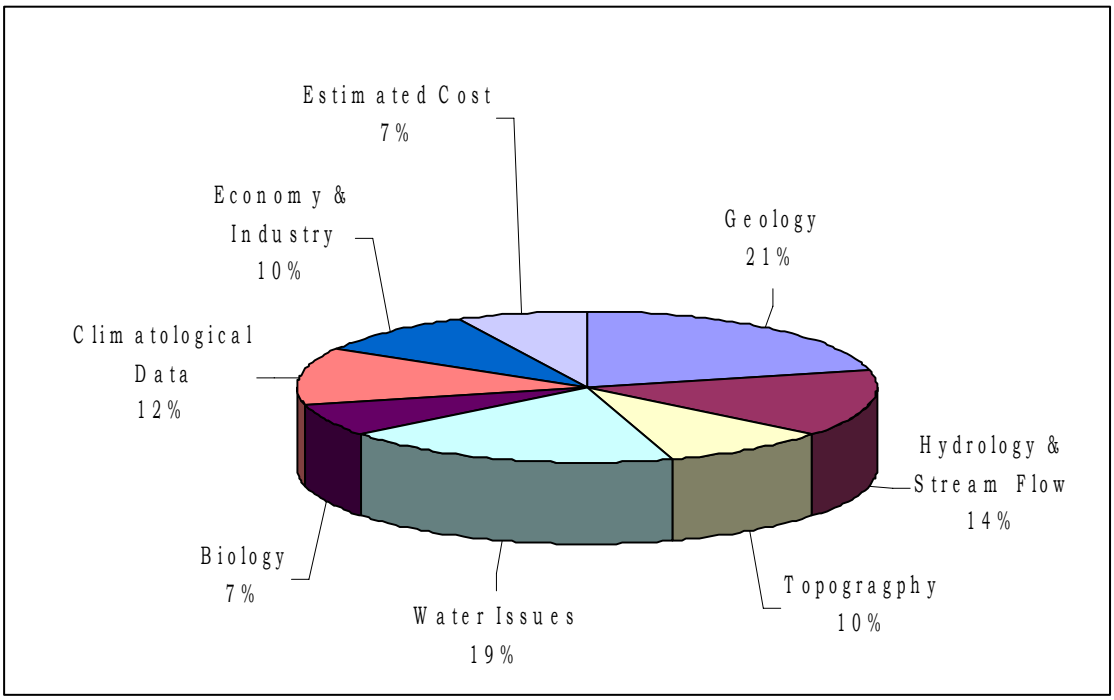


Figure 15. North Powder River Drainage Area – Percentage of Relevant Topics Within Timeframe.

12.6 PINE CREEK WATERSHED DOCUMENTS

Table 17. Pine Creek Watershed – Timeframe of Relevant Topics.

Year	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Bio-logy	Climato-logical Data	Economy & Industry	Est. Cost
2003				x	x			
2000	x	x		x	x	x	x	x
1972					x			x
1968	x	x	x	x	x		x	x

Table 18. Pine Creek Watershed – Percentage of Relevant Topics Within Timeframe .

	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Bio-logy	Climato-logical Data	Economy & Industry	Est. Cost
	50%	50%	25%	75%	100%	25%	50%	75%

Table 19. Pine Creek Watershed – Timeframe Of Relevant Topics.

	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Bio-logy	Climato-logical Data	Economy & Industry	Est. Cost
	1960	1960	1960	1960	1960	1960	1960	
					1970			1970
	2000	2000		2000	2000	2000	2000	2000
				2003	2003			

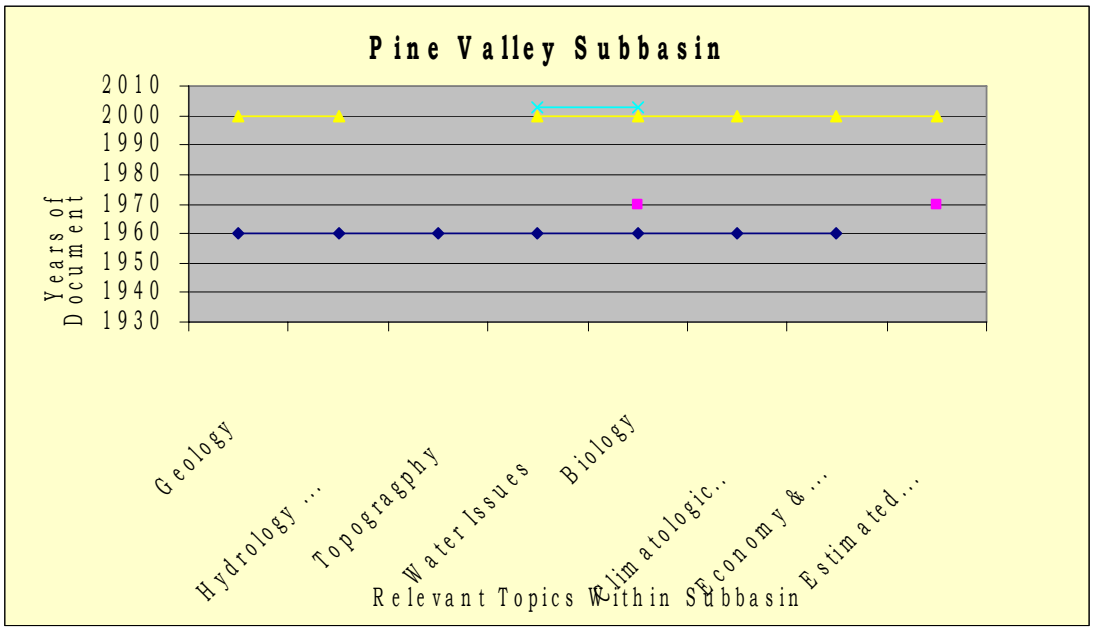


Figure 16. Pine Creek Watershed – Timeframe of Relevant Topics

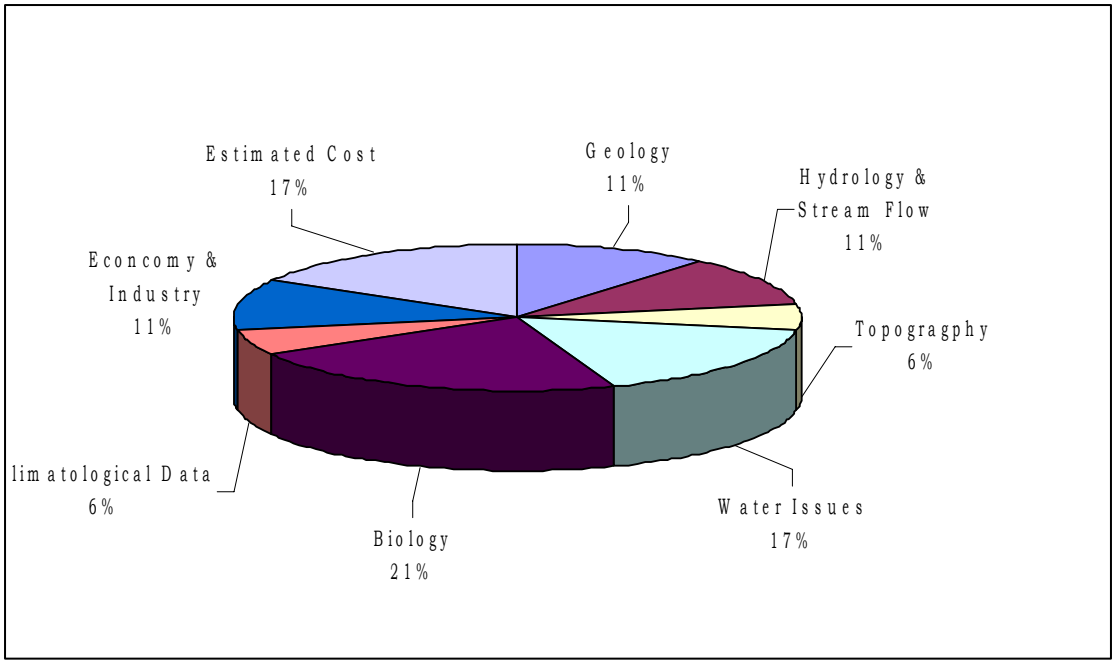


Figure 17. Pine Creek Watershed – Percentage of Relevant Topics Within Timeframe

12.7 RELATED REGIONAL DOCUMENTS

Table 20. Related Regional Documents – Timeframe of Relevant Topics.

Year	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Bio-logy	Climato-logical Data	Economy & Industry	Est. Cost
2005					x			
2005					x			
2004		x		x		x		
2003	x	x	x	x				x
2003	x	x		x	x			x
2002			x		x			x
1999				x	x	x	x	x
1998	x		x		x			
1998					x			
1997			x		x			
1997			x		x			
1996	x	x			x			
1996			x	x				
1979	x		x		x			
1979		x				x		

Table 21. Related Regional Documents – Percentage of Relevant Topics within Timeframe.

	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Bio-logy	Climato-logical Data	Economy & Industry	Est. Cost
	33%	33%	47%	33%	20%	73%	6%	27%

Table 22. Related Regional Documents – Timeframe of Relevant Topics.

	Geo-logy	Hydrology & Streamflow	Topo-gragphy	Water Issues	Bio-logy	Climato-logical Data	Economy & Industry	Est. Cost
	2000	2000	2000	2000	2000	2000		2000
	1990	1990	1990	1990	1990	1990	1990	1990
	1970		1970		1970	1970		

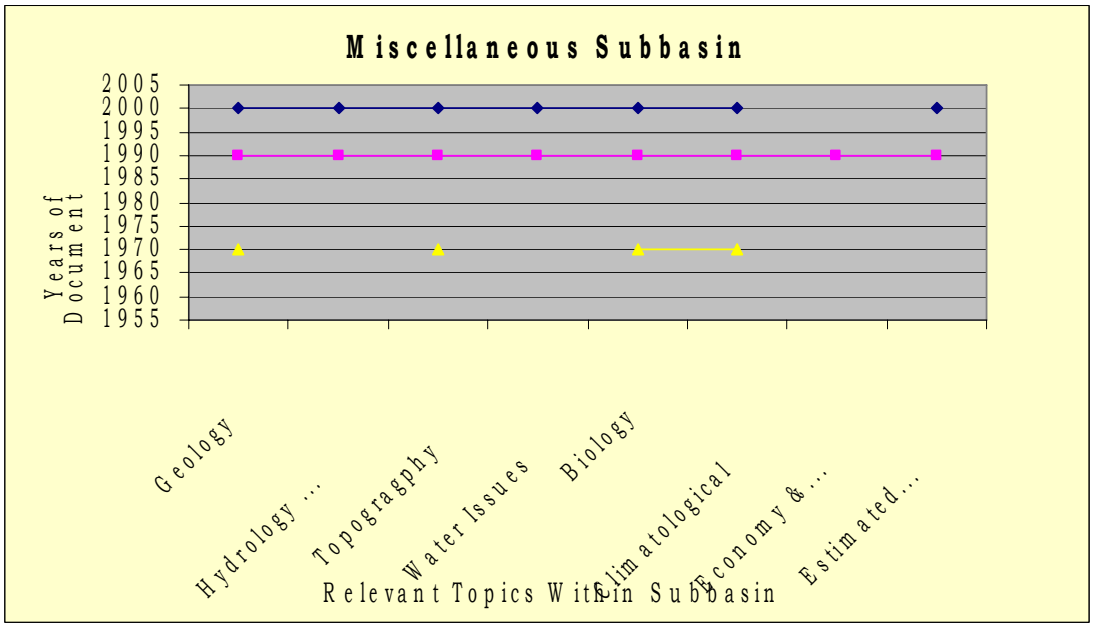


Figure 18. Related Regional Documents – Timeframe of Relevant Topics.

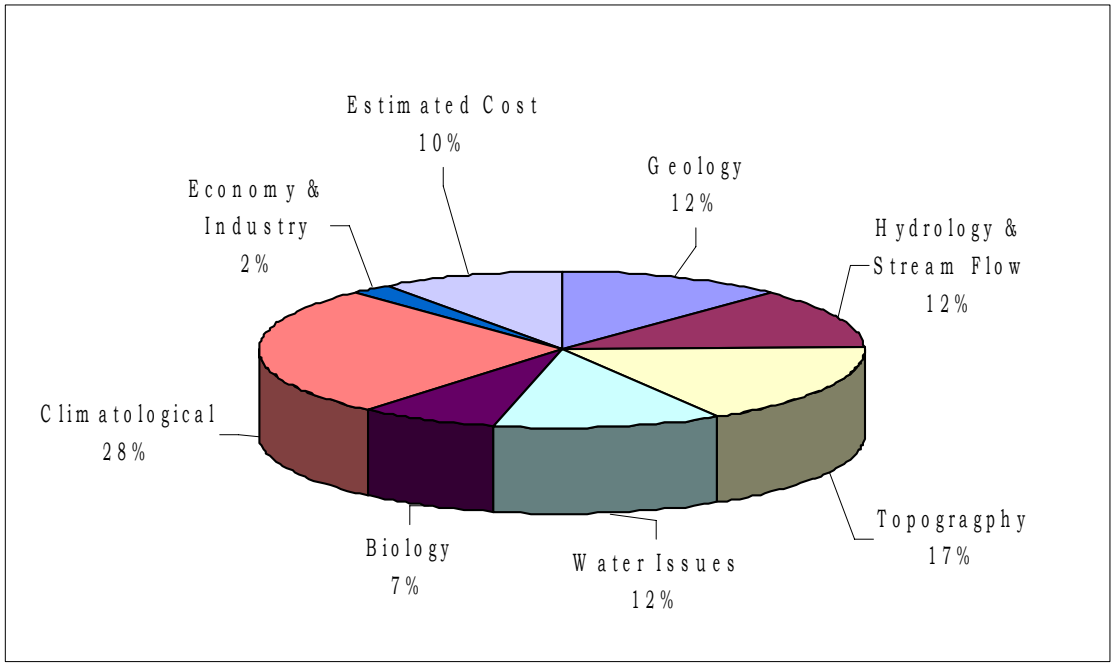


Figure 19. Related Regional Documents – Percentage of Relevant Topics within Timeframe.

13. EXISTING AND POTENTIAL DAM SITES – TABLE AND MAPS

Table 23. Existing Reservoirs of 200 Acre-Feet Capacity or More

[1/] = Potential to Expand

Storage Site Name	Height of dam	Storage (acre-feet)	Stream Diverted or Impounded	Location	Latitude	Longitude
Balm Creek Reservoir	65	2,926	Balm Cr. - Balm Cr. & Union S	T 7S/R43E/Sec 7	44.9699	117.491
Bennett Dam	22	206	East Sutton Creek & Sheep Flat	T11S/R41E/Sec 8	44.6239	117.7199
Burnt River		300	Trout Creek	T10S R36E S35	44.653	118.255
Camp Creek Reservoir	45	1,700	Camp Creek and Bull Run Creek	T13S/R38E/Sec 5	44.4654	118.0881
Clear Creek Res.-West Fork	16	257	West Fork Clear Creek	T 6S/R45E/Sec 12	45.0619	117.1508
Eagle Lake Dam	33	844	Eagle Lake	T 5S/R44E/Sec 17	45.1252	117.3421
Echo Lake Reservoir	10	300	West Eagle Creek	T 5S/R43E/Sec 21	45.117	117.4568
Fish Lake	22	825	Lake Fork Creek	T 6S/R46E/Sec 16	45.0449	117.0877
Goodrich Reservoir	65	603	Goodrich Creek	T 9S/R38E/Sec 4	44.8103	118.0586
Jimmy Creek Reservoir	42	675	Jimmy Creek	T 5S/R39E/Sec 35	45.0799	117.8936
Killamacue Reservoir	11	312	Killamacue Lake	T 8S/R37E/Sec 11	44.8752	118.146
Little Park Dam	31	280	Thorn Creek	T 6S/R41E/Sec 15	45.0428	117.678
Looking Glass Reservoir	13	527	Eagle Creek	T 5S/R44E/Sec 32	45.0827	117.363
Love Reservoir	30	920	Love – Lawrence - E. Love - W.	T 9S/R42E/Sec 24	44.7613	117.5213
Mason Dam	167	114,000	Powder River	T10S/R38E/Sec 24	44.6727	118.0005
Mehlhorn [1/] & Bassett	20	216	Clear Creek	T 6S/R46E/Sec 7	45.0586	117.13
Morfitt Reservoir	20	280	Off-Channel	T13S/R37E/Sec 20	44.4256	118.1941
Murray Reservoir	21	467	E Camp & Camp Ck Basin & La	T14S/R38E/Sec 18	44.3533	118.1056

Storage Site Name	Height of dam	Storage (acre-feet)	Stream Diverted or Impounded	Location	Latitude	Longitude
Pilcher Creek Reservoir [1/]	110	5,910	Anthony and Pilcher Creek	T 6S/R38E/Sec 16	45.0391	118.0707
Pine Creek Reservoir	18	2,100	Pine Creek	T 8S/R38E/Sec 32	44.826	118.0791
Reservoir #3	10	300	W. Fork Love Cr. +2 Gulches	T 9S/R43E/Sec 28	44.7433	117.4444
Rock Lake	28	452	Unnamed	T 8S/R38E/Sec 31	44.8229	118.1116
Salmon Creek Reservoir	41	255	Salmon Creek	T 9S/R39E/Sec 8	44.8008	117.9604
Shaw Dam & Dikes	48	504	Little, Dry, & Gussie Creeks, Trib/Powder	T 5S/R39E/Sec 31	45.0945	117.9913
Smith Lake	26	580	Powder Riv.	T 9S/R40E/Sec 15	44.7842	117.7942
Sugarloaf Reservoir [1/]	27	260	Elk Creek, Trib to	T 6S/R46E/Sec 5	45.0683	117.1146
Thief Valley Reservoir [1/]	66	17,400	Powder River	T 6S/R40E/Sec 26	45.015	117.7783
Unity Reservoir	67	50,000	Burnt River	T12S/R37E/Sec 21	44.5038	118.1807
Whited Reservoir	45	700	So. Fork of Burnt River	T13S/R36E/Sec 13	44.4423	118.2438
Wolf Creek Reservoir [1/]	125	10,800	Wolf Creek and Anthony Creek	T 6S/R38E/Sec 11	45.0524	118.0189

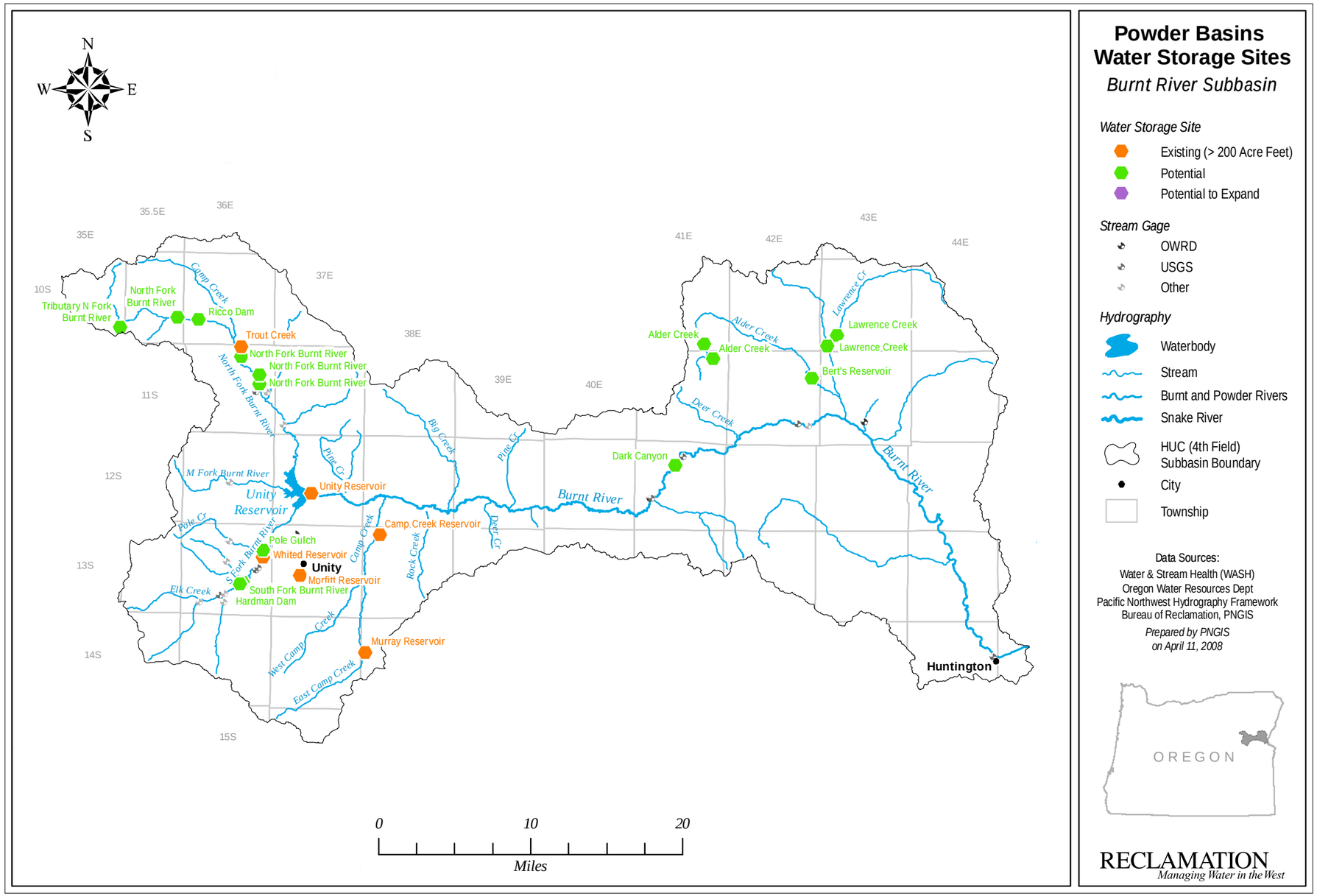
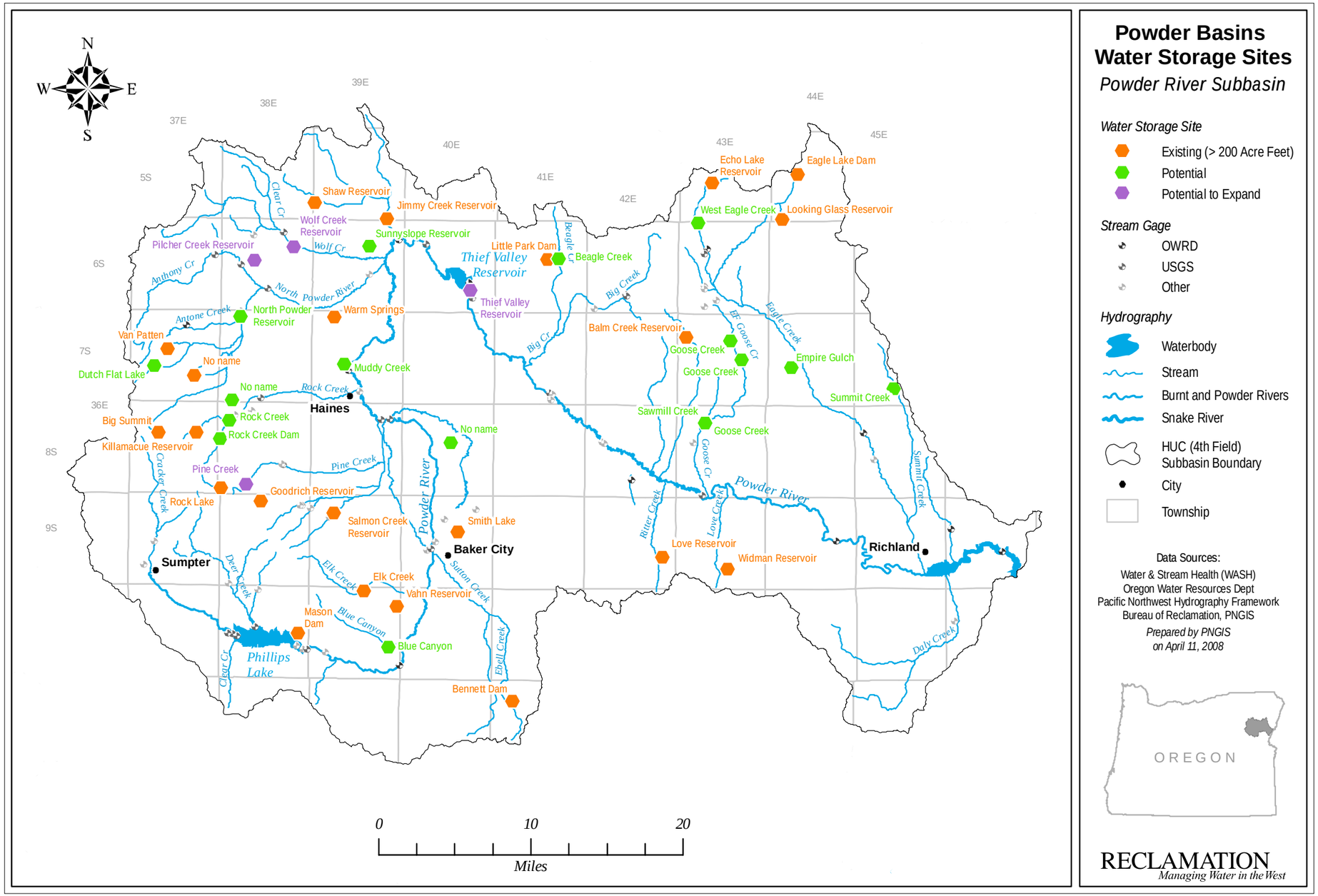


Figure 20. Burnt River Subbasin – Existing and Potential Dam Sites



Powder Basins Water Storage Sites

Powder River Subbasin

Water Storage Site

- Existing (> 200 Acre Feet)
- Potential
- Potential to Expand

Stream Gage

- OWRD
- USGS
- Other

Hydrography

- Waterbody
- Stream
- Burnt and Powder Rivers
- Snake River
- HUC (4th Field) Subbasin Boundary
- City
- Township

Data Sources:
Water & Stream Health (WASH)
Oregon Water Resources Dept
Pacific Northwest Hydrography Framework
Bureau of Reclamation, PNGIS

Prepared by PNGIS on April 11, 2008

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Figure 21. Powder River Subbasin – Existing and Potential Dam Sites

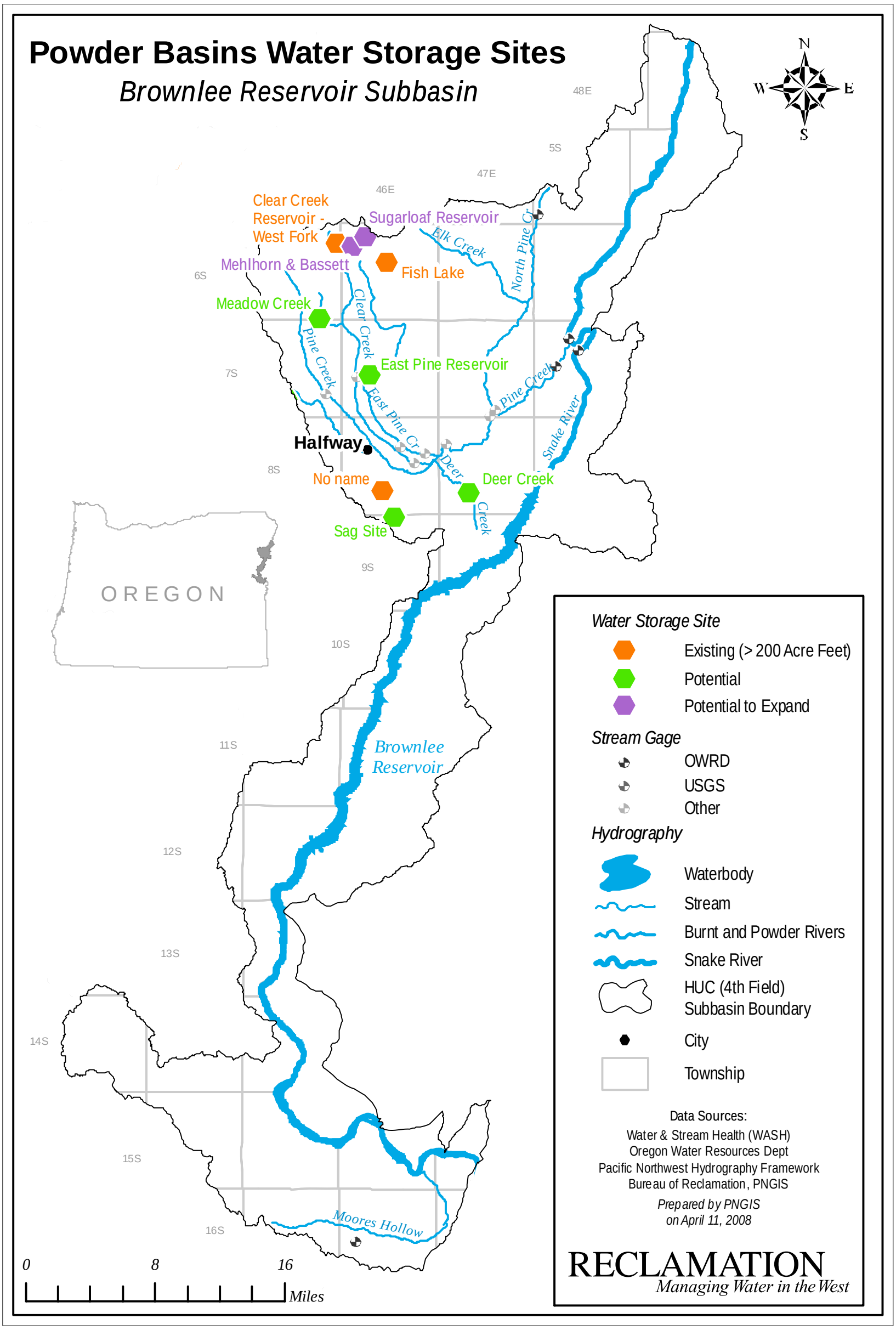

Figure 22. Pine Creek Watershed (in Brownlee Reservoir Subbasin) – Existing and Potential Dam Sites