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FINAL REPORT

MIDDLE NORTH PLATTE WATERSHED STUDY

WATERSHED MANAGEMENT PLAN

Topical Report RSI-2411

prepared for

Wyoming Water Development Commission
6920 Yellowtail Road
Cheyenne, Wyoming 82002

February 2014

RESPEC
CONSULTING & SERVICES

FINAL REPORT
MIDDLE NORTH PLATTE WATERSHED STUDY
WATERSHED MANAGEMENT PLAN

Topical Report RSI-2411

by

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February 2014

I hereby certify that this report was prepared by us or under our direct supervision and that we are duly licensed Professional Geologists and Engineers under the laws of the State of Wyoming.

Crystal M. Hocking, P.G.

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1.0 INTRODUCTION AND OVERVIEW

1.1 INTRODUCTION

In August 2011, the Natrona County Conservation District (NCCD) Board of Supervisors requested that the Wyoming Water Development Commission (WWDC) conduct a comprehensive study of the Middle North Platte Watershed and its water resources. The NCCD requested the Level I watershed study to evaluate watershed function, assess wetland and riparian conditions, develop geomorphic classifications, and identify resource concerns and water development opportunities on irrigated lands, rangelands, wetlands, and streams. In 2012, the WWDC approved funding for the watershed study and then contracted with RESPEC and its subconsultant, Anderson Consulting Engineers, Inc. (ACE), to provide technical or professional services for the Middle North Platte Watershed Study, Level I, in June 2012.

1.2 OVERVIEW

The Middle North Platte Watershed Study is a comprehensive evaluation and an initial inventory of the water and land resources within the study area. This Level I watershed study provides important information that the NCCD—the study's local sponsor, and the WWDC—the study's sponsor, could use in developing water resources and implementing conservation practices that address water and land resource concerns within the study area. This watershed study includes in-depth descriptions about needed water development projects that could provide economic, ecological, and social benefits to the state of Wyoming and its citizens.

The intent of this report, accompanied by the study's digital library and Geographic Information System (GIS) geodatabase, is to provide the results of the Middle North Platte River Watershed Study. This Level I watershed study included a review of previously conducted work contained in numerous databases, studies, and reports regarding the natural resources within the study area. Additionally, the information that was reviewed and determined to be relevant to the study's purpose was compiled into a "digital library" and a GIS dataset. Information in the digital library was combined with the data collected during the inventory effort and used to generate proposed conceptual alternatives outlined in Chapter 4.0, Middle North Platte Watershed Management and Rehabilitation Plan of this report.

1.2.1 What Is a Watershed Study?

A "watershed" is defined in the Merriam-Webster Dictionary as "a region or area bounded peripherally by a divide and draining ultimately to a particular watercourse or body of water" [Merriam-Webster, 2013]. The *Operating Criteria of the Wyoming Water Development Program*, [Wyoming Water Development Commission, 2011] describes watershed studies as the following:

> *These studies provide a detailed evaluation of an individual watershed. The studies may identify water development and system rehabilitation projects as well as address erosion control, flood control or other non-water development related environmental issues. Watershed improvement studies are an integral part of the Small Water Project Program, which has its own specific criteria. The studies may identify projects that may be eligible for the New Development, Rehabilitation, or Dam and Reservoir Programs.*

The *Operating Criteria of the Wyoming Water Development Program* describes Level I watershed studies as preliminary analyses and comparison of development alternatives although the designation of a Level I watershed study is also used for master plans, watershed improvement studies, and other water planning studies [Wyoming Water Development Commission, 2009]. However, a watershed study was best explained in an article titled, "Conservation and Watershed Studies. What's the Connection?" which appeared in the WWDC's *Water Planning News* Fall 2009 newsletter [Wyoming Water Development Commission, 2009].

> *Today, conservation by watershed is an old concept with new horizons. Watersheds have long been recognized in the western Unites States for their significant natural resources and the interrelationships found contained in land areas connected by stream systems. These relationships were recognized by John Wesley Powell from his early expeditions of the west and resulted in proposed conservation, low density open grazing, irrigation systems and state boundaries based on watershed areas.*
>
> *The conservation concept developed over time to coalesce in the early 1930's with the formation of special districts whose boundaries were often based on watersheds. At that time the relationship between stream systems and landscape function was recognized. This relationship was broadened to embrace watershed condition and quality and its response to human influences. This further provided some understanding of the historic land use effect on watershed condition and how management and restoration needs to be based on local landscape characteristics.*
>
> *Today, these relationships are embraced by the Wyoming Water Development Commission and Office through a watershed study program. On behalf of a local community sponsor, a watershed study can provide a comprehensive evaluation, analysis and description of the resources associated with a watershed and the watershed's water development opportunities. It is best stated that information related to the physical sciences is incorporated into a biological system.*
>
> *There are three prominent issues that are important considerations in a watershed information review and study. The first is surface water storage. Surface water storage is often of significant interest to a watershed community in order to address seasonal and/or annual shortages of water supply, augment late*

season stream flow to benefit riparian habitat and wildlife, address flood impacts, enhance recreation opportunities, improve water quality and steam channel stability.

Second is the evaluation of irrigation infrastructure and development of information necessary to guide its rehabilitation. Of interest to local water users are ways to improve water delivery and on-farm irrigation efficiencies often timed to address annual or seasonal shortages of water supply or irrigation water delivery issues.

Third is the enhancement of upland water resources and distribution for livestock and wildlife that allows grazing management adjustments for range resource improvement. Benefits to the watershed, through plant community invigoration, reduction of erosion and stream channel stabilization, can be achieved from water development projects being strategically implemented over the watershed. Other issues and opportunities such as making beneficial use of produced water and removal of high water demand invasive species can also be important.

A watershed study, providing management and rehabilitation plans for water storage, irrigation systems and upland water development, can help empower a community to proactively enhance their watershed. Conservation by watershed can be an effective holistic approach to embracing the natural resource challenges and opportunities facing a community. A watershed study can provide the information to meet those challenges.

The Middle North Platte Watershed Study is one of many watershed studies completed for the WWDC and the Wyoming Water Development Office (WWDO). The following is a list of completed, ongoing, and new Level I watershed studies.

- Prairie Dog Creek Watershed Study
- Popo Agie River Watershed Study
- Kirby Creek Watershed Study
- Cottonwood/Grass Creek Watershed Study
- Thunder Basin Watershed Study
- Shell Valley Watershed Study
- Clear Creek Watershed Study
- Nowood River Watershed Study
- Buffalo Creek Watershed Study
- Sweetwater River Watershed Study
- Little Snake River Watershed Study
- Badwater/Poison Creek Watershed Study
- Belle Fourche River Watershed Study
- Blacks Fork River Watershed Study
- Upper Green River Watershed Study
- Medicine Bow River Watershed Study
- Upper North Platte Watershed Study

1.2.2 Study Area

The study area for the Middle North Platte River Watershed encompasses the drainage area for the North Platte River from Pathfinder Dam and Reservoir downstream to about 15 miles east of Casper, Wyoming, where Cole Creek enters the North Platte River as shown in Figure1.1. The terms "watershed" and "study area" are used interchangeably throughout this report.

The Middle North Platte Watershed is located in the upper portion of the Pathfinder to Guernsey subbasin. The Pathfinder to Guernsey subbasin is shown in Figure 1.2 covers approximately 3.6 million acres, or about 5,600 square miles and is the second largest subbasin within Wyoming's Platte River Basin. The Middle North Platte Watershed Study Area comprises approximately 41 percent of the Pathfinder to Guernsey subbasin. The study area is primarily within Natrona County with small portions in Carbon and Converse counties. The study area covers approximately 2,323 square miles or 1,486,748 acres and includes the city of Casper, the towns of Mills and Evansville along with other small towns and rural subdivisions. Mining, energy production, ranching, irrigation, and power generation has influenced the area.

1.3 INSTITUTIONAL ISSUES IN THE MIDDLE NORTH PLATTE WATERSHED

Because the Level I watershed study area for the Middle North Platte Watershed is downstream of the Pathfinder Reservoir, it is necessary to understand the constraints and limitations for water development within the study area. Pathfinder Reservoir is one of the five largest reservoirs and waterbodies in the state of Wyoming [Jacobs and Brosz, 1993; WWC Engineering Inc., 2007]. Management of Pathfinder, Seminoe, and Alcova reservoirs influences the North Platte River, the Middle North Platte Watershed, and the water and land use activities within the study area. More importantly, this understanding is crucial in identifying potential opportunities, recommended alternatives, and proposed projects and components outlined in the Middle North Platte Watershed Management and Rehabilitation Plan, in Chapter 4.0. Sections 1.3.1 and 1.3.2 were authored specifically for the Middle North Platte Watershed Level I Watershed Study by Mr. Michael K. Purcell, Director of the WWDC in June 2012, [Wyoming Water Development Commission, 2012].

1.3.1 North Platte River Decree

The study area is located on a reach of the North Platte River located in an area between Pathfinder Dam and Guernsey Reservoir including the mainstem and tributaries entering in this reach. Lands intentionally irrigated by surface water and hydrologically connected groundwater are limited to 56,900 acres. The actual maximum acreage irrigated in this reach was 51,572 acres in 2009. Irrigated acreage is monitored and mapped at the Wyoming State Engineer's Office (SEO) in Torrington, Wyoming. This acreage limitation does not include the

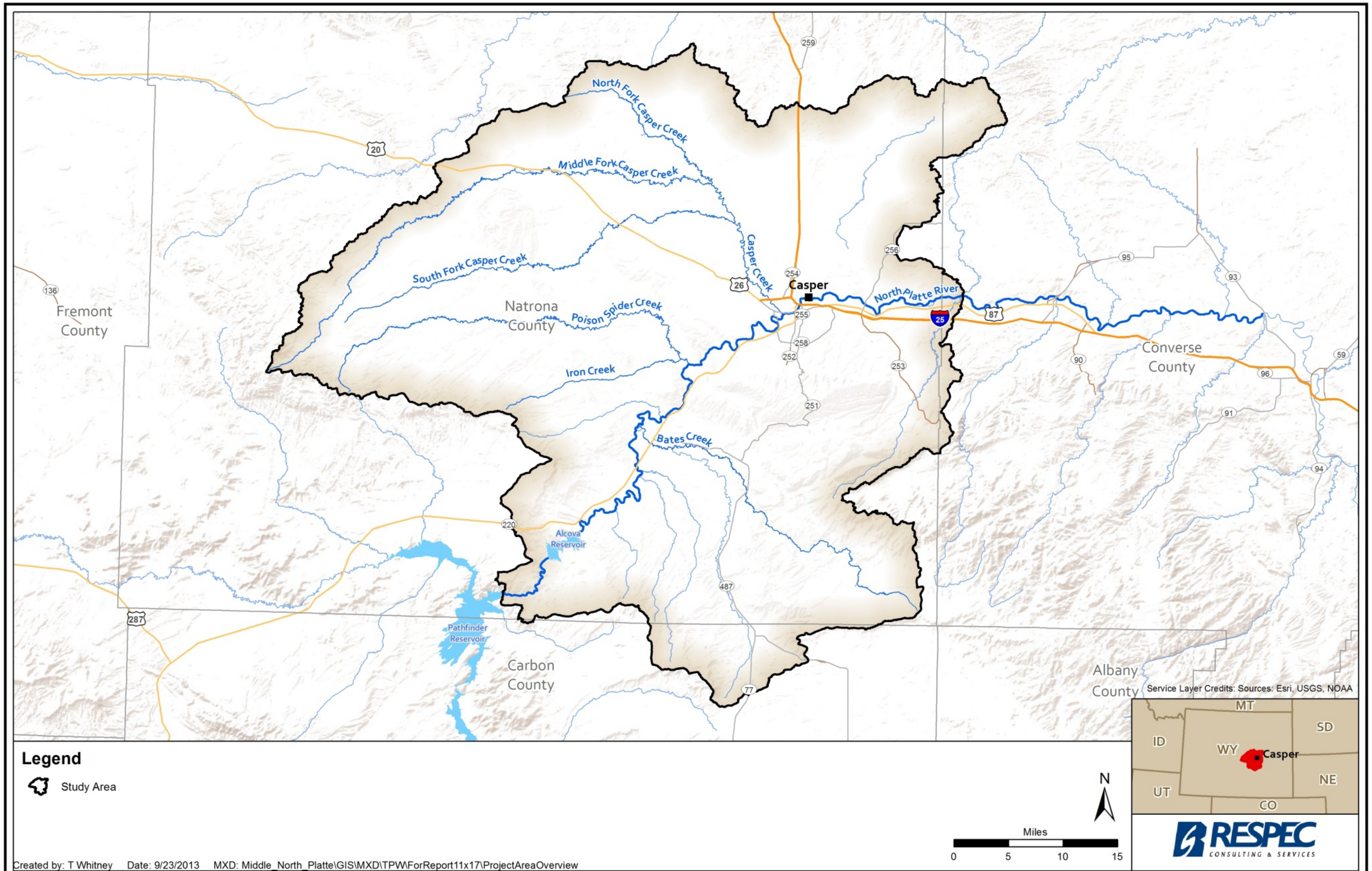

Figure 1.1. Middle North Platte Watershed Study Area.

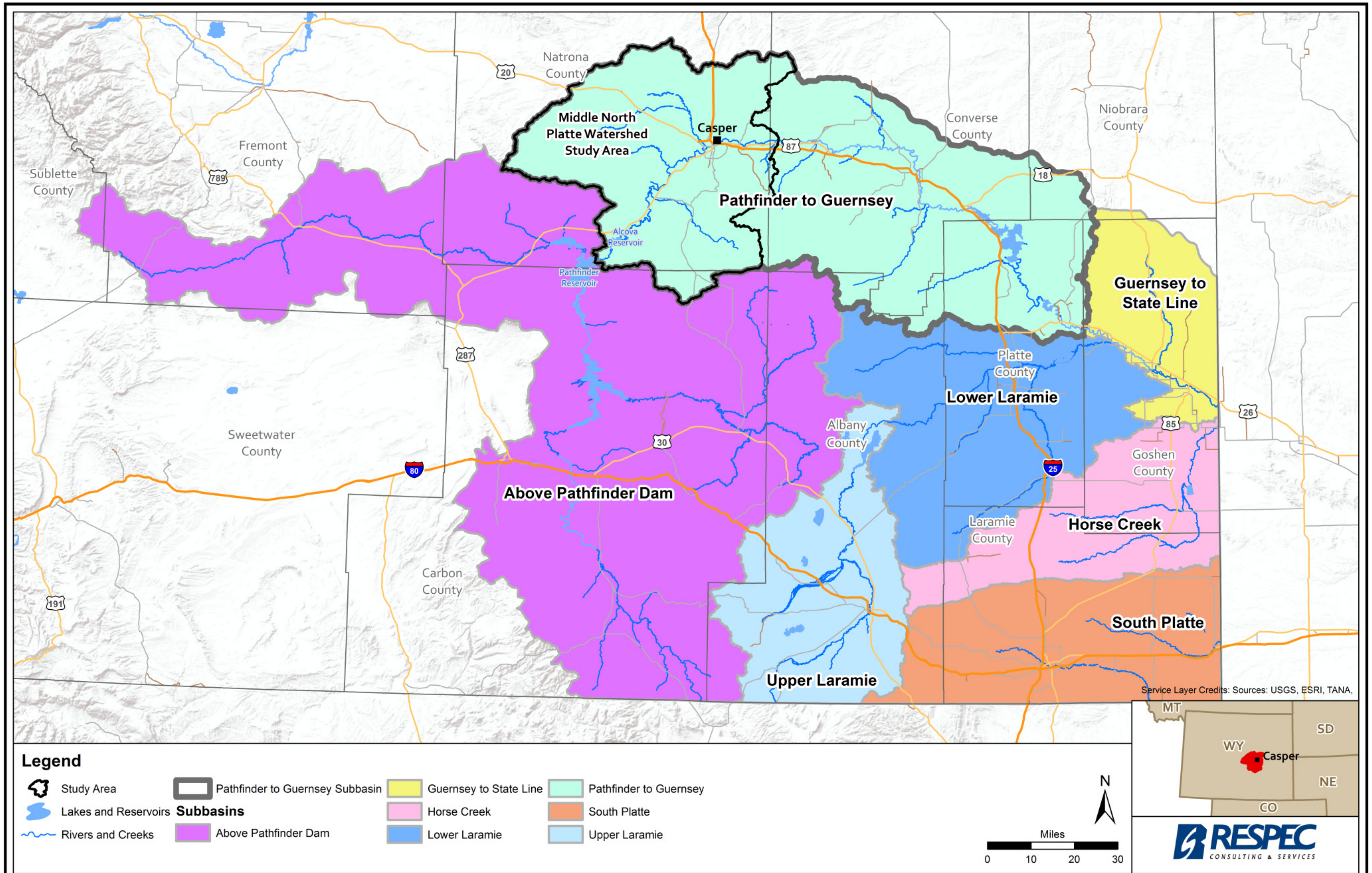

Figure 1.2. Middle North Platte Watershed Study Area Within the Pathfinder to Guernsey Subbasin.

Kendrick Project, which is operated and maintained by the Casper-Alcova Irrigation District (CAID). The Kendrick Project is limited to 24,248.23 irrigated acres in accordance with its water right. The irrigated acreage of the Kendrick Project is monitored by the U.S. Bureau of Reclamation (USBR) in Mills, Wyoming.

A hydrologically connected groundwater well is one located and constructed such that if water were intentionally withdrawn by the well continuously for 40 years, the cumulative stream depletion would be greater than or equal to 28 percent of the total groundwater withdrawn by that well. “Green area” maps have been developed and are available in the WWDO offices. These maps depict the areas in which the groundwater is deemed non-hydrologically connected and, therefore, well construction and groundwater use are not subject to limitations under the decree.

Water rights in this reach may be subjected to water rights administration in April for the benefit of the Inland Lakes in Nebraska with a priority date of December 6, 1904. In addition, water rights may be administered in February, March, and April for the benefit of Guernsey Reservoir with a priority date of April 20, 1923, and Glendo Reservoir with a priority date of August 30, 1951. Water rights are administered during an “allocation year” when it is forecasted that the supply for the North Platte Project (Pathfinder Reservoir, Guernsey Reservoir, and the Inland Lakes) is less than 1,100,000 acre-feet in any one year. During an allocation year, the USBR is deemed to have automatically placed a call for the benefit of the federal reservoirs. If the Wyoming State Engineer deems the call is valid, the water rights administration will be implemented.

Water rights can be administered on the mainstem of the North Platte River in an allocation year when diversions exceed 6,600 acre-feet in a 2-week period. This limitation is monitored by the SEO in Torrington. Diversions have not exceeded this limitation since the North Platte Decree was modified in 2001.

Water rights may be administered in this reach in the following manner. Storage water is released from Pathfinder Reservoir through Gray Reef Dam. Water officials apply conveyance losses to the releases to determine the amount of storage water that should arrive at the Orin gage above Glendo Reservoir. If water passing the Orin gage is less than the amount anticipated by the water officials, water rights could be administered to rectify the situation. This situation has rarely occurred and when it did occur, the situation was managed without strict water rights administration.

Consumptive use limitations were established in the Modified North Platte Decree. In this river reach, consumptive use is limited to 890,000 acre-feet for a 10-year period. The limitation is monitored as a 10-year running average. The annual consumptive use is calculated in the same manner that was used to develop the limitation. Therefore, the methodology to calculate consumptive use is unique to the situation. The annual consumptive use is calculated by the

SEO with the assistance of Mr. Bern Hinckley. More information can be obtained, if needed, by contacting Mr. Matt Hoobler, the SEO North Platte Coordinator.

1.3.2 Platte River Recovery Implementation Program

The Endangered Species Act (ESA) and the critical habitat for whooping cranes, piping plover, and least terns in the Central Platte River in Nebraska has impacted water management and development in the North Platte River Basin since the 1970s. Therefore, the states of Wyoming, Nebraska, and Colorado entered into a cooperative agreement for the Platte River Recovery Implementation Program (referred to as the "Program") with the U.S. Department of Interior (USDI). The states became interested in the Program when it became apparent that the ESA provided the U.S. Fish and Wildlife Service (USFWS) the authority to require the replacement of existing depletions until it achieved its water supply goal for the critical habitat in the Central Platte River in Nebraska. The water supply goal was 417,000 acre-feet per year. In addition, the USFWS could assess depletion fees to acquire 29,000 acres of habitat in the Central Platte River in Nebraska.

The Program serves as the reasonable and prudent alternative under the ESA for irrigation, municipal, industrial, and other water uses in place on or before July 1, 1997. Without the Program, the USFWS would use the ESA consultations required for future federal actions (permits, including renewals; funding; contracts; easements; and others) to require water users (irrigators, municipalities, industries, and others) to replace existing and proposed new depletions until the water goals were met.

The goal of the Program is to provide approximately 150,000 acre-feet of water and 10,000 acres of habitat in the Central Platte River. In addition, the states agreed to curtail new depletions that would impact the Program's water goals. In Wyoming, the North Platte River Basin is fully appropriated. In essence, this means there are more water rights than there is water in dry and some average years. Therefore, water rights with a current priority would not produce a reliable water supply. Water users seeking a reliable water supply would likely need to transfer water rights from other uses to secure that supply. Therefore, major, new depletions are curtailed under the water law, which made it easier for Wyoming to concede this point to the Program.

Each state wrote a depletion plan explaining how it would manage existing and future water depletions. The *Wyoming Depletions Plan* (referred to as the "Plan") identifies existing and new water related activities that are covered by the Program. The goal of the Plan is to provide coverage for depletions authorized by existing, valid Wyoming water rights with a priority date prior to July 1, 1997, the date negotiations began to formulate the Program. In addition, the Plan addresses new depletions if they do not exceed 20 acre-feet per year.

Water users seeking water rights in excess of 20 acre-feet per year will likely need to mitigate those depletions by retiring existing uses in the same quantities and timing as the new depletions or by providing other forms of mitigation. Mr. Matt Hoobler, the SEO North Platte Coordinator, is responsible for determining the depletions that can be covered by the Plan, identifying new depletions that will require mitigation, and approving any proposed mitigation plans required for new depletions.

1.4 STUDY ISSUES AND UNDERSTANDING

This Level I watershed study provides a comprehensive description and preliminary analysis of the Middle North Platte Watershed and concludes with the Watershed Management and Rehabilitation Plan, which is included in Chapter 4.0 of this report. The Watershed Management and Rehabilitation Plan outlines proposed practical and feasible alternatives that address water and land resource issues and concerns. The expectation of the NCCD and the WWDC was to identify water development opportunities within the study area. In developing the Watershed Management and Rehabilitation Plan, the consultant worked with the NCCD and WWDO and several study participants to address the following key issues within the watershed:

- Surface water availability and storage
- Irrigation system assessment and improvements
- Rangeland and grazing assessment and improvements
- Wetland and riparian area restoration and channel stability
- Selenium reduction and management
- Invasive and noxious weed management.

1.5 PURPOSE AND SCOPE

The primary purpose of this Level I watershed study was to combine all of the available and relevant data and information, in combination with the study-generated inventory data and information for the study area, into a GIS geodatabase and digital library. And to develop a comprehensive watershed management and rehabilitation plan outlining proposed and potential water development opportunities and watershed improvement alternatives. To accomplish this effort, the following objectives were completed:

- Foster communication among residents and landowners, the NCCD, and the WWDC.
- Solicit public participation in the watershed study.
- Inventory and evaluate the watershed with emphasis on surface water quantity and quality, and upland and riparian ecological conditions.
- Perform a geomorphic classification of the major tributaries in the study area to identify impaired reaches and improvement options to restore channel stability.

- Assess existing irrigation systems and generate rehabilitation alternatives for the irrigators participating in the study.
- Evaluate existing surface water features, storage requirements, and potential opportunities to improve water availability for livestock and wildlife.
- Prepare a watershed management and rehabilitation plan that includes problem areas and proposes improvement alternatives within the watershed.
- Identify permits, easements, and clearances necessary for plan implementation.
- Estimate costs for proposed improvement alternatives and potential projects.
- Complete an economic analysis and identify potential sources of funding.

2.0 PROJECT MEETINGS

2.1 INTRODUCTION

Public involvement and landowner participation were an important element of the Middle North Platte Watershed Study effort because of the amount and complexity of the water and land issues and concerns within the study area. Therefore, considerable emphasis and time was placed on this aspect of the study.

The public involvement effort began before RESPEC and ACE being awarded the contract in June 2012. The NCCD and the WWDO began coordinating activities in 2010 for the Sweetwater River Watershed Study, which was ongoing and encompassed the southwestern corner of Natrona County. Subsequently, the NCCD and WWDO began discussing a watershed study for the Middle North Platte Watershed because of the issues and concerns related to the North Platte River selenium total maximum daily load (TMDL).

2.2 SCOPING MEETINGS, LANDOWNER MEETINGS, AND FIELD VISITS

2.2.1 Scoping and Study Update Meetings

Scoping meetings, landowner meetings, and on-site field visits were conducted by RESPEC and ACE staff in cooperation with NCCD, WWDO, and Natural Resources Conservation Service (NRCS). Scoping meetings were coordinated by RESPEC and ACE with assistance from the NCCD, WWDO, and NRCS and typically included informal presentations conducted by RESPEC and ACE staff. Table 2.1 lists the meetings conducted during the watershed study. The objectives of the scoping meetings included the following:

- Discuss the purpose, existing data, and available information for the watershed study
- Obtain input and opinions from residents and landowners about the study area
- Identify concerns and answer questions about the area’s water and land resources
- Request participation in the study effort and coordinate inventory activities
- Present initial results and preliminary findings from the watershed study.

During the August 2012 scoping meetings in Casper and Alcova, Wyoming, RESPEC and ACE representatives made presentations, summarized study efforts, and outlined upcoming tasks. Available background information and draft maps generated by GIS data were presented to inform attendees of study progress. Questions were answered during the meetings but most of the informal discussions and question and answer sessions occurred between the attendees and representatives from RESPEC, ACE, NCCD, WWDO, and NRCS after each of the scoping meetings.

Table 2.1. Scoping, Landowner, Study, and Coordination Meetings (Page 1 of 3)

Number	Date	Type	Location
1	06/12/2012	Local Sponsor Meeting	NCCD Casper Office
2	06/26/2012	Coordination Meeting	City of Casper Office
3	06/26/2012	NCCD, Wyoming Game and Fish Department (WGFD), and University of Wyoming (UW) Meeting	NCCD Casper Office
4	06/27/2012	Local Work Group Meeting	NCCD Casper Office
5	07/10/2012	Local Sponsor Meeting	NCCD Casper Office
6	07/12/2012	Coordination Meeting	SEO Torrington Office
7	07/13/2012	Project Update/Status	CAID Mills Office
8	08/09/2012	Coordination Meeting	Natrona County Weed and Pest Office
9	08/22/2012	Scoping Meeting	Natrona County Agricultural Resource Learning Center (ARLC) Casper Office
10	08/23/2012	Scoping Meeting	Alcova School
11	08/31/2012	Landowner Meeting	Strohecker Ranch
12	09/11/2012	Local Sponsor Meeting	NCCD Casper Office
13	09/13/2012	Coordination Meeting	Bureau of Land Management (BLM) Casper Field Office
14	09/21/2012	Landowner Meeting	Two Bar Ranch
15	10/09/2012	Landowner Meeting	Morrison Property
16	10/09/2012	Landowner Meeting	Rim Rock Ranch
17	10/09/2012	Local Sponsor Meeting	NCCD Casper Office
18	10/10/2012	Landowner Meeting	Two Bar Ranch
19	10/10/2012	Landowner Meeting	Stewart Farm
20	10/10/2012	Landowner Meeting	Miles Land and Livestock Ranch
21	10/11/2012	Coordination Meeting	SEO Casper Office
22	10/11/2012	Landowner Meeting	Bentley Farm
23	10/12/2012	Project Update/Status	CAID Mills Office
24	11/04/2012	Landowner Meeting	Garrett Ranch
25	11/05/2012	Landowner Meeting	Bates Creek Cattle Company
26	11/06/2012	Landowner Meeting	Miles Land and Livestock
27	11/07/2012	Landowner Meeting	Whisler Ranch
28	11/08/2012	Landowner Meeting	Rafter Q Ranch
29	11/08/2012	Project Update/Status	Wyoming Oil and Gas Commission WYOGC
30	11/09/2012	Landowner Meeting	Cache Creek Property Farm

Table 2.1. Scoping, Landowner, Study, and Coordination Meetings (Page 2 of 3)

Number	Date	Type	Location
31	01/15/2013	Local Sponsor Meeting	NCCD Casper Office
32	01/16/2013	NCCD and WGFD Meeting	NCCD Casper Office
33	02/08/2013	Project Update/Status	CAID Mills Office
34	02/12/2013	Project Update/Status	NCCD Casper Office
35	02/21/2013	Coordination Meeting	BLM Casper Field Office
36	02/28/2013	Scoping Meeting	Natrona County ARLC Casper Office
37	02/28/2013	Scoping Meeting	Natrona County ARLC Casper Office
38	03/12/2013	Local Sponsor Meeting	NCCD Casper Office
39	04/10/2013	Local Sponsor Meeting	NCCD Casper Office
40	04/12/2013	Project Update/Status	CAID Mills Office
41	04/30/2013	Bates Creek Reservoir Company Meeting	Freeland School
42	05/14/2013	Project Update/Status	NCCD Casper Office
43	05/15/2013	Landowner Meeting	Murphy Ranch
44	06/11/2013	Landowner Meeting	M and D Land Company
45	06/11/2013	Local Sponsor Meeting	NCCD Casper Office
46	06/12/2013	Landowner Meeting	Garrett Ranch
47	06/19/2013	Landowner Meeting	3 J Ranch
48	06/19/2013	Landowner Meeting	Garrett Ranch
49	06/20/2013	Landowner Meeting	Murphy Ranch
50	06/20/2013	Landowner Meeting	Strohecker Ranch
51	06/21/2013	NCCD and City Coordination Meeting	NCCD Casper Office
52	07/18/2013	Project Update/Status	NCCD Casper Office
53	07/19/2013	Landowner Meeting	Two Bar Ranch
54	07/19/2013	Landowner Meeting	Garrett Ranch
55	08/06/2013	Landowner Meeting	Forgey Ranch
56	08/06/2013	Project Update/Status	NCCD Casper Office
57	08/07/2013	Landowner Meeting	Strohecker Ranch
58	08/08/2013	Landowner Meeting	Two Bar Ranch
59	08/08/2013	Landowner Meeting	Miles Land and Livestock Ranch
60	08/08/2013	Landowner Meeting	Murphy Ranch
61	08/08/2013	Landowner Meeting	Track Land and Cattle Company
62	08/14/2013	Landowner Meeting	Furnival Farm

Table 2.1. Scoping, Landowner, Study, and Coordination Meetings (Page 3 of 3)

Number	Date	Type	Location
63	09/09/2013	NCCD and City Coordination Meeting	NCCD Casper Office
64	09/09/2013	Project Update/Status	NCCD Casper Office
65	09/10/2013	Local Sponsor Meeting	NCCD Casper Office
66	09/25/2013	Landowner Meeting	NCCD Casper Office
67	09/26/2013	Landowner Meeting	M and D Land Company
68	11/05/2013	Landowner Meeting	Rim Rock Ranch
69	11/22/2013	Landowner Meeting	M and D Land Company
70	11/22/2013	Project Update/Status	NCCD Casper Office
71	12/17/2013	Local Sponsor Meeting	NCCD Casper Office

In February 2013, study meetings were held in Casper, Wyoming. During the meeting, RESPEC and ACE representatives presented draft maps, explained initial findings, and described potential alternatives. Draft maps were generated using GIS data to update attendees of available information and data analysis progress. Similar to previous meetings, questions were answered during the meetings but most of the discussions occurred between the attendees and representatives from RESPEC, ACE, NCCD, WWDO, and NRCS after the meetings.

In April 2013, the Bates Creek Reservoir Company held its annual meeting at the Freeland School and invited representatives from RESPEC, ACE, NCCD, WWDO, and NRCS to present preliminary findings and potential alternatives for improving Bates Creek Reservoir. WWDO personnel also provided program information and answered questions from attendees.

2.2.2 Landowner Meetings and Field Visits

After scoping and study meetings, landowners interested in participating in the watershed study typically contacted the consultant, NCCD, and NRCS staff. Individual meetings with landowners were then scheduled at landowners' residences and properties where discussions focused on land and water resource concerns and issues specific to the landowner. Usually, the landowner gave a tour of the property to the consultant, often accompanied by a representative from the NCCD or NRCS. During these property visits, initial planning and conceptual project designs were discussed for upland livestock/wildlife and irrigation water improvements.

For efficiency, field inventory efforts were often conducted in coordination with planned scoping meetings, NCCD board meetings, and landowner visits. Field activities focused on irrigation inventory, upland livestock/wildlife water opportunities, riparian and stream channel conditions, dam and reservoir assessment, and hydrologic investigations. The results from field investigations were relayed to the landowners as quickly as possible following completion of the fieldwork and analyses.

Throughout the watershed study, local ranchers, irrigators, and residents who invited the study team to visit their properties and discuss issues and concerns demonstrated extensive knowledge and valuable insight about the watershed. Because of the willingness of landowners to share information, insight, and direction, the study team was able to incorporate this knowledge and experience into the study and provide a more effective evaluation of the watershed.

3.0 WATERSHED DESCRIPTION AND INVENTORY

3.1 INTRODUCTION AND PURPOSE

There is a substantial amount of existing information about the land and water resources within the Middle North Platte Watershed Study Area. The objective of the watershed description and inventory task was to gather, review, and compile data and findings in existing databases, studies, and reports regarding the resources within the study area into a digital library and GIS geodatabase. This material was then used to describe, characterize, and summarize key features; identify problems or issues; and outline water development opportunities and improvement alternatives within the watershed.

This description and inventory section covers many of the study area's natural resources including history, land use, land ownership, transportation, irrigation, energy, climate, hydrology, geology, soils, and vegetation. This section also includes brief reviews of the current conditions of natural resources in the area. Specifically, the soil, vegetative, hydrologic, agricultural, urban, and wildlife data were mapped, analyzed, and summarized. In addition to the mapped features of the watershed, summary data tables are included for several study area characteristics.

3.2 DATA COLLECTION AND MANAGEMENT

3.2.1 Collection of Existing Information

There was a substantial amount of data, plans, and reports regarding the land and water resources collected as part of the Middle North Platte River Watershed Study. Much of this information is accessible and obtainable from local, state, and federal personnel and websites.

During this study, representatives of private, local, state, and federal organizations were contacted in person, by telephone, and by email to request available data and information and to verify and validate the datasets downloaded from websites. The following list includes many of the private, local, state, and federal organizations that were contacted:

- Natrona County Conservation District (NCCD)
- Casper-Alcova Irrigation District (CAID)
- City of Casper
- Town of Evansville
- Town of Mills
- Natrona County

- Natrona County Weed and Pest District
- Platte River Parkway Trust
- The Nature Conservancy
- Wyoming Water Development Commission (WWDC)
- Wyoming Department of Environmental Quality (WDEQ)
- Wyoming State Engineer's Office (SEO)
- Wyoming Department of Transportation (WYDOT)
- Wyoming Game and Fish Department (WGFD)
- Wyoming State Geological Survey (WSGS)
- Wyoming Geographic Information Science Center (WyGISC)
- Wyoming Oil and Gas Conservation Commission (WOGCC)
- Wyoming Office of State Lands and Investments (OSLI)
  - Wyoming State Board of Land Commissioners (SBLC)
  - Wyoming State Loan and Investment Board (SLIB)
- Wyoming Wildlife and Natural Resources Trust (WWNRT)
- U.S. Department of Agriculture (USDA)
  - Farm Service Agency (FSA)
  - Forest Service (USFS)
  - Natural Resource Conservation Service (NRCS)
- U.S. Environmental Protection Agency (EPA)
- U.S. Department of the Interior (USDI)
  - U.S. Bureau of Reclamation (USBR)
  - U.S. Geological Survey (USGS)
  - Bureau of Land Management (BLM)
  - U.S. Fish and Wildlife Service (USFWS)

3.2.2 Geographic Information System

The data collected for this study was compiled into a comprehensive GIS using ESRI's **ArcGIS** geodatabase (version 10.1) format. This geodatabase format allows the data to be visualized, analyzed, compared, and evaluated to interpret and understand it and possibly illustrate patterns and trends for many resource attributes within the study area. The geodatabase also allows for centralized data storage of spatial and tabular data. GIS helps with integrating the watershed's spatial and tabular data in conjunction with linking analytical spreadsheets, reference documents, photographs, and field inventory data. As part of the GIS, ESRI **ArcMap** documents ("mxd" file extension) were created for the various datasets and features to display figures in subsequent sections of this report and to be opened and used by **ArcGIS** software users.

The data in the study's GIS is stored in an **ArcMap 10.1 File Geodatabase**, which was selected because it improves GIS performance, allows for custom storage structure, and promotes data transferability. The GIS data are stored as a file geodatabase (Middle_North_Platte.gdb) and includes datasets that contain feature classes representing the spatial data supplied by the agencies and developed as part of the watershed study. Because the spatial data within the study's GIS changes with updated information depending on the data source, future users are encouraged to obtain the latest datasets from the agencies to update the geodatabase.

The spatial data gathered during the Middle North Platte Watershed Study were obtained from Natrona County, SEO, WDEQ, WyGISC, BLM, USGS, NRCS, WGFD, USFS, and others. In addition, spatial data were collected and developed in association with landowners and participants within the watershed during the study. Table 3.1 lists the datasets, maps, and imagery included in study's GIS. The study's GIS was used to generate most of the maps and figures included in this report. The study's GIS can be used for future planning efforts, such as completing permits, environmental assessments, program applications, and mapping tasks.

3.2.3 Digital Library

The study's digital library includes reference documents, maps, figures, spreadsheets, and images collected and produced during the study. The digital library contains a list of all available documents which can be viewed by clicking the links, searching for keywords, or browsing the library. Where feasible, the project areas of the most pertinent library documents were digitized and included in the study's GIS.

3.3 WATERSHED STUDY AREA

The study area for the Middle North Platte Watershed encompasses the drainage area for the North Platte River from Pathfinder Dam and Reservoir downstream to approximately 15 miles east of Casper, Wyoming, where Cole Creek enters the North Platte River as shown in Figure 1.1. The Middle North Platte Watershed covers approximately 2,323 square miles or 1,486,748 acres in central Wyoming. The watershed is primarily situated within Natrona County with small portions in Carbon and Converse counties and includes the cities, towns, and communities of Alcova, Allendale, Bar Nunn, Casper, Evansville, Mills, Mountain View, Natrona, Paradise Valley, and Powder River.

The Middle North Platte Watershed is located in the upper portion of the Pathfinder Dam to Guernsey subbasin which is one of six subbasins in the Platte River Basin of Wyoming. The

Table 3.1. Geospatial Data, Maps, and Imagery Contained in the Study's Geographic Information System (Page 1 of 3)

Feature Dataset	Feature Class	Summary/Description	Feature Dataset	Feature Class	Summary/Description
Boundaries	Project	Project area	**Irrigation**	caid_boundary	CAID
	Project_Buffers	Project area with buffered rings		caid_ditches	Ditches
Climate	AveMaxTemp_1981_2010	Annual maximum temperature 1981–2010		caid_ditches_irrigated_acres	Ditches
	AveMinTemp_1981_2011	Annual minimum temperature 1981–2010		caid_ditches_line_type	Ditches segmented by line type
	AvePrecip1971_2000	Average annual precipitation 1971–2000		caid_irr_acres_crops	Irrigated crop types (2000)
	AvePrecip1981_2010	Avergae annual precipitation 1981–2010		caid_irrigated_parcels	Irrigated land
	AvgJanMinTemp_1971_2000	January minimum temperature 1971–2000		caid_public_land_ownership	Public land ownership
	AvgJulyMaxTemp1971_2000	July maximum temperature 1971–2000		Irrigated_Land	Irrigated land
	AvgMeanTemp_1971_2000	Average annual temperature 1971-2000		POD	Irrigation diversions
	Weather_Stations	Subset of Wyoming weather stations		SEO_Irrigation_District	Irrigation district
Drainage	KendrickRPA	Kendrick Project Area	**Land Management**	acec_blm	Areas of critical concern
	Subwatershed	Middle North Platte Subwatershed		BLM_allotments	Grazing allotments federal lands
Ecology	cfo_weeds_points	Weed locations		cfo_Public_lotic	Proper functioning condition (PFC)
	cfo_weeds_polygons	Weed locations		ConservationDist	Conservation districts
	ecoregions	General ecosystems		rngreg_cra_based	Rangeland regions
	sagegrouse_coreareas_v3	Sagegrouse breeding and nesting habitat		nrgreg_ecoreg_based	Rangeland regions
	sagegrouse_develop_habitat	Sagegrouse habitat with existing or future development		surface_ownership	Surface and mineral ownership
	sagegrouse_habitat	5 types of sagebrush habitat	**Oil_Gas**	Oil_Gas_areal_fields	Field locations
	sagegrouse_leks_2011	Known leks in 2011		Oil_Gas_Pipelines	Major oil and gas pipelines
	sagegrouse_leks_2011_pt	Known leks in 2011		Oil_Gas_wells	Oil and gas wells
Energy	Pipelines	Oil, gas and CO_2 pipelines	**Other**	Fire_Extent	Extent of recent fires
	Power_Generation	Electric power facilities		SHPO_CRISP_MNP	Cultural sites per section
	powerlines_WY	Various powerlines		WYPDES	Discharge permits
	WindProjects	Wind farm locations	**Parcels**	NC_Ownership	Ownership parcels
Geography	Cities	Cities	**Soils**	AWC	Available water capacity
	Counties	Counties		ESN	Ecological site numberr
	States	Wyoming, Montana, South Dakota, North Dakota, Colorado		ESName	Ecological site name
	qq24k	Quarter-quarter sections		HSG	Hydrologic soil group
	sections24k	Sections		k_rockfree	k factor for rock free erosion
	tr24k	Township and range		K_WS	k factor for whole soil

Table 3.1. Geospatial Data, Maps, and Imagery Contained in the Study's Geographic Information System (Page 2 of 3)

Feature Dataset	Feature Class	Summary/Description	Feature Dataset	Feature Class	Summary/Description
Geology	Active_Mine_Permits	Active mine operations in the study area	Soils	MUN	Map unit names
	bedrock_geology	Bedrock geology clipped to project area		PMN	Parent material name
	Faults	Faults in project area		Soil_Surface_Texture	Surface texture
	GeolUnitAge	Same as bedrock geology with additional fields		SSURGO_DL_MapUnits	Map units
	landslides	Landslides		STATSGO_MUN	Generalized soils
	Mine_Pits	Sand and gravel mine permits		t_domcond	t factor for dominant condition
	surface_geology	Surficial geology		t_WA	t factor for weighted average
Habitat	AquaticCrucial_hp09	Aquatic crucial areas		WEG	Wind erodibility group
	AquaticEnhancement_hp09	Aquatic enhancement		WEI	Wind erodibility index
	CombCrucial_hp09	Aquatic and terrestrial crucial areas	Transportation	Major_Highways	Highways
	CombEnhancement_hp09	Aquatic and terrestrial enhancement		railroads	Railroads
	CriticalStreamCorridors	Critical stream corridors	Wells	SEOWells	Water wells/water rights
	KNWA	Key nongame wildlife areas		Underground Injection Control Well (UIC)	UIC wells permitted by WDEQ
	TerrestrialCrucial_hp09	Terrestrial crucial areas		WDEQ_Class_I_V	Class I and V UIC wells
	TerrestrialEnhancement_hp09	Terrestrial enhancement	Wildlife	ant05mb	Antelope migration barrier
	WGFD_Streams_blue	Blue ribbon streams		ant08mr	Antelope migration route
Hydrologic Units	HUC_10	HUC 10 watershed		ant12cr	Antelope crucial range
	HUC_12	HUC 12 subwatershed		ant12hh	Antelope herd areas
	Subbasin	HUC 8 subbasin		ant12pa	Antelope parturition area
Hydrology	AlcovaGuernsey_GreenAreas	Areas where groundwater is not hydrologically connected		ant12sr	Antelope seasonal range
	Ditches			bhs05mb	Bighorn sheep migration barrier
	Impaired_Lakes	4 impaired lakes 2008		bhs08mr	Bighorn sheep migration route
	Impaired_Lakes_draft2012			bhs12cr	Bighorn sheep crucial range
	Impaired_Streams	Wyoming streams listed on 303d list in 2008		bhs12hh	Bighorn sheep herd areas
	Impaired_Streams_draft2012			bhs12pa	Bighorn sheep parturition area
	MNP_Streams_Rosgen			bhs12sr	Bighorn sheep seasonal range
	nhdflowline	Flowlines		elk05mb	Elk migration barrier
	nhdwaterbody	Waterbodies		elk08mr	Elk migration route
	Reaches	North Platte River (reaches)		elk12cr	Elk crucial range
	Spring_BLM	BLM Springs to nearest Q-Q		elk12hh	Elk herd areas
	Springs_Seeps	USGS springs and seeps		elk12pa	Elk parturition area

Table 3.1. Geospatial Data, Maps, and Imagery Contained in the Study's Geographic Information System (Page 3 of 3)

Feature Dataset	Feature Class	Summary/Description	Feature Dataset	Feature Class	Summary/Description
Hydrology	TMDL_Lakes	Lakes modeled as part of TMDL	Wildlife	elk12sr	Elk seasonal range
	TMDL_Streams	Streams modeled as part of TMDL		mdr05mb	Mule deer migration barrier
	USGS_Gages	9 USGS gages in watershed		mdr08mr	Mule deer migration route
	Wetlands	Wetlands and riparian		mdr12cr	Mule deer crucial range
Rasters	elev_ft	Digital elevation model (DEM) elevation in feet		mdr12hh	Mule deer herd areas
	elev_m	DEM elevation in meters		mdr12pa	Mule deer parturition area
	gaplc_wy	Land cover		mdr12sr	Mule deer seasonal range
	Hillshade	Hillshade (of elev_ft)		moo05mb	Moose migration barrier
	NLCD_2001	2001 land use		moo06mr	Moose migration route
	NLCD_2006	2006 land use		moo12cr	Moose crucial range
	Slope	Slope (of elev_ft)		moo12hh	Moose herd areas
	Soil_loss	Soil loss in tons/acre/yr using RUSLE		moo12pa	Moose parturition area
Tables	BLM_allotments_sum_stats	Summary stats by field office		moo12sr	Moose seasonal range
	BLM			rmg12cr	Rocky mountain goat crucial range
	landcover_sum_stats	Summary stats by NVC_Class type		rmg12hh	Rocky mountain goat herd area
	NHDFCode	Table of Fcode Types		rmg12pa	Rocky mountain goat parturition area
	NLCD_Sum_Stats	Summary stats for 2006 NLCD by description		rmg12sr	Rocky mountain goat seasonal range
	own_county	Ownerships type by county		wtd05mb	Whitetail deer migration barrier
	owner_sum_stats	Summary statistics by type		wtd06mr	Whitetail deer migration route
				wtd12cr	Whitetail deer crucial range
				mtd12hh	Whitetail deer herd areas
				wtd12sr	Whitetail deer seasonal range

Platte River Basin drains the central to south-southeast portion of the state and covers almost one-quarter of Wyoming. The Middle North Platte Watershed Study Area comprises approximately 41 percent of the Pathfinder to Guernsey subbasin and is shown in Figure 1.2. The Pathfinder to Guernsey subbasin covers approximately 3.6 million acres, or approximately 5,600 square miles and is the second largest subbasin within Wyoming's Platte River Basin.

The Middle North Platte Watershed is approximately 60 miles long and 60 miles wide. The study area is bounded as follows: on the north by the Salt Creek drainage and the northeast by the Dry Fork Cheyenne drainage; on the northwest by the South Fork Powder River drainage and on the southwest by the Sweetwater River drainage and the Rattlesnake Range; on the south by the Pathfinder Dam and Reservoir, Little Medicine Bow drainage, and Shirley Mountains and Basin; and on the east by the Deer Creek and Sand Creek drainages and the Deer Creek Range.

The North Platte River and major tributaries, Bates Creek, Bolton Creek, Casper Creek, Muddy Creek, Poison Spider Creek, Poison Spring Creek, are in the watershed. The study area begins where the North Platte River flows out of Pathfinder Reservoir and ends after the confluence of Muddy Creek and before Cole Creek enters the river. The North Platte River flows from Pathfinder Dam northeasterly for 63 miles to Casper and then flows easterly for 19 miles. Of the 4,797 stream miles in the study area, approximately 566 miles are classified as perennial.

3.4 LAND USES AND ACTIVITIES

3.4.1 History of the Study Area

Approximately 9 thousand to 12 thousand years ago, humans arrived in central Wyoming evidenced by a variety of sites in Natrona County where archaeologists have excavated and located bison jumps, butchering sites, and areas where supplies of rocks provided materials for tools [Hunt, 2011]. Many Native American tribes (including the Lakota, Cheyenne, Arapaho, Crow, and Shoshone) hunted and passed through Natrona County. The western portion of the county was the Shoshone's home territory [Hunt, 2011].

Fur trappers, traders, and explorers were the first Europeans to visit the area in the late 1700s and early 1800s. Mr. Robert Stuart, a partner in Mr. John Jacobs Astor's fur company, and his company of men built a cabin near Bessemer Bend in the fall of 1812 and left a few weeks later when a group of Arapahos frightened them into moving out of the area [Hunt, 2011].

The North Platte River has had an historical impact on the settlement of Casper and Natrona County, with the establishment of ferry crossings and bridges on the North Platte River for the Oregon, Mormon, and California trails near present-day Casper [Larson, 1977; Hunt, 2011; CH2M Hill, 1982]. To keep the trails open, the U.S. Army posted the first company of troops near Richard's Bridge during the fall of 1855 [Hunt, 2011]. Fort Caspar, previously known as Platte Bridge Station, named for Caspar Collins, a lieutenant killed in 1865, was used from 1858 until 1867 to protect fur traders and overland travelers, while safeguarding a transcontinental mail route, a stagecoach line, and a telegraph station [Larson, 1977; Hunt, 2011; Wyoming State Historic Preservation Office; 2013].

The Homestead Act of 1862 and the Desert Land Act of 1877, which expanded the Homestead Act, and the construction of the Union Pacific Railroad had a great impact on Wyoming and Natrona County by opening up settlement of farm and ranch lands and providing access to cattle markets via the transcontinental railroad [Hunt, 2011]. On July 25, 1868, the U.S. Congress divided the Dakota Territory along with the eastern parts of Idaho and Utah to create the Territory of Wyoming. Cattle and sheep ranching operations were established in Natrona County from the late 1870s through the 1890s. Casper became a main shipping depot for the sheep and cattle ranches. To supply adequate livestock forage and water, stock and irrigation development began in the 1880s. Cattle and sheep ranching both have become major agricultural industries within the study area. Subsequently, a number of towns emerged in Natrona County, which was divided from Carbon County in 1890. Bessemer was platted in 1888 and the town of Casper was incorporated in 1889 [Hunt, 2011].

Casper is the second largest city in Wyoming. Casper, Bar Nunn, Evansville, and Mills had a population of 63,534 in 2010. Since 1970, the population of Casper, Bar Nunn, Evansville, and Mills has increased over 50 percent. Natrona County is the second most populated area in Wyoming with a population of 75,450 in 2010. Mining and oil production also have long histories in Natrona County, Casper, and the surrounding area. The Salt Creek Oil Field, approximately 40 miles north of Casper, was discovered in 1889 [Bureau of Land Management, 2007]. Soon after, an oil refinery was built in Casper and the nearby Teapot Dome oil field was discovered. Oil and gas have been a major influence on the area's economy and growth.

Irrigation in the study area dates to the 1880s. The earliest water rights were filed on the North Platte River, Bates Creek, Beaver Creek, Corral Creek, Elkhorn Creek, Garden Creek, Muddy Creek, Stinking Creek, and Wolf Creek [Wyoming State Engineer's Office, 2013]. In 1902, with the passage of the Newlands or Reclamation Act, the North Platte River, from its headwaters in northern Colorado through Wyoming and into Nebraska, was investigated for possible water storage sites and the Pathfinder Dam and Reservoir was authorized 1904 as part of the North Platte Project [Autobee, 1996; Klajic, 2000]. Also in 1904, the Bureau of Reclamation first began plans for the Casper Canal, for irrigation delivery to the Kendrick Project (originally the Casper-Alcova Project) [Klajic, 2000; Anderson Consulting Engineers, Inc., 2008].

3.4.2 Land Ownership

The study area covers approximately 2,323 square miles or 1,486,748 acres in central Wyoming. Land management within the watershed consists of 58.2 percent of parcels or approximately 865,287 acres under privately ownership, 30.8 percent of parcels or 457,918 acres managed by federal agencies, and 10.5 percent of parcels or 155,663 acres owned by the state of Wyoming. Water covers approximately 7,880 acres or 0.5 percent of the study area. Ninety-five percent of the study area is located within Natrona County with 2 percent and 3 percent of the study area in Converse and Carbon counties, respectively. The BLM manages 454,435 acres or 99 percent of the federal lands within the watershed while the USFS and the USFWS manage the remaining 3,483 acres or 1 percent of the Middle North Platte Watershed.

The distribution of ownership by type within each county is shown in Table 3.2. In addition to the generalized categories of surface land ownership, parcel data from the Natrona County Assessor were collected and included in the study's geodatabase. Statewide land ownership spatial and tabular data were obtained from the BLM and incorporated into the study's geodatabase. Figure 3.1 displays the ownership percentages within the study area.

Table 3.2. Land Ownership by County Within the Study Area

County	Federal		State		Private		Total	
	Sq. Mi.	%	Sq. Mi.	%	Sq. Mi.	%	Sq. Mi.	%
Carbon	49.5	64.9	6.9	9.1	19.8	26.0	76.2	3.3
Converse	14.0	30.5	5.7	12.3	26.3	57.2	46.0	2.0
Natrona	651.2	29.6	230.5	10.5	1,306.9	59.4	2,200.8	94.7
Total	**714.8**	**30.8**	**243.0**	**10.5**	**1,353.0**	**58.2**	**2,323.0**	**100.0**

Sq. Mi. = square miles

3.4.3 Transportation and Energy Infrastructure

Transportation is concentrated around Casper, Evansville, and Mills, including Interstate 25 and U.S. Highway 87 from the north and east. U.S. Highway 20/26 runs east-west through Casper. State highways are located throughout the study area with various other local roads and unimproved trails. The Burlington Northern Santa Fe (BNSF) Railway transfer yard and railroad lines are located north of Interstate 25 east of Casper, and U.S. Highway 20/26 west of Casper. Major roads and railroads in the study area are shown on Figure 3.2.

Power generation within the study area consists of two hydro facilities near Alcova Reservoir and one wind facility east of Casper. Other wind facilities and a coal facility are east of the study area and several power transmission lines traverse the study area. Power generation and power transmission lines in and near the study area are shown on Figure 3.3. There are numerous pipelines within the study area for carbon dioxide, crude oil, water, natural gas, and fuel products as shown on Figure 3.4. These maps of the energy and power lines that go across the study area are general estimates of the locations and alignment.

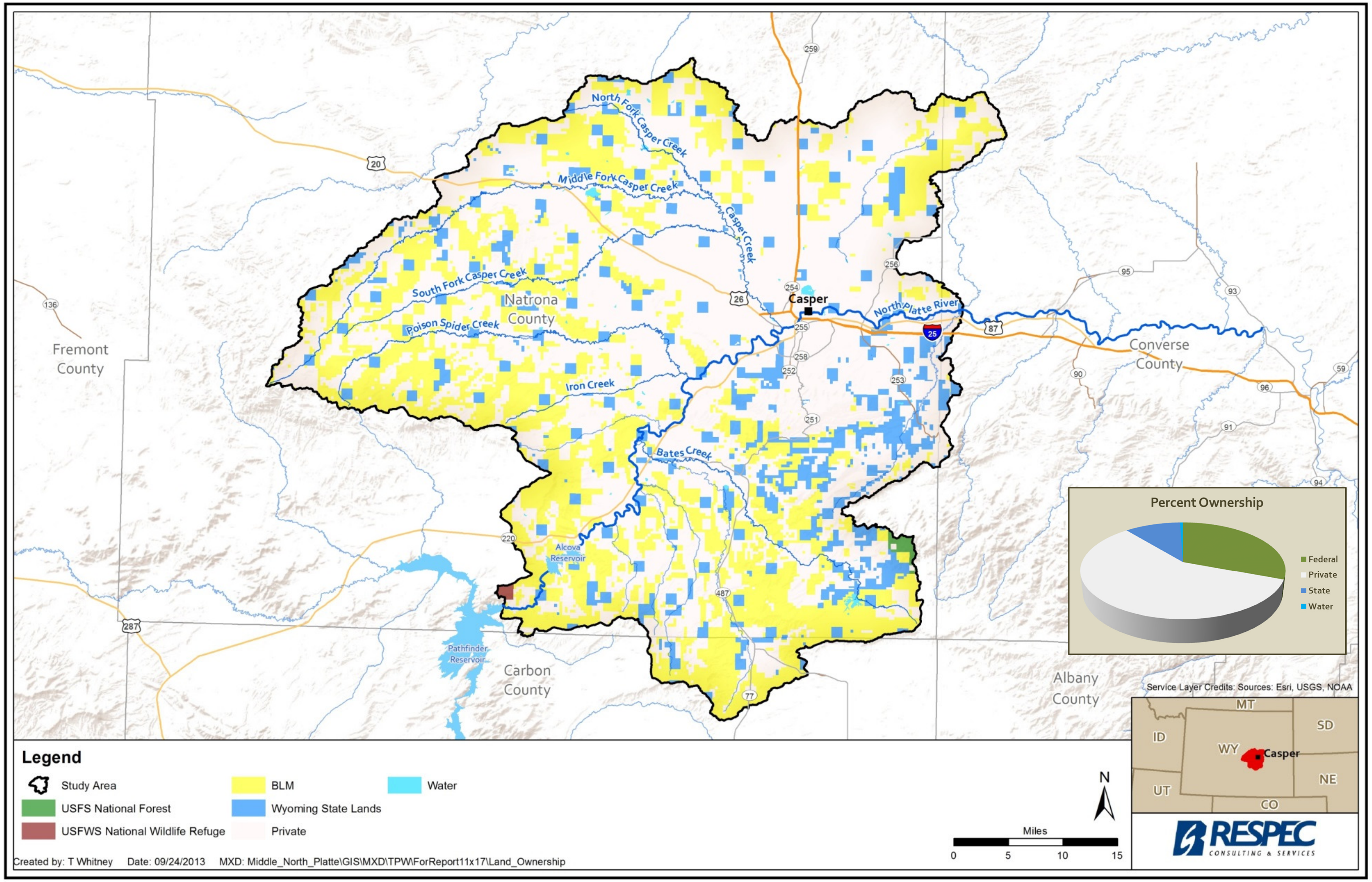

Figure 3.1. Categories of Land Ownership Within the Study Area.

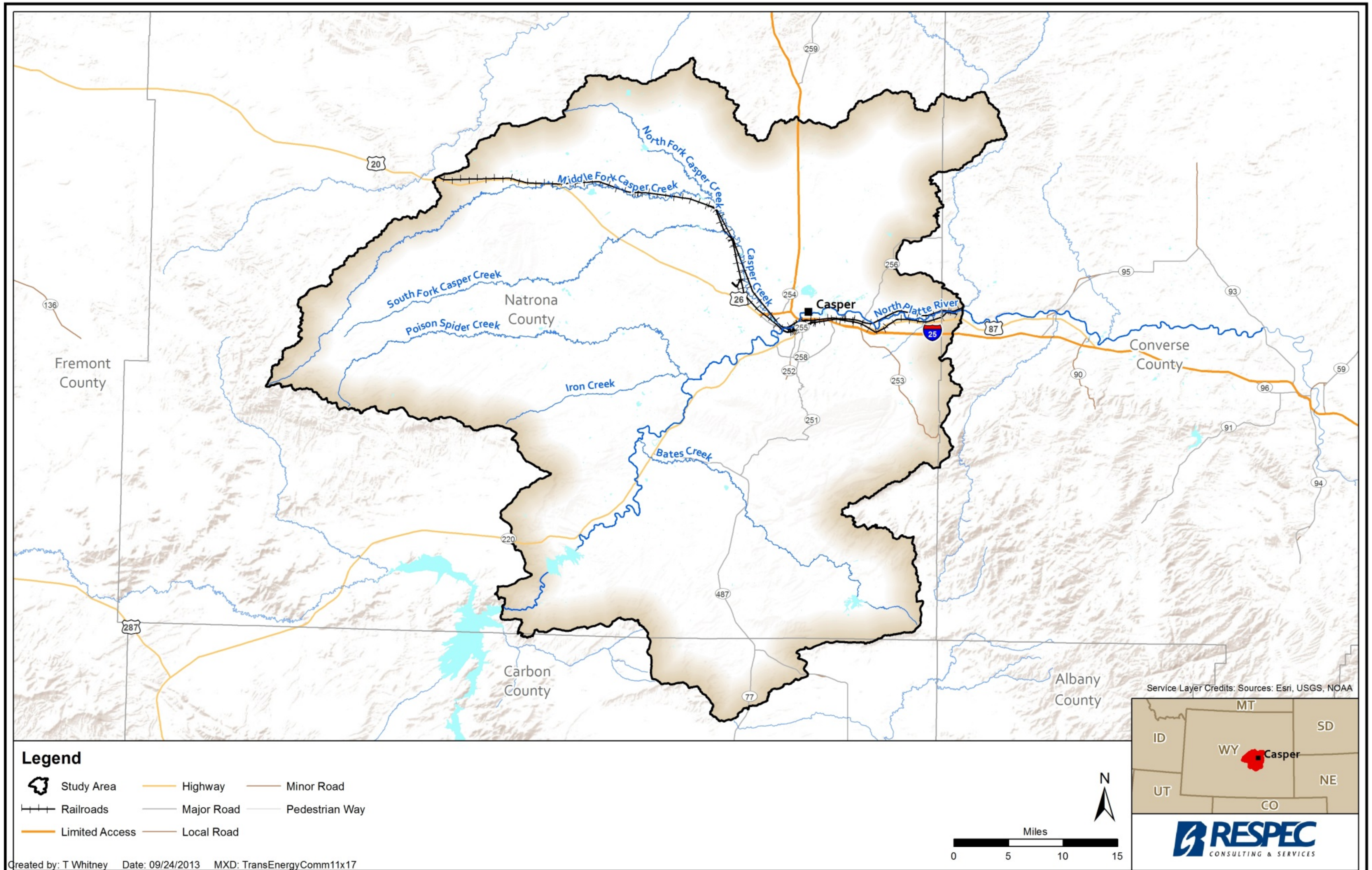

Figure 3.2. Infrastructure Features in the Study Area.

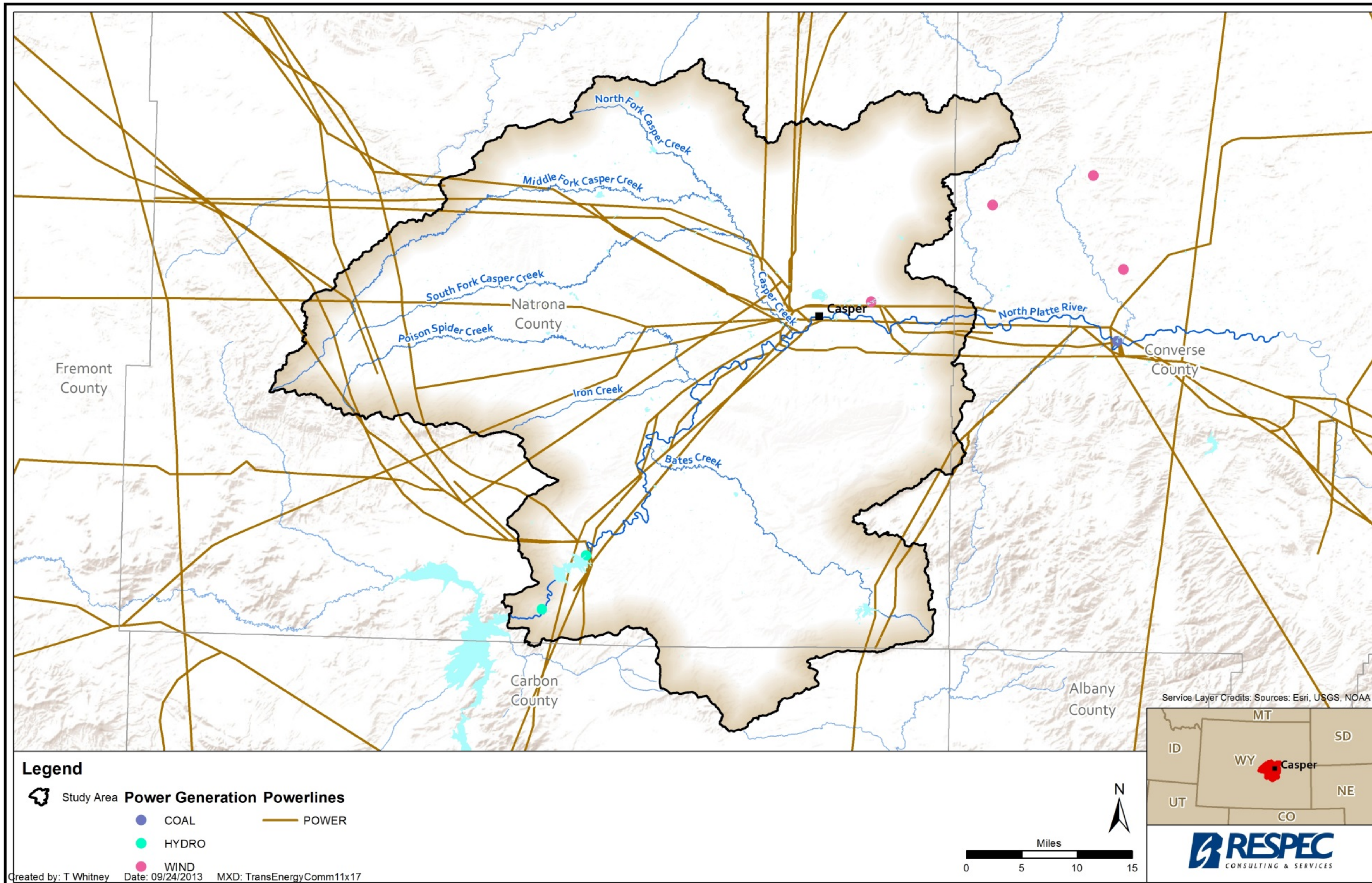

Figure 3.3. Power Generation and Transmission Lines Within the Study Area.

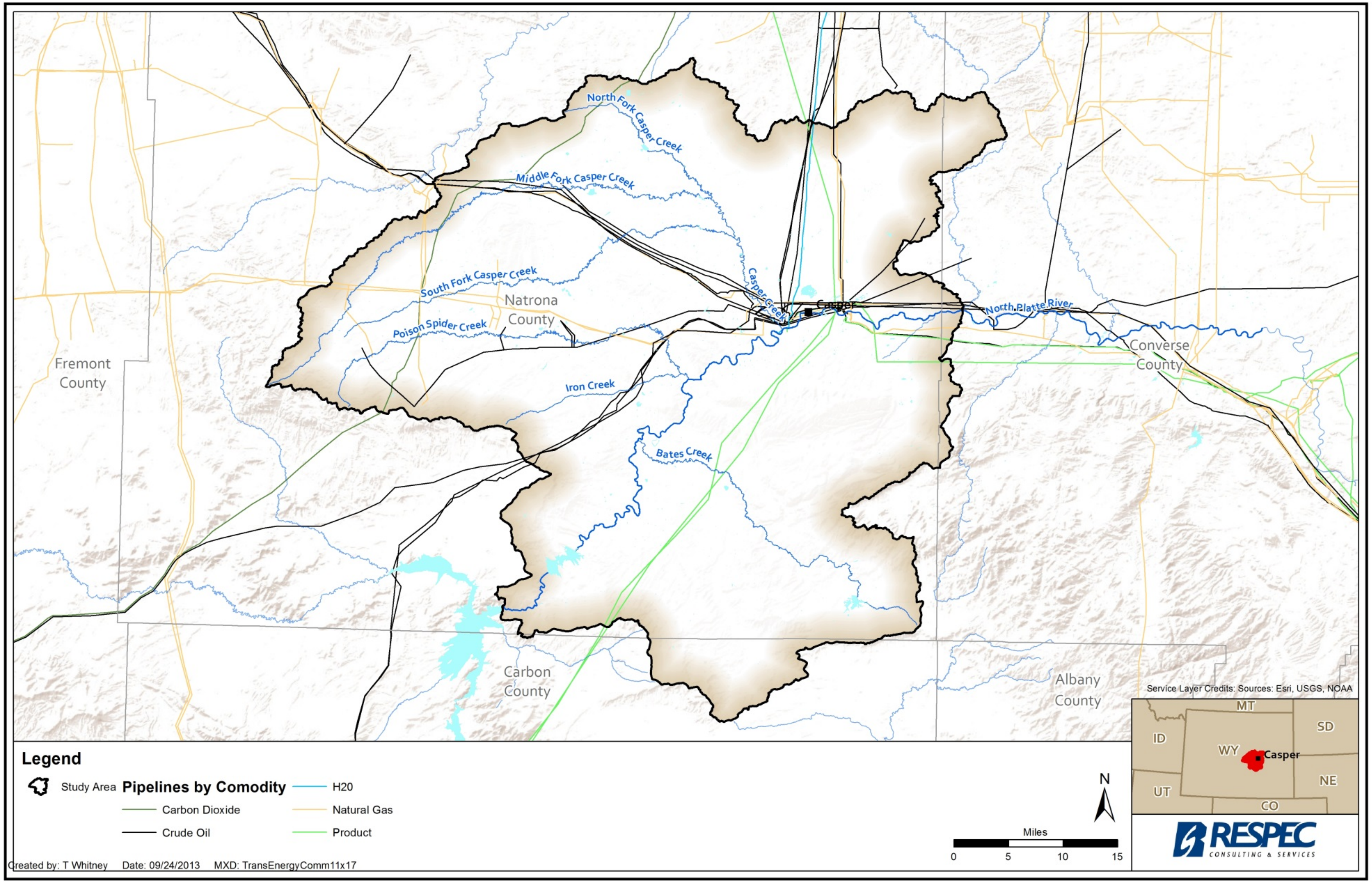

Figure 3.4. Pipelines Within the Middle North Platte Watershed Study Area.

Datasets such as streets and roads within the study area are not shown in the figures because of the resolution needed to display the data. The datasets for streets and roads were provided by Natrona County in the study's GIS geodatabase for use by the NCCD in support of future project planning efforts.

3.4.4 Irrigation

Irrigation within the study area is primarily agricultural use. Based upon evaluation of the irrigated acreage provided by the WWDO, approximately 35,061 acres of irrigated lands comprises 2.4 percent of the study area as shown in Figure 3.5. Of the 35,061 irrigated acres, approximately 34,774 acres or 99.2 percent of the irrigated parcels are in Natrona County with the remaining 287 acres or 0.8 percent of irrigated parcels are in Converse County. There were no irrigated parcels in Carbon County within the study area. Additionally, four golf courses with approximately 400 acres of irrigated turf have independent permitted irrigation supplies and use municipal water within the study area [Trihydro, 2006].

Approximately 24,248 acres or 69 percent of the irrigated lands in the study area are within the CAID, which was formed with the creation of the Kendrick Project by the USBR. The remaining 10,813 acres or 31 percent of the irrigated lands in the study area are located outside of the CAID and primarily located along Bates Creek, Corral Creek, Elkhorn Creek, Muddy Creek, and the North Platte River. The irrigated acres located within the study area are listed by subwatershed (HUC10) in Table 3.3. The crops primarily grown on irrigated lands within the study area include alfalfa, hay, and small grains such as oats and barley.

3.4.4.1 Kendrick Project

In 1904, the USBR conceived plans for the Casper Canal to deliver irrigation water to the Kendrick Project [Klajic, 2000; Anderson Consulting Engineers, 2008]. The USBR approved the North Platte Project in 1905 and the Kendrick Project in 1933 to supply much needed irrigation water in Wyoming and Nebraska [Autobee, 1996; Klajic, 2000]. However, work did not commence until 1935, when the USBR allocated funds for irrigation and hydropower facilities on the North Platte River. Alcova Reservoir, which supplies most of the water for irrigation in the CAID was completed in 1938 [Klajic, 2000; Anderson Consulting Engineers, 2008]. The Kendrick Project encompasses over 123,507 acres from Alcova Reservoir north to Casper between the North Platte River and the Casper Canal. However, the irrigated acres within the Kendrick Project are limited to 24,248 acres [Wyoming Water Development Commission, 2012]. The Kendrick Project conserves North Platte water for irrigation and for power generation [Anderson Consulting Engineers, Inc., 2008].

3.4.4.2 Casper Alcova Irrigation District

The CAID is located along the west and north side of the North Platte River from Alcova Dam to northwest of Casper and Mills. The first irrigation water was delivered through the

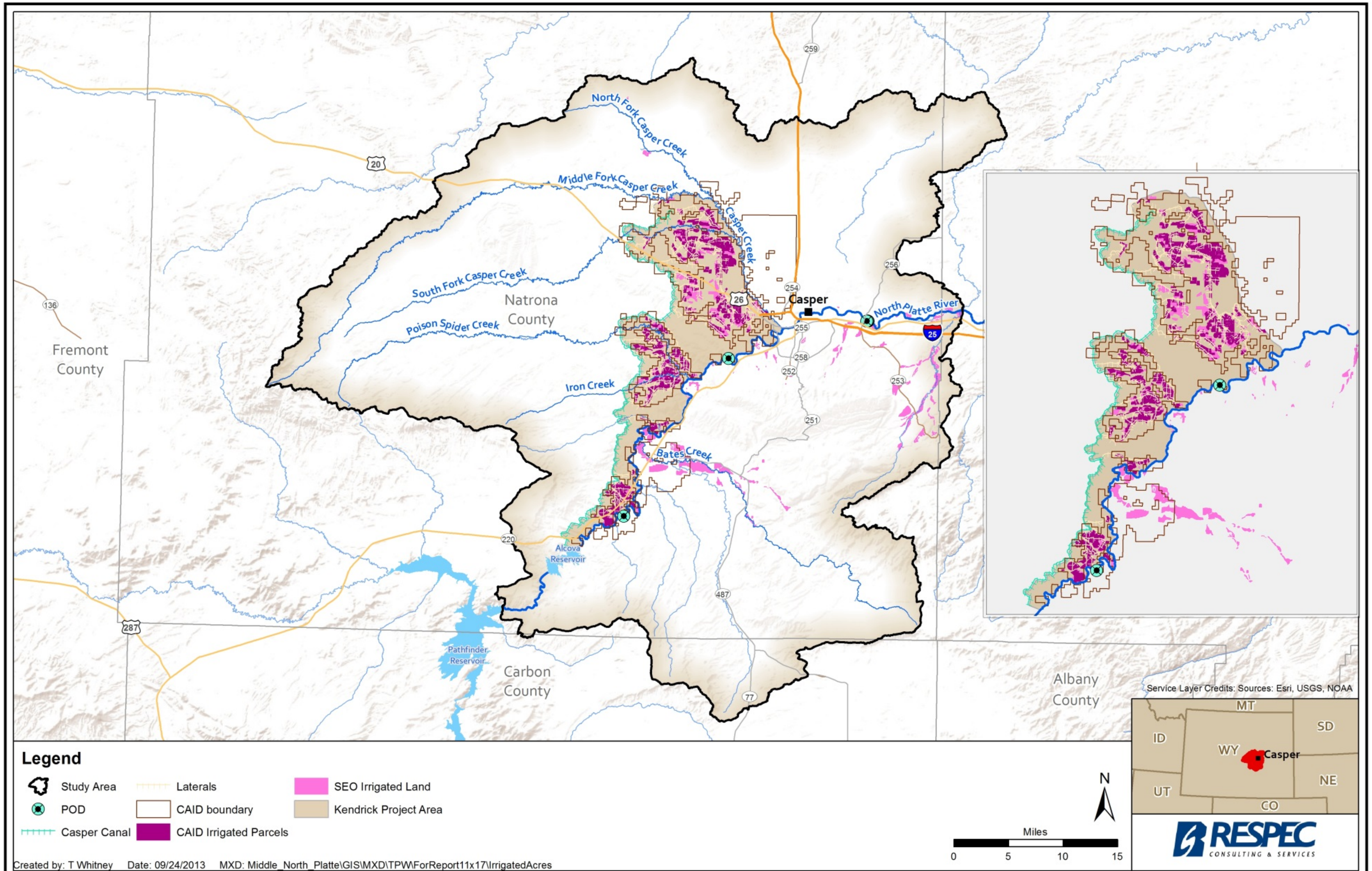

Figure 3.5. Irrigated Lands in the Middle North Platte Watershed.

Casper Canal in 1946 and the Alcova Powerplant began power production in 1955. Approximately 24,248 acres or 69 percent of the 35,061 irrigated acres in the study area are found within the CAID as shown in Figure 3.5. Through a contract agreement with the USBR, the CAID operates and maintains the water conveyance system, which annually delivers approximately 65,000 to 70,000 ac-ft of water to over 500 irrigators through the 62-mile-long Casper Canal, 149 miles of laterals and sublaterals, and 41 miles of drainage ditches [Anderson Consulting Engineers, Inc., 2008].

Table 3.3. Irrigated Lands by Subwatershed (HUC10) Within the Study Area

Subwatershed (HUC10)	Estimated Acres	Percent of Total	Within CAID
Bolton Creek-North Platte River	2,750	7.8	Yes
Casper Creek	9,250	26.4	Yes
Middle Fork Casper Creek	98	0.3	Yes
Muddy Creek-North Platte River	4,150	11.8	Yes
Poison Spider Creek	5,250	15.0	Yes
South Fork Casper Creek	2,750	7.8	Yes
Subtotal	24,248	69.2	Yes
Bates Creek	4,450	12.7	No
Bolton Creek-North Platte River	103	0.3	No
Casper Creek	160	0.5	No
Muddy Creek-North Platte River	6,100	17.4	No
Subtotal	10,813	30.8	No
Total Estimated Acres	**35,061**	**100.0**	

Alfalfa is the main crop grown in the CAID with other crops such as grass pasture, corn, and small grains [Anderson Consulting Engineers, Inc., 2008]. The irrigation season typically begins in May and ends in September. The predominant irrigation method in 2000 was flood-furrow, which occurred on 20,571 acres or 85 percent, followed by 2,762 acres or 11 percent irrigated by center-pivot sprinklers, and 892 acres or 4 percent irrigated by side-roll sprinklers of the 24,248 acres of irrigated parcels [Anderson Consulting Engineers, Inc., 2003]. Conversion of flood-furrow irrigation to sprinkler irrigation increased efficiency and decreased selenium in area waterbodies by reducing the volume of water in contact with the selenium rich soils. Since 2000, an estimated 9,659 acres of flood-furrow irrigated lands have been converted to sprinkler irrigation resulting in an estimated 13,336 acres or 55 percent of the irrigated parcels under sprinkler systems. Flood-furrow irrigation remains on approximately 10,912 acres or 45 percent of the 24,248 irrigated acres within the irrigation district.

The CAID, often in partnership with the local irrigators, WWDC, USBR, WDEQ, and the city of Casper, has completed several rehabilitation projects. Seminoe Reservoir was impacted by the construction of the Pathfinder Modification Project. To mitigate these impacts, CAID and its partners secured grant funding to construct irrigation improvements that would increase irrigation delivery and application efficiency to conserve water and reduce selenium issues within the irrigation district [Wyoming Water Development Commission, 2012].

In 2000, the WWDC contracted with Anderson Consulting Engineers, Inc. (ACE) to complete a rehabilitation needs analysis to identify areas with excessive water losses and water conservation opportunities [Anderson Consulting Engineers, Inc., 2003]. The work was completed in 2003 and included taking inventory of existing facilities, evaluating alternatives, developing conceptual designs, and estimating project costs [Anderson Consulting Engineers, Inc., 2003]. Also in 2003, the WWDC approved the CAID's Tunnel Rehabilitation Project, which rehabilitated the deteriorating Tunnel 3 and Tunnel 4 on the Casper Canal in 2005. Completion of the tunnels ensured delivery of irrigation water [Wyoming Water Development Commission, 2005].

In 2006, the WWDC approved the Casper Alcova GIS project for the CAID. This GIS project was completed in 2007 and involved mapping the main canals and laterals and each structure, providing condition estimates which would be placed into a fully integrated GIS that would assist the CAID with long term planning and management of the conveyance system and control structures [Anderson Consulting Engineers, Inc., 2008]. From 2004 through 2009, the WWDC approved the CAID Ditch Rehabilitation Projects, which included various ditch to pipe conversions and structure replacements on Lateral 128-170, Lateral 239, Lateral 256-680, Lateral 256-681, Lateral 57, Lateral 256, Lateral 210, and Lateral 210-50 to ensure efficient water delivery [Wyoming Water Development Commission, 2006; Wyoming Water Development Commission, 2010; Wyoming Water Development Commission, 2013]. The project included the following components:

- The Lateral 128-170 project replaced an earthen ditch with approximately 3,600 feet of pipe to deliver irrigation water, reduce seepage losses, and improve efficiency.
- The Lateral 239 project replaced several concrete drop structures with a pipe drop approximately 1,500 feet long with inlet and outlet structures.
- The Laterals 256-680 and 256-681 project was the largest project completed. The project converted ditches to a delivery pipe system, which facilitated flood to sprinkler conversions that reduced seepage losses and decreased selenium loading in the Oregon Trail Drainage.
- The Lateral 57 open ditch was converted to pipe to facilitate efficient water delivery and was completed before the 2010 irrigation season.

- The Laterals 210 and 210-50 projects replaced ditches with a buried pipeline to efficiently deliver irrigation water to 1,213 irrigated acres and were completed prior to the 2013 irrigation season.
- The Lateral 256 project replaced one drop structure and rehabilitated three others, which delivered irrigation water from 1,953 acres to 9,712 acres.

3.4.4.3 Bates Creek

The Bates Creek subwatershed encompasses approximately 253,682 acres and includes approximately 4,450 acres of irrigated lands that cover approximately 1.8 percent of the subwatershed. The irrigated acres are supplied by surface water primarily from Corral Creek, Dry Fork Bates Creek, East Fork Bates Creek, and Stinking Creek and groundwater pumped from irrigation wells. Approximately 34 miles of ditches in the subwatershed convey surface water to irrigated parcels within the drainage.

Permitted for irrigation use and storage, the Bates Creek Reservoir is located on the Dry Fork Bates Creek and supplied by water delivered from the East Fork Bates Creek through the Bates Creek Reservoir Company's 3.3-mile earthen inlet ditch. The reservoir has a permitted capacity of 4,717 ac-ft and a dam outlet consisting of a 24-inch diameter concrete pipe and a 200-foot wide spillway [Trihydro Corporation, 2006]. In 2010, the Bates Creek Reservoir filled to capacity. This, combined with ongoing natural flow, provided above average supplies for water users [Wyoming State Engineer's Office, 2010].

There have been conflicts with management of surface water and groundwater in the Bates Creek subwatershed. The Bates Creek subwatershed has been the subject of monitoring and modeling studies to determine the effects of groundwater pumping on surface water depletions in a stream underlain by an alluvial aquifer [Glover, 1983; Langstaff, 2006; Wyoming State Engineer's Office, 2009; Ogden and Harm-Benson, 2010]. In 2009, stream flows in Bates Creek showed signs of improvement and did not require priority administration or regulation for the first time in over 10 years [Wyoming State Engineer's Office, 2009]. Also in 2009, the Bates Creek Reservoir accrued substantial water and supplied nearly 30 days of secondary supply to its users, however, this drainage continues to receive less than what most water users would consider full supplies [Wyoming State Engineer's Office, 2009].

Surface water and groundwater management was identified as an issue in the Bates Creek drainage during the public involvement process for this watershed study. However, the scope of work for this Level I study focused on identifying rehabilitation needs and developing improvement alternatives for irrigation water storage delivery and conveyance systems within the Bates Creek subwatershed.

3.4.5 Range Conditions and Grazing Practices

More than 1.29 million acres of rangelands are located within the Middle North Platte Watershed. Rangelands cover approximately 87 percent of the watershed. Private land encompasses approximately 739,463 acres or 57.3 percent of the rangelands within the study area. The BLM manages approximately 31.9 percent or 411,673 acres and the Wyoming OSLI manages 10.4 percent or 155,663 acres, and the remaining 5,162 acres or 0.4 percent of rangelands in the study area are managed by the USFS and USFWS as shown in Table 3.4.

Table 3.4. Rangelands by Ownership/Management Within the Study Area

Land Ownership or Management	Rangeland Acres	Percent of Total Rangeland Acres
Private	739,463	57.3
BLM	411,673	31.9
State of Wyoming	134,213	10.4
Other (USFS, USFWS)	5,162	0.4
Total	**1,290,511**	**100.0**

Public land management policies directly affect the management of the private rangelands as public grazing allotments and leases are integral components of a typical private grazing operation within the study area. Another vital component needed to maintain or improve range conditions is a system of well-distributed, reliable water sources. There is considerable information about soils, hydrology, ecology, production, and vegetation within the study area. The ecological site description, which helps in evaluating the condition of a range or forest site by comparing the current growth to what the site is capable of growing, can be a valuable tool for landowners in decision-making.

3.4.5.1 Bureau of Land Management Grazing Allotments

Grazing on federal lands within the Middle North Platte Watershed is primarily administered by the BLM. Approximately 146 BLM grazing allotments are within the study area. The BLM Casper Field Office administers approximately 79 percent of the 146 allotments while the BLM Lander Field Office administers 11 allotments and the BLM Rawlins Field Office administers 20 allotments as shown in Figure 3.6 and summarized in Table 3.5. Also, some of these BLM allotments encompass private and state lands and are situated in neighboring watersheds but extend into the study area.

The BLM allotments are administered by the BLM's Casper, Lander, and Rawlins Field Offices under the respective Record of Decisions and approved 2007 Casper Resource

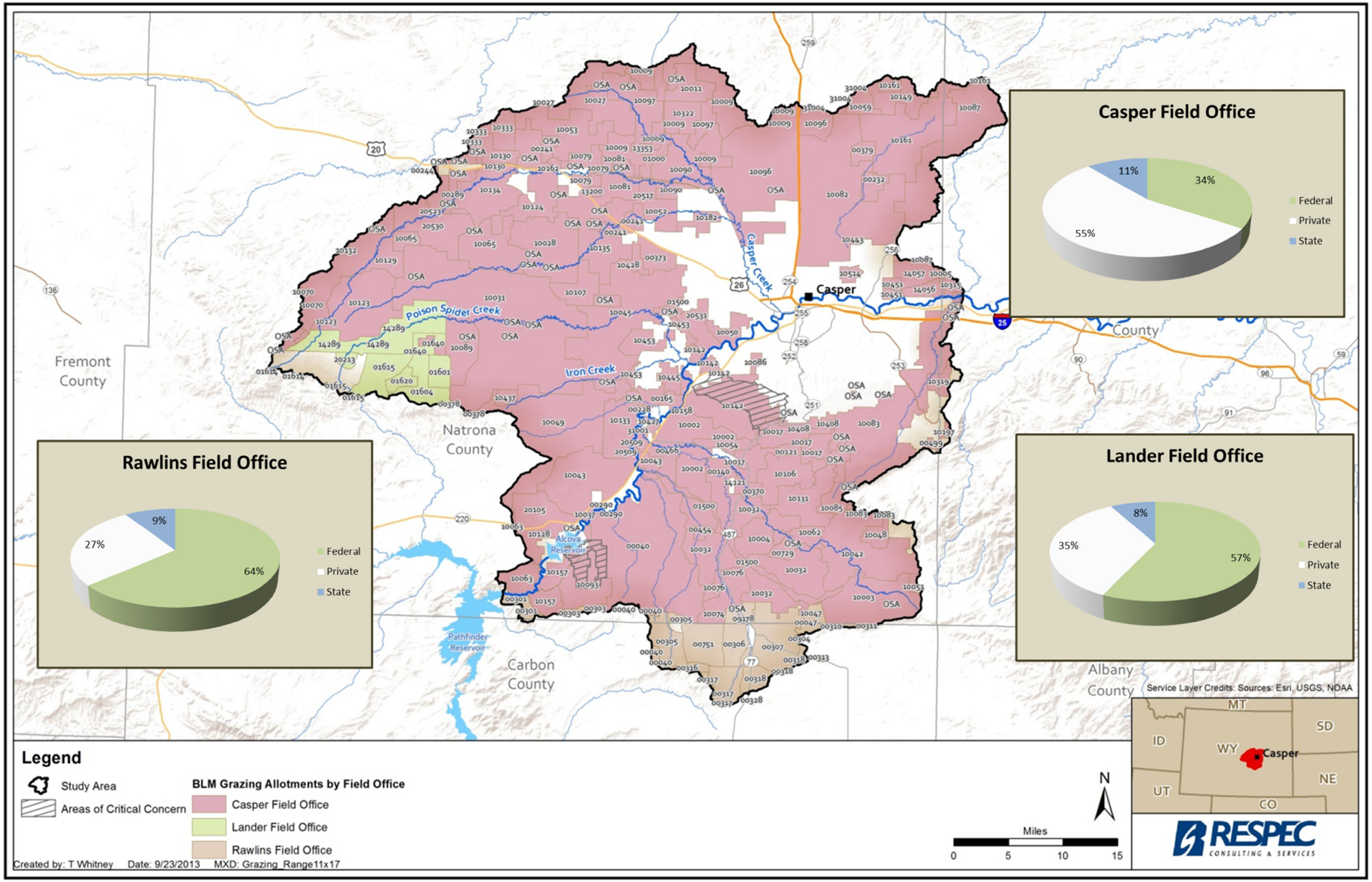

Figure 3.6. Grazing Allotments in the Study Area.

Table 3.5. Bureau of Land Management Allotment Summary for the Study Area (Page 1 of 3)

Allotment Number	Allotment Name	Area (acres)	Allotment Number	Allotment Name	Area (acres)
Casper Field Office			**Casper Field Office**		
40	Marton	57,539	10152	Big Muddy	380
121	Pitch Pine	5,464	10157	Alcova Lake	8,219
140	Schnoor	8,049	10158	Schmidt	94
165	Bessemer Mountain	1,694	10161	Seven L	28,429
228	North Platte River	461	10162	Buzan	707
232	Sand Spring	3,112	10182	Thirty Three Mile	3,139
241	South Fork Casper Creek	5,212	10197	Banner Mountain	854
244	Wyatt Draw	17	10315	North Platte 2	1,699
289	Wheatfield	207	10319	Muddy Creek	2,774
290	Hollingsworth	151	10322	Lavern Davis	5,189
370	Bates Creek 2	1,192	10333	Yj Ranch	5,182
373	Casper Canal	4,769	10408	Muddy Mountain 2	1,906
378	UC Ranch	40	10414	Bessemer Bend	1,154
379	Mckenzie Draw	2,496	10427	Bobsled	964
454	Haystack Buttes	1,170	10428	Tudor Draw	2,227
466	Bates Creek 3	4,406	10434	Poison Spider Creek	705
499	Hess Draw	650	10437	Meadow Creek	1,716
729	Pocket	2,271	10443	Klingensmith	319
1000	33 Mile Sdw	4,633	10445	Snodgrass William	2,893
1500	Bates Hole Sdw	7,965	10451	Strand	2,124
1640	Garson Ranch	3,777	10453	Oil Mountain	7,202
10002	Two Bar	17,235	10514	Hussion	1,657
10003	Bates Creek	20,284	13200	Tie Bridge Gulch	640
10004	Posvar	8,960	13353	Zimmerman	814
10005	Boner	392	14056	Geary Dome	2,925
10009	Burke	22,897	14057	Strand 2	4,931
10011	Hemingway	6,729	14121	Adobe Hills	1,790
10017	Muddy Mountain	8,863	14289	Upper Poison Spider Creek	20,151
10027	Beck Place	17,064	20105	Childers	8,347

Table 3.5. Bureau of Land Management Allotment Summary for the Study Area (Page 2 of 3)

Allotment Number	Allotment Name	Area (acres)	Allotment Number	Allotment Name	Area (acres)
Casper Field Office			**Casper Field Office**		
10028	Cummings	18,954	20509	North Platte River 2	338
10031	F.L. Ranch	88,442	20517	Ellis	1,955
10032	Garrett	40,813	20523	Eccles	3,798
10037	Bond Place	702	20530	Wyatt Place	14,149
10040	Purvis	23	20531	Rimrock West	5,952
10042	Ice Cave Mountain	25,361	31001	Bates Creek 4	1,464
10043	Alcova	23,498	31004	Twentymile Hill	573
10045	Poison Spider	38,143	OSA	Muddy Mountain EEA	1,034
10047	Lone Tree	4,070	OSA	OSA	1,104
10048	Spruce Cr/Bates USFS	2,943	OSA	Private	24,321
10049	Rattlesnake	38,328	OSA	Private	170
10050	Emigrant Gap	4,218	OSA	R&PP	358
10051	Deer Creek	1,009	OSA	Sub-Division	1,477
10052	Stone Ranch	8,180	**Lander Field Office**		
10053	Potter	14,388	1640	Garson Ranch	2,530
10054	Little Red Creek	3,243	14289	Upper Poison Spider Creek	20,242
10059	Little Pine Ridge	3,465	378	UC Ranch	45
10062	Lewis	3,185	1601	Dodds Allotment	3,775
10063	Pathfinder	5,290	1614	Circle Bar Allotment	9
10065	Strohecker	16,062	1604	#17 Horse Heaven Pasture	6,972
10070	Stone Cabin	274	1620	Cabin Creek Pasture	2,547
10074	Elk Creek	4,308	1615	North Of Drift Fence	8,425
10076	Robert Body	5,599	1640	Garson Ranch	2,530
10079	Brewer	3,879	14289	Upper Poison Spider Creek	20,242
10081	Bucknum	7,784	20213	Elkhorn-LRA	1,574
10082	Ormsby	55,911	**Rawlins Field Office**		
10083	Smith Creek	42,571	301	Pathfinder	1,928
10085	Clemons	3,524	303	Canyon Creek	486
10086	Coates	982	305	Camp Creek	1,751

Table 3.5. Bureau of Land Management Allotment Summary for the Study Area (Page 3 of 3)

Allotment Number	Allotment Name	Area (acres)	Allotment Number	Allotment Name	Area (acres)
Casper Field Office			**Rawlins Field Office**		
10087	Cole Creek	28,205	318	Shirley Ridge	3,612
10089	Dodds	9,765	328	Sullivan	0
10090	Big	17,411	316	Dry Creek Rim	1,506
10093	Bear Spring Creek	14,610	313	West Little Medicine	1
10096	Forgey	47,721	317	Upper Dry Creek	522
10097	Gowin	13,771	305	Camp Creek	7,218
10106	Corral Creek	9,795	9178	Kirk Ranch Natrona	2,928
10107	Haughton	6,771	751	Elk Creek	8,664
10123	M & D	21,498	311	Bates Benchmark	328
10123	M&D	118	47	NA	3,172
10124	Manning	10,396	310	Antelope Springs	549
10128	Benton Basin	5,016	307	Bates Hole	22,088
10129	Forgey Place	22,293	301	Pathfinder	2,851
10130	Miller	6,105	304	Wagon Tongue	546
10131	Sheep Creek	11,112	303	Canyon Creek	1,004
10132	Wallace Creek	299	40	Marton	746
10133	Clarkson Hill	11,952	306	Kirk Ranch	5,072
10134	Pine Mountain	13,862			
10135	Barker	16,519			
10142	Eagle Ridge	22,645			
10149	Staple Three	7,115			

Management Plan (RMP), the 1987 Lander Resource Management Plan (RMP), and the 2008 Rawlins Resource Management Plan (RMP). Currently, the Lander Field Office is revising the existing Lander RMP and preparing a related environmental impact statement (EIS). Grazing management on BLM land is conducted in accordance with the Federal Land Policy and Management Act of 1976 and the Taylor Grazing Act of 1934. Policies and procedures for managing grazing on BLM lands are outlined in the BLM's regulations, which were revised in 1995 to sustain or improve rangeland health. Grazing activities on BLM lands in the state of Wyoming have to meet the requirements specified in *Standards for Healthy Rangelands and Guidelines for Livestock Grazing Management for the Public Lands* [Bureau of Land Management, 2013].

More information approximately the BLM's grazing management standards and guidelines can be found online (*http://www.blm.gov/wy/st/en/programs/grazing.html*). The BLM's grazing management guidelines which are pertinent for this watershed study include the following summaries:

- Support infiltration, maintain soil moisture, stabilize soils, and sufficient water to maintain system function and soil permeability.
- Restore, maintain, or improve riparian plant communities to sustain adequate residual plant cover for sediment capture and groundwater recharge.
- Implement riparian improvements to maintain or enhance stream channel morphology.
- Develop springs, seeps, reservoirs, wells or other water development projects in a manner protective of watershed ecological and hydrological functions.
- Implement range improvements away from riparian areas to avoid conflicts in achieving or maintaining riparian function.
- Adopt management practices and implement range improvements that protect vegetative cover and thereby maintain, restore, or enhance water quality.

3.4.5.2 State of Wyoming Grazing Lands

Most of the state lands within the Middle North Platte Watershed are leased to private landowners for grazing. These leases are typically issued by the Board of Land Commissioners and administered by the Wyoming OSLI. Management practices and improvements on state lands are usually established and implemented by the lessee. Improvements are typically paid for and owned by the lessee. Upon transfer of the state lease, the new lessee reimburses the previous lessee for improvements. Grazing on Private Lands

Grazing practices on private lands are established by the landowner, often with technical assistance from the local NRCS Field Office or a range consultant. Management practices and improvements on private lands are established and implemented by the landowner or manager. Landowners and operators who voluntarily participate in Farmbill programs may be required to follow NRCS standards and specifications or an approved grazing plan included in a conservation plan schedule of operations developed for the enrolled property or applicable Farmbill program.

3.4.5.3 Existing Water Supply

A dependable water supply is the foundation for grazing management; it is necessary to provide sufficient amounts of suitable-quality water to animals over private and public rangelands. Numerous upland water sources are currently within the study area. Many rangeland improvements and grazing management projects have developed existing water sources such as springs, wells, and perennial streams. These projects often included storage tanks, ponds, reservoirs, pumping plants, and spring developments with pipelines carrying livestock and wildlife water to remote stock tanks.

Existing water sources on properties of participating landowners and managers were mapped within the watershed study. Mapping was not completed for the majority of private lands in the watershed because many landowners or managers did not participate in the study. The mapping is not a complete account of all viable water sources but serves as a baseline for estimating livestock and wildlife water needs within the watershed. Mapping viable water sources within the watershed included the following items:

- Maps of springs were obtained from the BLM Casper Field Office.
- Maps of stock wells were obtained from the SEO.
- Interviews with landowners were conducted during study meetings and field visits.
- Maps were developed and existing stock ponds and reservoirs were initially assessed using aerial imagery, infrared imagery, topographic maps, and hydrography datasets.

This mapping effort indicated the existence of 297 stock reservoirs, ponds, or lakes. Digitized locations of springs were included using USGS topography maps. Although a detailed field verification of these sites was beyond the scope of this study, an initial review of the existing sources was completed. Recent high-resolution aerial imagery was examined using the GIS geodatabase to determine the status and viability of the water features. Existing structures containing water and showing no breaches of the dam or spillway were determined to be likely water sources. Some of the structures showed visible evidence of dam and spillway breaches and were determined to be nonfunctional. Other structures were observed to have filled with sediment and were determined to be nonfunctional. Other structures were dry and designated as potential water sources.

An example of the mapping process is shown in Figure 3.7. The results of this mapping effort are presented in Figure 3.8. approximately 254 of the structures appear to be viable sources and 43 structures appear to be breached or sediment filled requiring field visits to verify site conditions.

Several livestock/wildlife water development projects have been completed within the study area. Typically, these projects included wells, spring developments, pipelines, and stock tanks. A 1-mile buffer was delineated around the existing viable water source locations within the study area and is presented in Figure 3.9. This figure of mapping results does not include surface water sources such as perennial and intermittent streams, undeveloped springs, or breached or nonfunctional ponds and reservoirs.

The existing water supply is augmented by the Central Wyoming Regional Water System (CWRWS), which serves Casper and surrounding communities. The CWRWS relies on both surface water and groundwater to supply water to CWRWS members, such as the city of Casper, Pioneer Water and Sewer District, Salt Creek Joint Powers Board, Wardwell Water and Sewer District, Poison Spider Improvement and Service District, Sandy Lake Estates, 33 Mile Service and Improvement District, and Lakeview Improvement District [Trihydro, 2006].

Figure 3.7. Geographic Information System Evaluation of Stock Ponds and Reservoirs Within the Study Area.

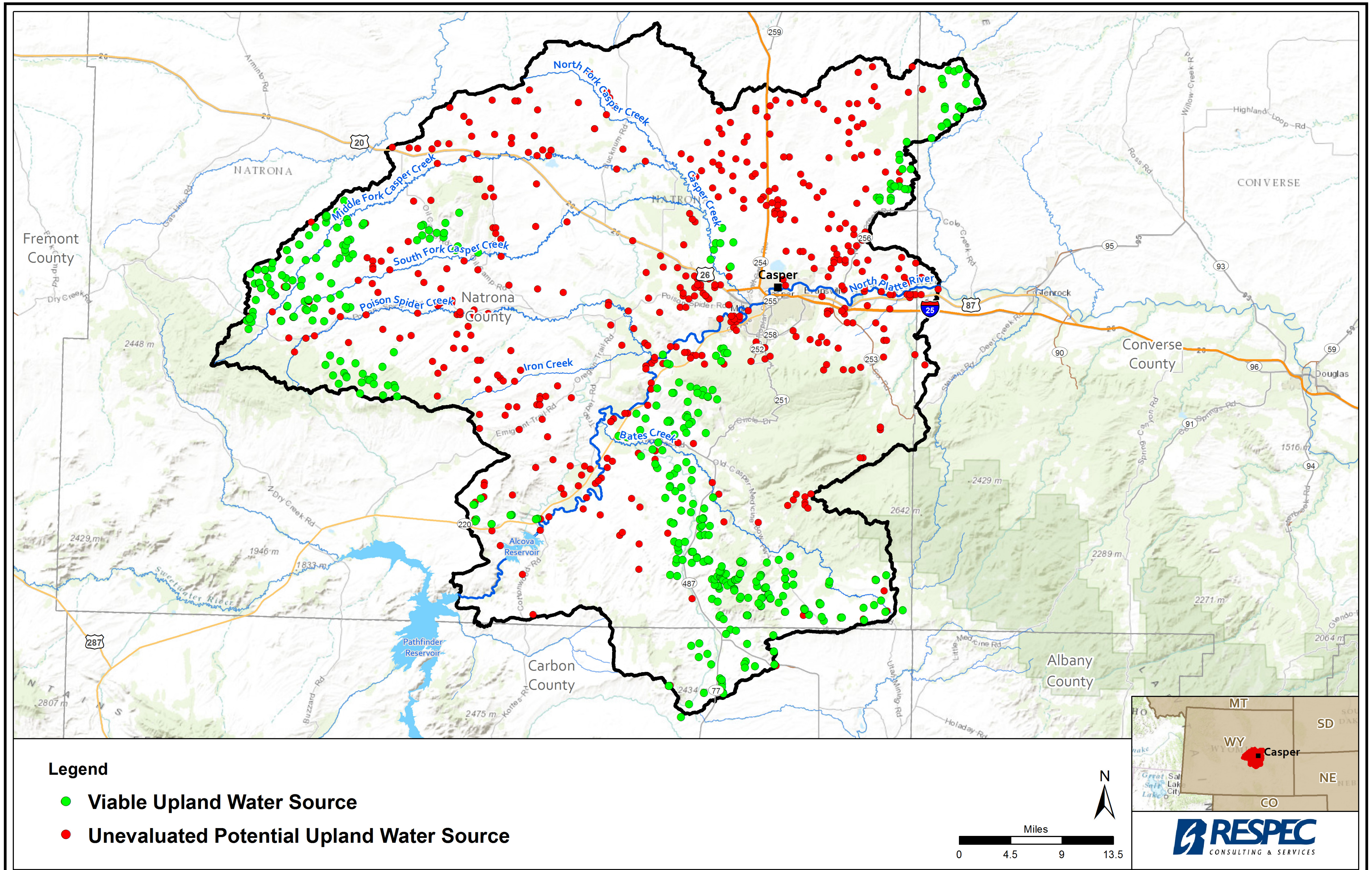

Figure 3.8. Viable Water Sources in the Study Area.

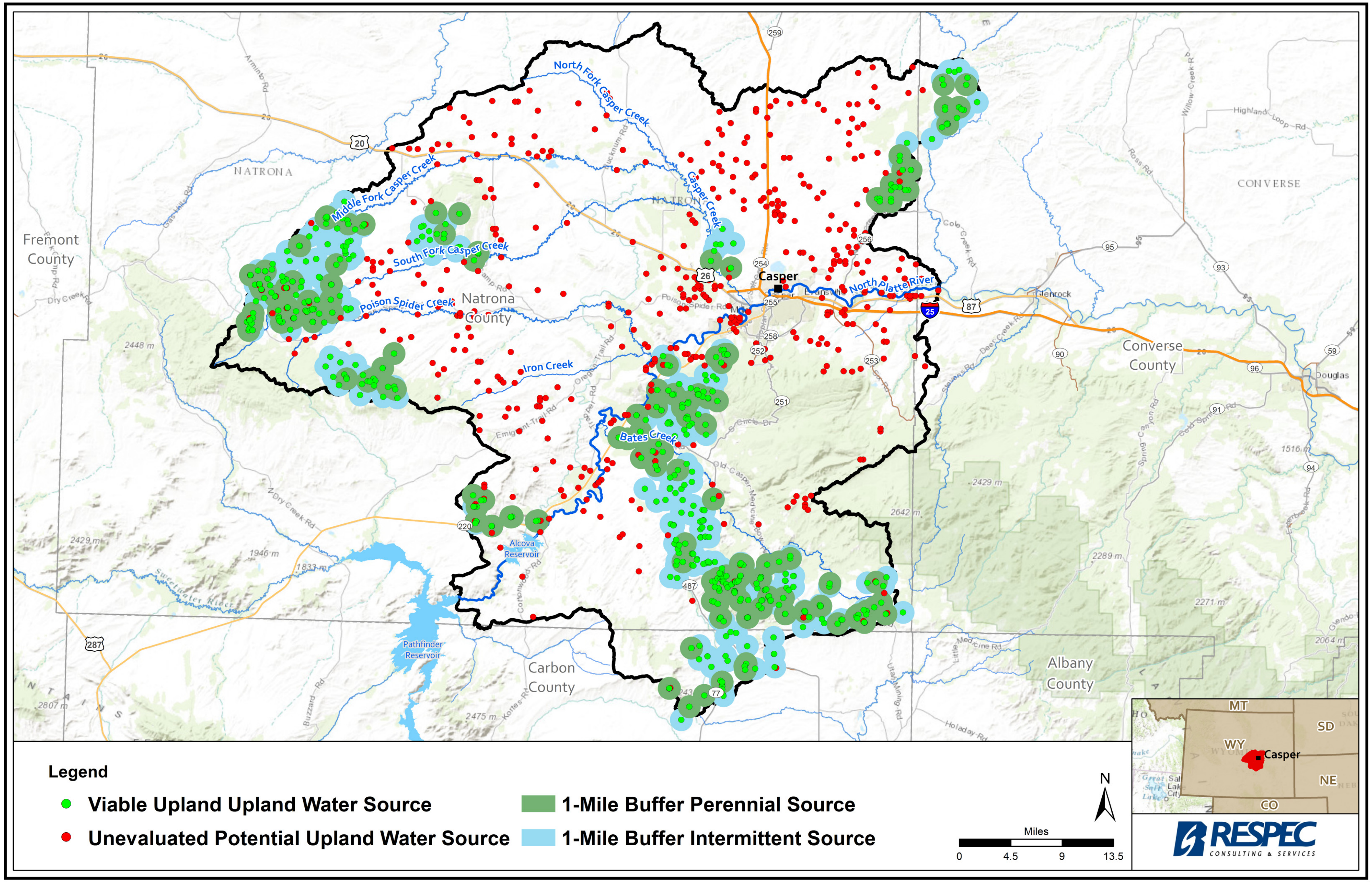

Figure 3.9. Viable Water Sources With a 1-Mile Buffer in the Study Area.

Generally, viable water sources are within the southeastern, northeastern, and western portions of the watershed, as shown in Figure 3.9. Viable water sources appear to be scarce within in the southern, northwestern, central, and Casper Mountain portions of the watershed with the lack of wells. However, this situation may represent the lack of inventory information for those areas, which were not evaluated because no property owners within those areas participated in the watershed study.

3.4.5.4 Ecological Site Descriptions

Rangelands are classified as ecological sites based on soils, topography, and climate that create each site's unique characteristics. An ecological site is a conceptual division of the landscape defined by the BLM, USFS, and NRCS [Caudle et al., 2013] as the following:

> *A distinctive kind of land based on recurring soil, landform, geological, and climate characteristics that differs from other kinds of land in its ability to produce distinctive kinds and amounts of vegetation and in its ability to respond similarly to management actions and natural disturbances.*

Ecological sites incorporate environmental factors such as climate, soils, landform, hydrology, vegetation, and natural disturbance regimes that together define the site and its relationships between these factors and how they influence plant community composition [Caudle et al., 2013]. The characteristics differentiating ecological sites and their features are documented as an ecological site description (ESD), which includes the following:

- Data used to define the distinctive properties and characteristics of the sites
- Biotic and abiotic characteristics that differentiate the site (i.e., climate, physiographic, soil characteristics, plant communities)
- Ecological dynamics including how changes in climate, disturbance processes and management can affect the site.

An ESD includes interpretations about the land uses that a specific ecological site can support and management alternatives for achieving objectives. ESDs are valuable tools that can be used to help landowners and managers make decisions through evaluating the condition or health of a range or forest site by comparing the current vegetation composition to the type of plants the site is capable of growing. The ecological sites and associated descriptions were developed over many years of data collection and range site monitoring and are dependent on the location of a site within defined precipitation zones and existing soil characteristics. ESDs available from the NRCS (*https://esis.sc.egov.usda.gov/Welcome/pgReportLocation.aspx?type=ESD*) describe the following for each ecological site:

- **Site characteristics –** physiographic, climate, soil, and water features.
- **Plant communities –** plant species, vegetation states, and ecological dynamics.
- **Site interpretations –** management alternatives for the site and its related resources.
- **Supporting information –** relevant literature, information, and data sources.

The ESDs and NRCS soil map units are available and have been compiled for approximately 90 percent of the study area. Soils data was not available for Carbon County or approximately 10 percent of the study area. Figure 3.10 shows the locations of the major ecological sites within the study area. There are five predominant ESDs within the study area that cover approximately 55 percent of the watershed as listed in Table 3.6. Each of these five ESDs covers a minimum of 6 percent of the study area. The loamy (Ly) 10- to 14-inch precipitation zone, High Plains Southeast ESD is the largest in the watershed covering approximately 402,796 acres or 27 percent of land area within the study area. All of the ESDs found within the watershed area listed in Table 3.7.

Rangelands contain numerous ESDs. More than one plant community can occur within an ESD given the site characteristics discussed above. Each range ecological site has a specific plant community that has developed because of these factors and is referred to as reference or Historic Climax Plant Community (HCPC). The HCPC describes the potential plant community and potential productivity of each individual range site. Plant communities have distinct forage production potential; the HCPC usually has the greatest potential. The HCPC can be used to compare the current vegetation growing on a site to the plant community that could be grown on the site. This comparison using the HCPC can be a good indicator of potential site productivity.

The following descriptions of the HCPC associated with these five predominant ESDs within the study area were obtained directly from the NRCS *ESD System for Rangeland and Forestland Data* website that can be accessed online (*https://esis.sc.egov.usda.gov/Welcome/pgReportLocation.aspx?type=ESD*).

> ***Loamy (Ly) 10–14 inch Precipitation Zone, High Plains Southeast***
> *The interpretive plant community for this site is the Historic Climax Plant Community. Potential vegetation is estimated at 80 percent grasses or grass-like plants, 10 percent forbs and 10 percent woody plants. The major grasses include rhizomatous wheatgrass, needle and thread, bluebunch wheatgrass, and green needlegrass. Big sagebrush and rubber rabbitbrush are the major woody plants. A typical plant composition for this state consists of rhizomatous wheatgrass 30 to 40 percent, needle and thread 10 to 20 percent, bluebunch wheatgrass 5 to 15 percent, green needlegrass 5 to 10 percent, muttongrass 5 to 10 percent, perennial forbs 5 to 10 percent, and big sagebrush 5 to 15 percent. Ground cover, by ocular estimate, varies from 30 to 40 percent.*
>
> *The total annual production (air-dry weight) of this state is about 1,100 pounds per acre, but it can range from about 600 pounds per acre in unfavorable years to about 1,400 pounds per acre In reply to: above average years. This state is extremely stable and well adapted to the Cool Central Desertic Basins and Plateaus climate. The diversity in plant species allows for high drought resistance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity). Transitions or pathways leading to other plant communities are as follows:*

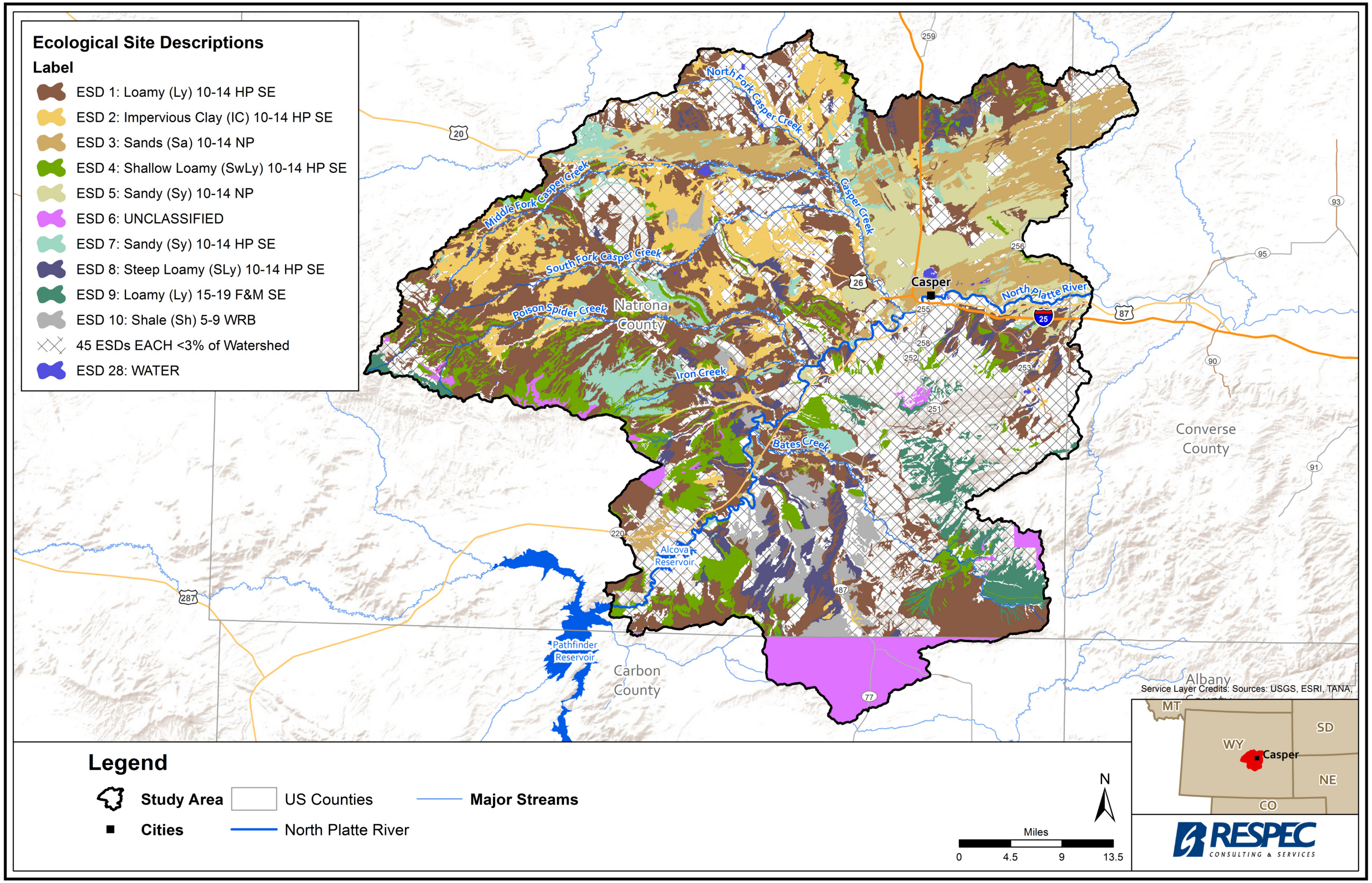

Figure 3.10. Ecological Site Descriptions Within the Watershed.

- *Continuous Season-long Grazing will convert the plant community to the Big Sagebrush-Mid Grass Plant Community if big sagebrush is present at 5–10 percent.*
- *Moderate Continuous Season-long Grazing or Continuous Spring Grazing will convert the plant community to the Blue Grama Sod Plant Community.*
- *Heavy Continuous Season Long Grazing with Wild Fire will convert this plant community to the Rabbitbrush/Cheatgrass plant community.*

Table 3.6. Predominant Ecological Sites, Descriptions, and Areas Within the Study Area

Indentifier	Ecological Site I.D.	Description	Area (Acres)	Percent of Study Area
1	R034AY322WY	Loamy (Ly) 10–14 inch Precipitation Zone (PZ) High Plains Southeast	402,726	27.1
2	R034AY318WY	Impervious clay (IC) 10–14 inch PZ High Plains Southeast	121,048	8.1
3	R058BY146WY	Sands (Sa) 10–14 inch Northern Plains PZ	101,054	6.8
4	R034AY362WY	Shallow loamy (SwLy) 10–14 inch PZ High Plains Southeast	99,634	6.7
5	R058BY150WY	Sandy (Sy) 10–14 inch Northern Plains PZ	91,736	6.2
Total			**816,198**	**54.9**

Impervious Clay (IC) 10–14 inch Precipitation Zone, High Plains Southeast

The interpretive plant community for this site is the Historic Climax Plant Community. Potential vegetation is estimated at 50 percent grasses or grass-like plants, 5 percent forbs and 45 percent woody plants. The major grasses include western wheatgrass, bottlebrush squirreltail, Indian ricegrass, and Sandberg bluegrass. Birdfoot sagebrush is the major woody plant. Other woody plants that may occur include Gardner's saltbush and winterfat. A typical plant composition for this state consists of western wheatgrass 20 to 45 percent, bottlebrush squirreltail 10 to 20 percent, Indian ricegrass 10 to 20 percent, up to 5 percent Sandberg bluegrass, perennial forbs 1 to 5 percent, birdfoot sagebrush 25 to 40 percent, and 5 to 10 percent other woody species. Ground cover, by ocular estimate, varies from 30 to 45 percent.

The total annual production (air-dry weight) of this state is about 500 pounds per acre, but it can range from about 350 pounds per acre in unfavorable years to about 700 pounds per acre in above average years. This state is extremely stable and well adapted to the Cool Central Desertic Basins and Plateaus climate. The diversity in plant species allows for high drought resistance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity). Transitions or pathways leading to other plant communities are as follows:

Table 3.7. Ecological Sites, Descriptions, and Areas for Study Area (Page 1 of 2)

Identifier	Ecological Site I.D.	Description	Area (acres)	Percent of Study Area
1	R034AY322WY	Loamy (Ly) 10–14 inches P.Z. High Plains Southeast	402,726	27.1
2	R034AY318WY	Impervious clay (IC) 10–14 inches P.Z. High Plains Southeast	121,048	8.1
3	R058BY146WY	Sands (Sa) 10–14 inches Northern Plains Precipitation	101,054	6.8
4	R034AY362WY	Shallow loamy (SwLy) 10–14 inches P.Z. High Plains Southeast	99,634	6.7
5	R058BY150WY	Sandy (Sy) 10–14 inches Northern Plains Precipitation	91,736	6.2
6	NA	UNCLASSIFIED	60,392	4.1
7	R034AY350WY	Sandy (Sy) 10–14 inches P.Z. High Plains Southeast	59,142	4.0
8	R034AY368WY	Steep loamy (SLy) 10–14 inches P.Z. High Plains Southeast	50,381	3.4
9	R049XA122WY	Loamy (Ly) 15–19 inches Foothills & Mountains Southeast Precip.	38,815	2.6
10	R032XY254WY	Shale (Sh) 5–9 inches Wind River Basin Precipitation	38,249	2.6
11	NA	Rock outcrop – UNCLASSIFIED	35,783	2.4
12	R034AY336WY	Saline loamy (SnLy) 10–14 inches P.Z. High Plains Southeast	34,915	2.3
13	R034AY376WY	Very shallow (VS) 10–14 inches P.Z. High Plains Southeast	31,489	2.1
14	R034AY356WY	Shallow breaks (SwB) 10–14 inches P.Z. High Plains Southeast	31,103	2.1
15	R034AY344WY	Saline upland (SU) 10–14 inches P.Z. High Plains Southeast	27,457	1.8
16	R034AY338WY	Saline lowland (SL) 10–14 inches P.Z. High Plains Southeast	21,266	1.4
17	R058BY104WY	Clayey (Cy) 10–14 inches Northern Plains Precipitation	20,567	1.4
18	R049XA162WY	Shallow loamy (SwLy) 15–19 inches Foothills/Mountains SE Prec.	19,474	1.3
19	R034AY358WY	Shallow clayey (SwCy) 10–14 inches P.Z. High Plains Southeast	18,338	1.2
20	R034AY304WY	Clayey (Cy) 10–14 inches P.Z. High Plains Southeast	17,559	1.2
21	R049XA160WY	ShallowiIgneous (SwIg) 15–19 inches Foothills/Mountains SE Prec.	14,019	0.9
22	R032XY238WY	Saline lowland (SL) 5–9 inches Wind River Basin Precipitation	13,371	0.9
23	NA	Urban land complex – UNCLASSIFIED	12,014	0.8
24	NA	Alflack–Foxton complex – UNCLASSIFIED	11,172	0.8
25	R034AY326WY	Loamy overflow (LyO) 10–14 inches P.Z. High Plains Southeast	10,890	0.7
26	R058BY158WY	Shallow clayey (SwCy) 10–14 inches Northern Plains Precipitation	10,890	0.7
27	R058BY122WY	Loamy (Ly) 10–14 inches Northern Plains Precipitation	9,866	0.7
28	NA	Water UNCLASSIFIED	8,107	0.5
29	R043BY160WY	ShallowiIgneous (SwIg) 20 inches+ P.Z. High Mountains	6,965	0.5
30	R034AY354WY	Shale (Sh) 10–14 inches P.Z. High Plains Southeast	6,661	0.4
31	R034AY342WY	Saline subirrigated (SS) 10–14 inches P.Z. High Plains Southeast	6,453	0.4
32	R034AY366WY	Shallow sandy (SwSy) 10–14 inches P.Z. High Plains Southeast	6,098	0.4
33	NA	Badlands UNCLASSIFIED	5,397	0.4
34	NA	Forest UNCLASSIFIED	4,295	0.3
35	R034AY308WY	Coarse Upland (CU) 10–14 inches P.Z. High Plains Southeast	4,196	0.3

Table 3.7. Ecological Sites, Descriptions, and Areas for Study Area (Page 2 of 2)

Identifier	Ecological Site I.D.	Description	Area (acres)	Percent of Study Area
36	R043BY322WY	Loamy (Ly) 15–19 inches Foothills and Mountains	4,169	0.3
37	NA	Rubble land – UNCLASSIFIED	3,197	0.2
38	R058BY162WY	Shallow loamy (SwLy) 10–14 inches Northern Plains Precipitation	2,989	0.2
39	R049XA174WY	Subirrigated (Sb) 15–19 inches Foothills and Mountains	2,754	0.2
40	R058BY166WY	Shallow sandy (SwSy) 10–14 inches Northern Plains Precipitation	2,746	0.2
41	R058BY142WY	Saline subirrigated (SS) 10–14 inches Northern Plains Precip.	2,644	0.2
42	R058BY128WY	Lowland (LL) 10–14 inches Northern Plains Precipitation	2,496	0.2
43	NA	Salt flats UNCLASSIFIED	1,945	0.1
44	R043BY308WY	Coarse upland (CU) 15–19 inches Foothills and Mountains	1,827	0.1
45	R032XY222WY	Loamy (Ly) 5–9 inches Wind River Basin Precipitation	1,818	0.1
46	NA	Pits and dumps UNCLASSIFIED	1,571	0.1
47	R049XA108WY	Coarse upland (CU) 15–19 inches Foothills & Mountains SE Prec.	1,387	0.1
48	R034AY374WY	Subirrigated (Sb) 10–14 inches P.Z. High Plains Southeast	1,306	0.1
49	R043BY376WY	Very shallow (VS) 15–19 inches Foothills and Mountains	1,208	0.1
50	R043BY362WY	Shallow loamy (SwLy) 15–19 inches Foothills and Mountains	1,127	0.1
51	NA	Dune land UNCLASSIFIED	924	0.1
52	R058BY144WY	Saline upland (SU) 10–14 inches Northern Plains Precipitation	838	0.1
53	058BY104WY_2	CLAYEY (10–14NP)	172	0.011
54	043XY322WY	LOAMY (15–19E)	73	0.005
55	R032XY244WY	Saline upland (SU) 5–9 inches Wind River Basin Precipitation	27	0.002
56	R058BY106WY	Clayey overflow (CyO) 10–14 inches Northern Plains Precipitation	8	0.001
Total			**1,486,748**	**100.0**

- *Heavy Continuous Season-long Grazing will convert the plant community to the Heavy Birdfoot Sage Plant Community.*
- *Moderate Continuous Season-long Grazing will convert the plant community to the Birdfoot Sage/ Rhizomatous Wheatgrass Plant Community.*

Sands (Sa) 10–14 inch Northern Plains Precipitation Zone

The interpretive plant community for this site is the Historic Climax Plant Community. This state evolved with grazing by large herbivores and is well suited for grazing by domestic livestock. Potential vegetation is about 85 percent grasses or grass-like plants, 10 percent forbs, and 5 percent woody plants. This state is a mix of warm and cool season midgrasses. The major grasses include *needleandthread, prairie sandreed, sand bluestem, and Indian ricegrass. Other grasses occurring in this state include Sandberg bluegrass, sand dropseed, and threadleaf sedge. Silver sagebrush is a conspicuous element of this state, occurs in a mosaic pattern, and makes up 5 to 10 percent of the annual production.*

The total annual production (air-dry weight) of this state is about 1,400 pounds per acre, but it can range from about 900 pounds per acre in unfavorable years to about 1,700 pounds per acre in above average years. This plant community is extremely stable and well adapted to the Northern Great Plains climatic conditions. The diversity in plant species allows for high drought tolerance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity). Transitions or pathways leading to other plant communities are as follows:

- *Moderate Continuous Season-Long grazing will convert the plant community to the Needleandthread/ Threadleaf sedge/ Yucca Vegetation State.*
- *Frequent and Severe grazing will convert the plant community to a blowout with a Yucca, Sandbur, and Western ragweed Vegetation State.*

Shallow Loamy (SwLy) 10–14 inch Precipitation Zone, High Plains Southeast
The interpretive plant community for this site is the Historic Climax Plant Community. Potential vegetation is about 70 percent grasses or grass-like plants, 10 percent forbs, and 20 percent woody plants. The major grasses include bluebunch wheatgrass, western wheatgrass, needleandthread, and Indian ricegrass. Other grasses include, Sandberg and mutton bluegrass, prairie junegrass, bottlebrush squirreltail, plains reedgrass, and threadleaf sedge. Black sagebrush, big sagebrush, and green rabbitbrush are the major woody plants. A typical plant composition for this state consists of bluebunch wheatgrass 15 to 30 percent, western wheatgrass 15 to 25 percent, needleandthread 5 to 10 percent, muttongrass 5 to 10 percent other grasses and grass-like plants 10 to 20 percent, perennial forbs 5 to 15 percent, black sagebrush 5 to 10 percent, and other shrubs 5 to 10 percent Ground cover, by ocular estimate, varies from 15 to 25 percent.

The total annual production (air-dry weight) of this state is about 900 pounds per acre, but it can range from about 700 pounds per acre in unfavorable years to about 1,200 pounds per acre in above average years. The state is stable and well adapted to the Cool Central Desertic Basins and Plateaus climatic conditions. The diversity in plant species allows for high drought resistance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity). Transitions or pathways leading to other plant communities are as follows:

- *Moderate Continuous Season Long Grazing will convert this plant community to the Black Sagebrush/Rhizomatous Wheatgrass Plant Community.*

- *Heavy Continuous Season-long Grazing will convert this plant community to the Short Grass and Grasslike/Forb plant community.*

Sandy (Sy) 10–14 inch Northern Plains Precipitation Zone
The interpretive plant community for this site is the Historic Climax Plant Community. This state evolved with grazing by large herbivores and is well suited for grazing by domestic livestock. Potential vegetation is about 75 percent grasses or grass-like plants, 15 percent forbs, and 10 percent woody plants. The state is a mix of warm and cool season midgrasses. The major grasses include needleandthread, prairie sandreed, little bluestem, and Indian ricegrass. Other grasses occurring in the state include rhizomatous wheatgrasses, Sandberg bluegrass, blue grama, and threadleaf sedge. Silver sagebrush and green rabbitbrush are conspicuous components of this state.

The total annual production (air-dry weight) of this state is about 1,200 pounds per acre, but it can range from about 750 pounds per acre in unfavorable years to about 1,600 pounds per acre in above average years. The state is stable and well adapted to the Northern Great Plains climatic conditions. The diversity in plant species allows for high drought resistance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity). Transitions or pathways leading to other plant communities are as follows:

- *Moderate, Continuous Season-Long grazing will convert the plant community to the Needleandthread/Threadleaf sedge/Fringed sagewort Vegetation State.*
- *Frequent and Severe grazing will convert the plant community to the Threadleaf sedge/Fringed sagewort/Plains Pricklypear Vegetation State.*

3.4.5.5 Range Conditions and Needs

Range conditions depend on a number of factors including, but not limited to, climate and precipitation, soil and water, plants and animals, topography and geology, and natural disturbances. Range conditions on BLM-managed allotments within the study area are detailed in the “Affected Environment” chapters of BLM’s proposed and approved RMPs and associated EIS documents for the Casper, Lander, and Rawlins field offices. Comparison of range condition data from surveys completed in the 1950s and 1960s and surveys completed in the 1980s and 1990s indicate that the condition of public lands in the Casper RMP planning area has improved because of improved livestock management both by the BLM and grazing lessees [Bureau of Land Management, 2007].

Goals, objectives, and actions are included in an approved RMP; however, grazing permits or leases for a particular allotment are not included within a RMP. Grazing leases and permits frequently include an allotment management plan (AMP), coordinated resource management plan (CRMP), or similar agreement that outlines a grazing plan and is prepared in cooperation with the permittees or operators. These plans often include goals and objectives, management indicators, use patterns, desired conditions, and monitoring techniques to measure progress.

Rather than focusing on specific details or obtaining information from the allotment management plans, study efforts focused on working with participants and permittees to identify areas where water developments could enhance grazing and rangeland conditions. Additionally, study efforts concentrated on identifying areas where participating landowners and managers indicated that developing water sources could assist with improved grazing distribution and could improve range conditions over time. Taking inventory of range or pasture conditions on a specific property was outside the scope of this study although some initial livestock feed and forage balances were completed in cooperation with the study participants and the NRCS Casper Field Office.

Upland plant communities are dominated by grass and sagebrush species. Pine forests and other woodlands are present on a small portion of the watershed. In general, the major desirable grass species in the watershed include rhizomatous wheatgrass, needleandthread, bluebunch wheatgrass, western wheatgrass, bottlebrush squirreltail, Sandberg bluegrass, prairie sandreed, little bluestem, and Indian ricegrass. Generally, these plant communities have been altered by surface activities, grazing, wildfires, and invasive or noxious species.

A vital component needed to maintain or improve range conditions is a system of well-distributed, reliable water sources. Dependable water supplies are the foundation for implementing management strategies that can benefit many of the resources such as wildlife and livestock on uplands within the watershed. When viable water sources are available, more grazing management options can be considered by landowners and managers to enhance grazing systems and improve range conditions.

In the absence of well-distributed watering facilities, animals tend to spend more time near perennial or intermittent surface water sources. The animals graze riparian vegetation but underuse adjacent upland vegetation areas. Seasonal or intermittent water sources are often available only during short periods of the grazing season. This results in continual grazing during critical plant growth periods causing shifts in desirable plant communities, range conditions, and production. During the growing season, grasses and other forage vegetation require varying recovery periods, adequate leaf and root biomass, and sufficient soil moisture to capture sunlight, regrow leaves, restore root reserves, and maintain plant vigor. If these processes do not occur, ultimately the grasses and other desirable species decrease and less desirable and/or invasive plants increase in composition and density.

These undesirable shifts in rangeland conditions can be avoided or changed if grazing intensity and timing are adapted to allow plant recovery and regrowth resulting in desired plant communities and increased production. To accomplish this, landowners and managers typically implement grazing systems with cross fencing or realignment, increased grazing timing and scheduling, and herding or low stress handling methods. Viable water sources and distribution systems are needed because more animals graze during shorter periods in a specific area or pasture resulting increased water availability and reliability requirements.

Although viable water sources are in the southeastern, northeastern, and western portions of the watershed, water supplies appear to be limited in the southern, northwestern, central, Casper Mountain, and some western portions of the watershed because of drought or precipitation patterns and varying hydrologic and geologic conditions.

Healthy uplands and rangelands contribute to the function of a watershed by enhancing precipitation infiltration, improving soil percolation, reducing surface water runoff, recharging soil moisture and groundwater, and increasing habitat availability and diversity. Grazing management and rangeland projects routinely benefit livestock and watershed management efforts but can also help in improving wildlife habitat and management. Since there are species of concern within the watershed, project planners should consider whether the proposed activities are beneficial or detrimental to the habitat requirements of the particular species. Sage grouse is an example of a species that would benefit from changes in grazing management. Grazing management changes could improve sagebrush, forb, and grass composition. Proposed water tank and troughs should have wildlife escape ramps to provide the sage grouse access to water but prevent drowning.

Recommended alternatives and proposed conceptual projects for improving livestock/wildlife water sources are included in Section 4.3 of this report. Suggested management options to address other issues and concerns on uplands and rangeland are included in Section 4.6. These recommendations, proposals, and suggestions were developed in consideration of cost-effectiveness, site characteristics and accessibility, and technical and economic feasibility.

3.4.6 Mining and Mineral Resources

Twelve operating mineral mines are within the study area. Information about the mines was obtained from WDEQ and summarized in Table 3.8 and Figure 3.11. Sand and gravel mines constitute the majority of permitted mine operations with other minerals mined within the study rea include bentonite, feldspar, and limestone. The largest operation within the study area is the Eagle Creek mine on a permitted acreage of 440 acres.

3.4.7 Oil and Gas Production and Resources

Information and data regarding the active and abandoned oil and gas wells within the study area was obtained from the WOGCC by accessing their website (*http://wogccms.state.wy.us/*) and by communicating with WOGCC staff. Approximately 19 producing gas wells, 257 producing oil wells, and 1,112 plugged and abandoned wells are within the study area. Locations of the active oil and gas wells and plugged and abandoned wells are displayed in Figure 3.12.

Table 3.8. Current Mineral Resource Mines Within the Study Area

Permit I.D.	Permitted Mine	Permittee	Commodity	Mine Acres
PT0215	Casper Pit	Knife River (JTL Group)	Sand/Gravel	433.4
PT0347	NA	Pacer Corporation	Feldspar	23.0
PT0361	NA	Mobile Concrete Inc.	Sand/Gravel	200.3
PT0547	NA	71 Construction	Sand/Gravel	147.0
PT0610	Wardwell	McMurry Ready Mix Co.	Sand/Gravel	292.3
PT0614	Miles	Mobile Concrete Inc.	Sand/Gravel	111.5
PT0666	Eagle Creek	McMurry Ready Mix Co.	Limestone	440.0
PT0668	Government Bridge Gravel	Mobile Concrete Inc.	Sand/Gravel	55.7
PT0695	487 Pit	71 Construction	Sand/Gravel	366.0
PT0706	71 Pit	71 Construction	Sand/Gravel	122.0
PT0714	Wing	Rock Springs Mineral Proc.	Bentonite	360.0
PT0732	Mills	Rock Springs Mineral Proc.	Bentonite	108.8

Thirty-seven oil and gas fields encompass approximately 23,230 surface acres in the watershed. However, all of the 197 wells that produced oil, gas, and water in 2012 were located in 23 of the 37 oil and gas fields within the watershed. These fields are located mostly in the Poison Spider Creek, Casper Creek, Muddy Creek, and Sand Spring Creek subwatersheds.

In 2012, the oil and gas wells in the the 23 fields produced approximately 450,353 barrels (bbls) of oil, 925,708 thousand cubic feet (mcf) of natural gas, and 23,650,528 bbls of water [Wyoming Oil and Gas Conservation Commission, 2013]. Table 3.9 summarizes the 2012 oil and gas production by field for the oil and gas wells in the 23 fields within the study. Field locations and pipelines are shown on Figure 3.13.

3.4.8 Wildlife and Habitat

3.4.8.1 Big Game

The WGFD provides a system of control, propagation, management and protection, and regulation of all wildlife in Wyoming [Wyoming Game and Fish Department, 2013a]. The WGFD monitors and maintains big game, small game, non-game, and fish populations through studies, surveys, and habitat analysis. The WGFD has recorded, mapped, and analyzed data for big game and developed geodata showing hunt areas, herd units, seasonal range, crucial range, parturition area, and migration routes and barriers for antelope, bighorn sheep, bison, elk, mule deer, moose, Rocky Mountain goat, and white-tailed deer.

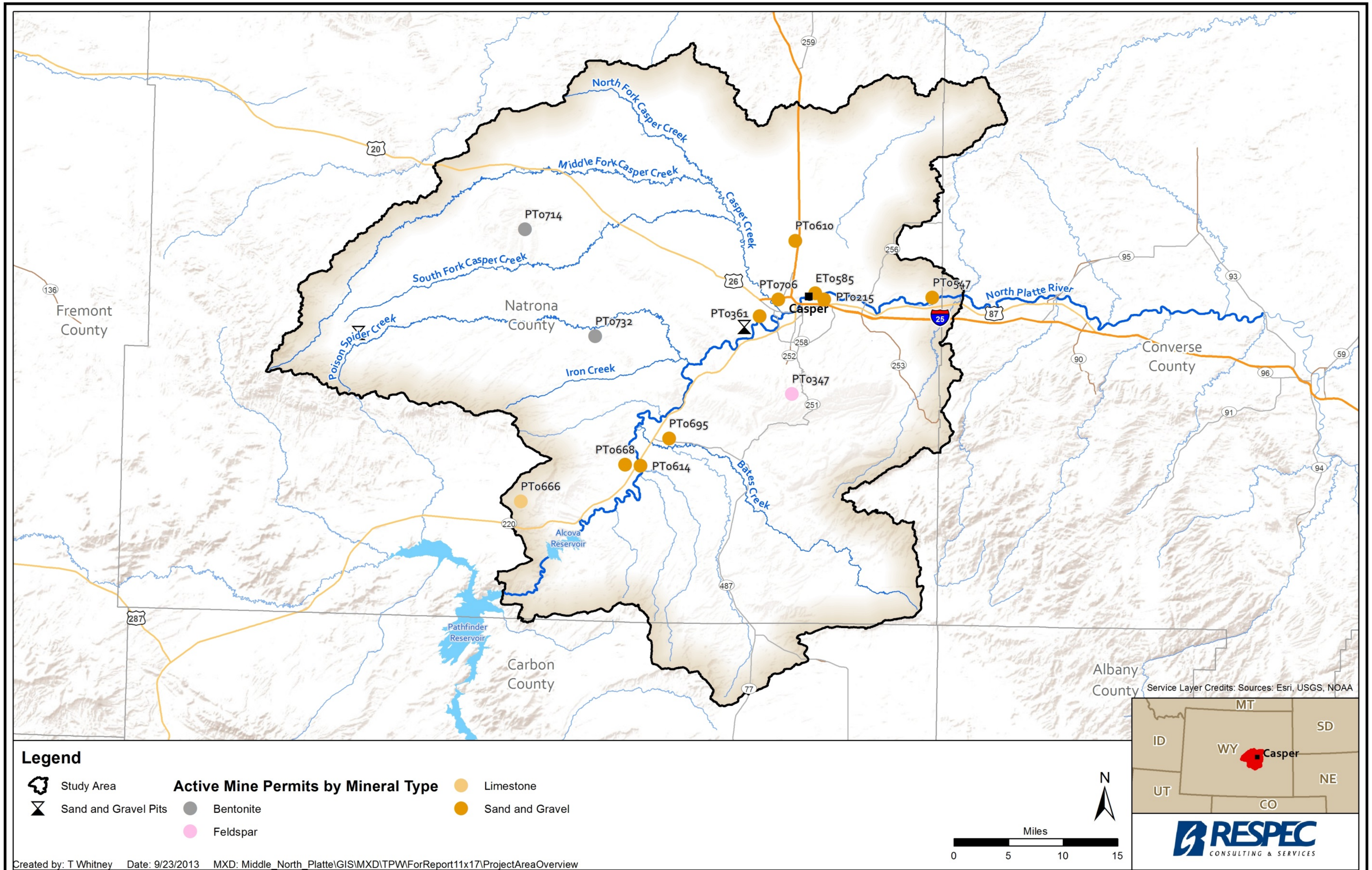

Figure 3.11. Permitted Mines Within the Middle North Platte Watershed.

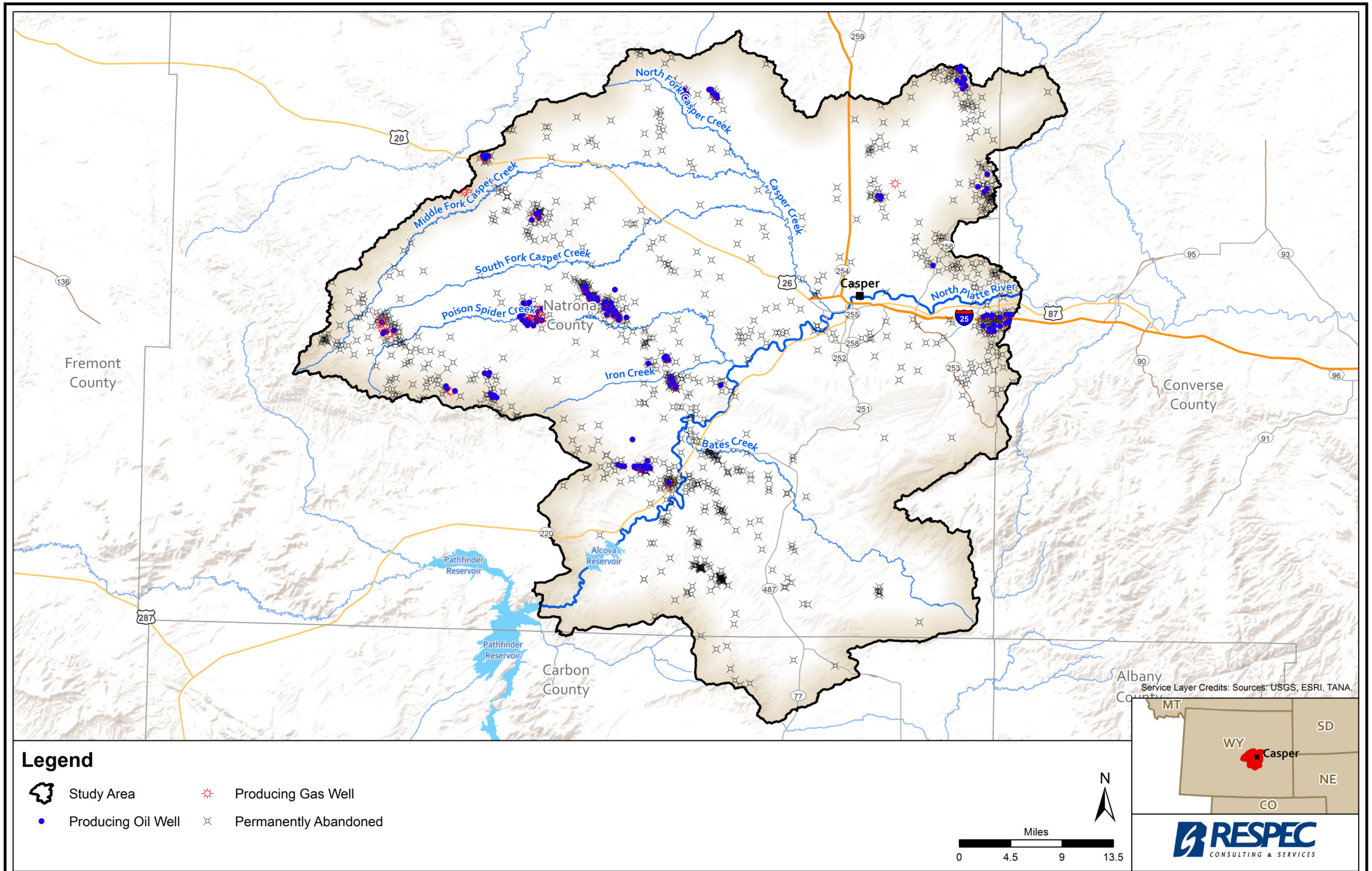

Figure 3.12. Active Oil and Gas Wells Within the Middle North Platte Watershed.

Table 3.9. Oil and Gas Production by Fields for 2012 Within the Study Area

Oil or Gas Field	Producing Wells	Abandoned Wells	Oil (bbls)[a]	Gas (mcf)[b]	Water (bbls)[a]
Austin Creek	1	1	23,617	680,761	1,486
Bates Creek	0	6	114	0	99
Brooks Ranch	11	41	21,722	0	13,459
Burke Ranch	3	1	3,847	0	135,220
Canal	0	3	3,443	6,886	0
Casper Creek North	1	4	8,524	0	1,935,324
Casper Creek South	51	35	134,384	0	15,649,909
Clark Ranch	3	4	15,442	0	402,125
Cole Creek	2	36	48,916	0	24,123
Geary Dome	0	1	2,017	0	2,666
Government Bridge	8	3	9,667	2,507	10,043
Grieve	2	0	2,040	0	301,443
Grieve North	2	8	0	16,197	0
Horse Ranch	4	6	8,502	0	1,976,096
Iron Creek	25	20	4,069	36	153,130
Oil Mountain	5	2	15,826	0	403,107
Pine Mountain	7	9	3,322	2,119	490,365
Poison Spider	40	21	66,793	0	743,835
Poison Spider West	27	11	23,683	123,787	12,544
Saddle Rock	2	0	338	67,726	0
Sage Spring Creek	4	8	56,699	23,424	1,528,309
Schrader Flats	0	10	76	0	0
Sun Ranch	0	6	212	2,265	0
Tipps	0	1	947	0	2,465
Total	**198**	**236**	**450,353**	**925,708**	**23,650,528**

(a) bbls = one barrel equals 42 (U.S.) gallons of liquid at 60°F at atmospheric pressure.
(b) mcf = One thousand cubic feet of natural gas.

Crucial range has been defined as seasonal ranges found to be the determining factor affecting a herd's ability to maintain stable and healthy populations. Parturition areas are those where lambing, fawning, or calving occur [Wyoming Game and Fish Department, 2013b]. Within the study area, approximately 416,700 acres (28 percent) have been classified as crucial range for elk, antelope, or mule deer. Figures 3.14–3.16 display the herd units, crucial range, and seasonal range for antelope, elk, and mule deer. These figures show that almost the entire watershed is seasonal range for antelope, elk, and mule deer although crucial range makes up a much smaller portion of the study area. No parturition areas are classified for any big game species within the study area.

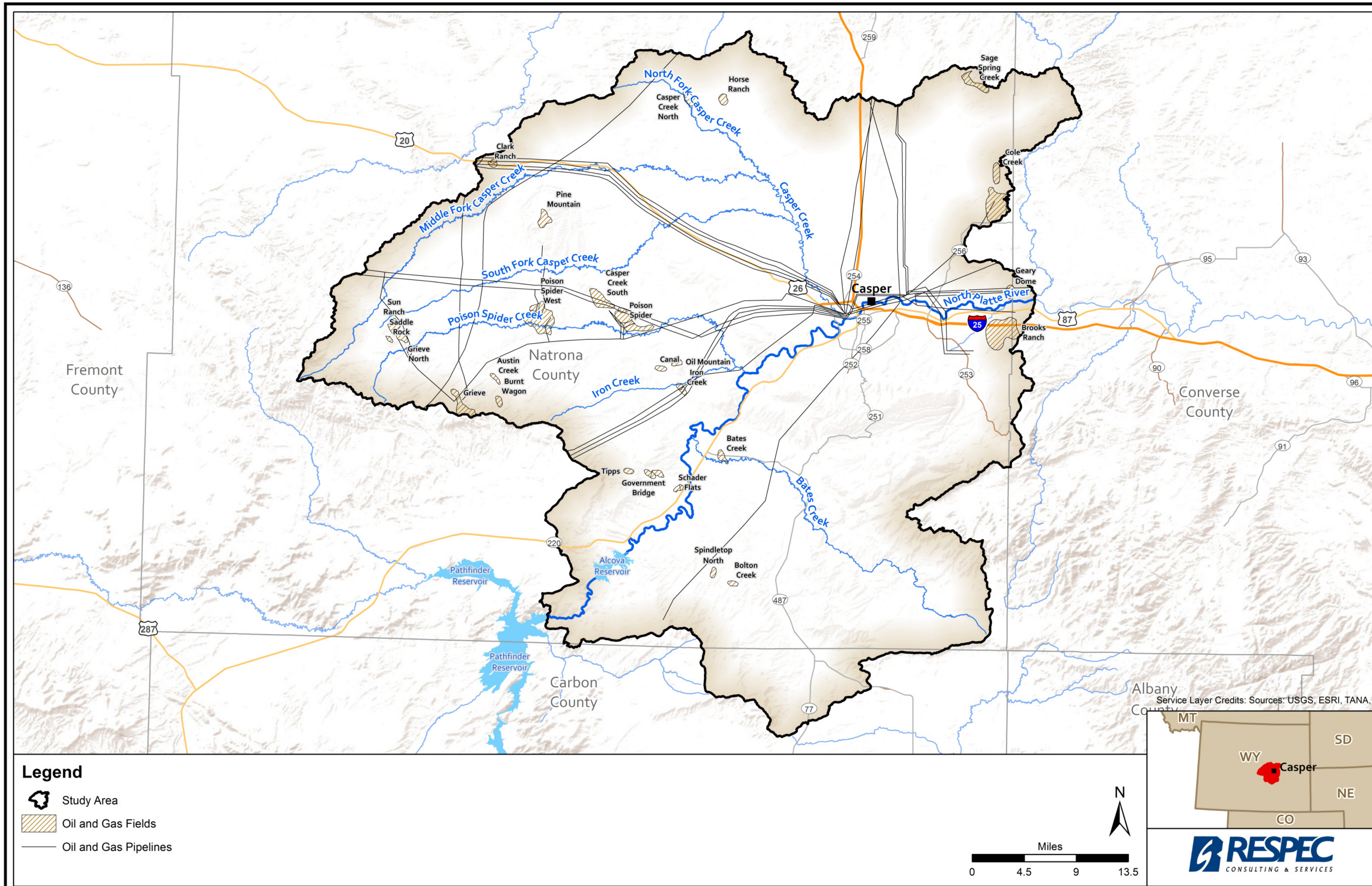

Figure 3.13. Active Oil and Gas Fields and Pipelines Within the Middle North Platte Watershed.

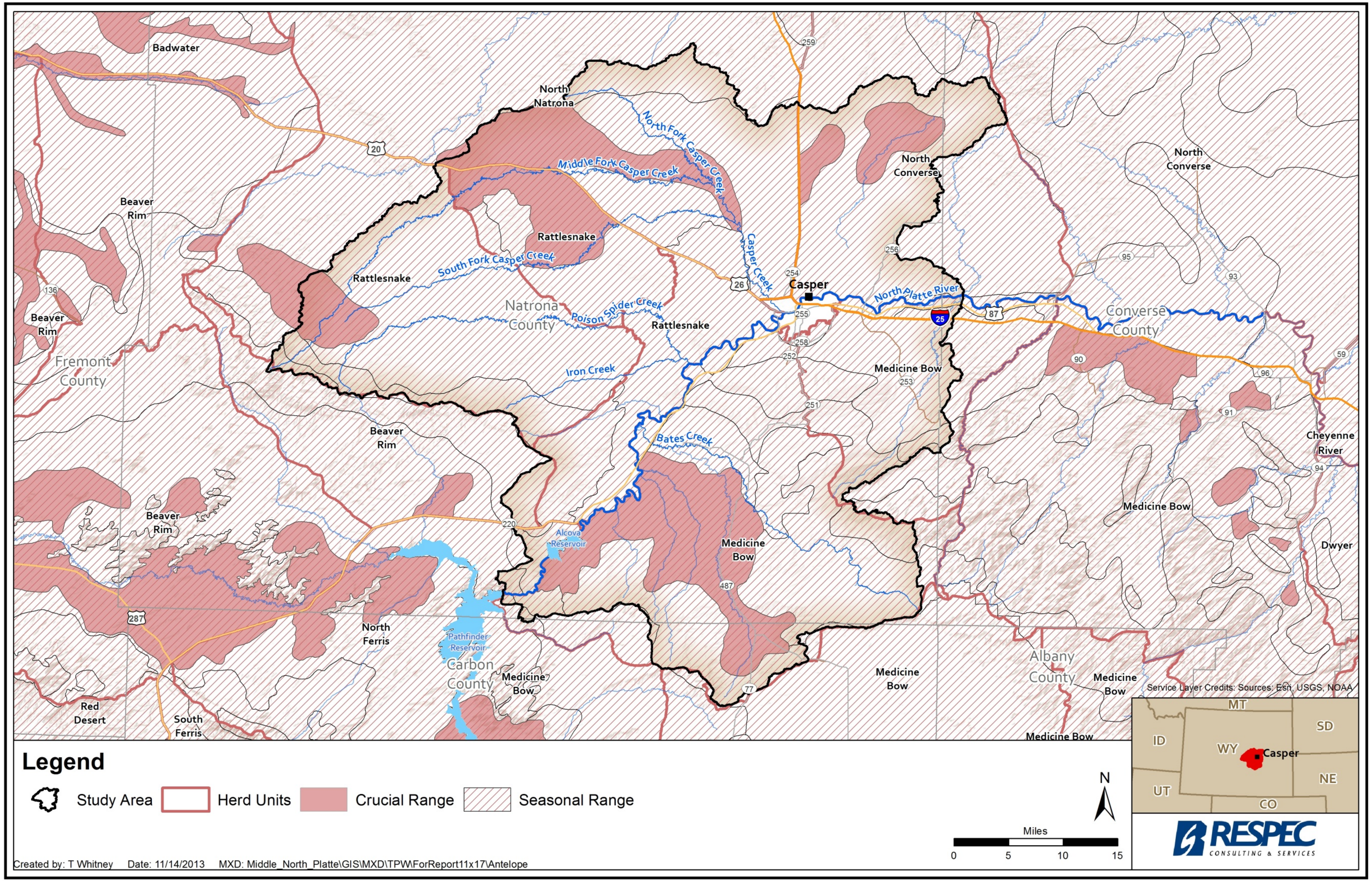

Figure 3.14. Antelope Habitat Within the Middle North Platte Watershed.

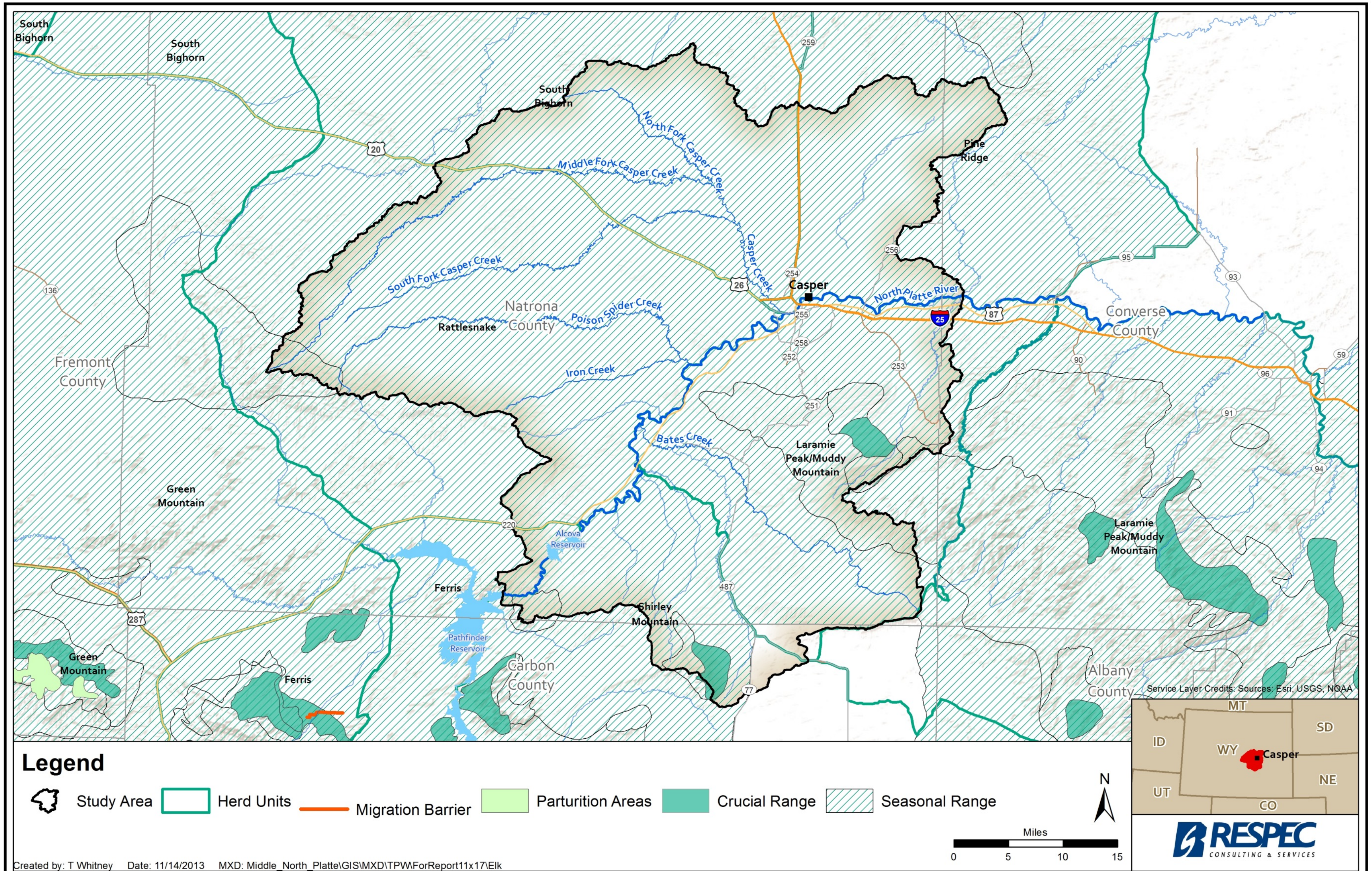

Figure 3.15. Elk Habitat Within the Middle North Platte Watershed.

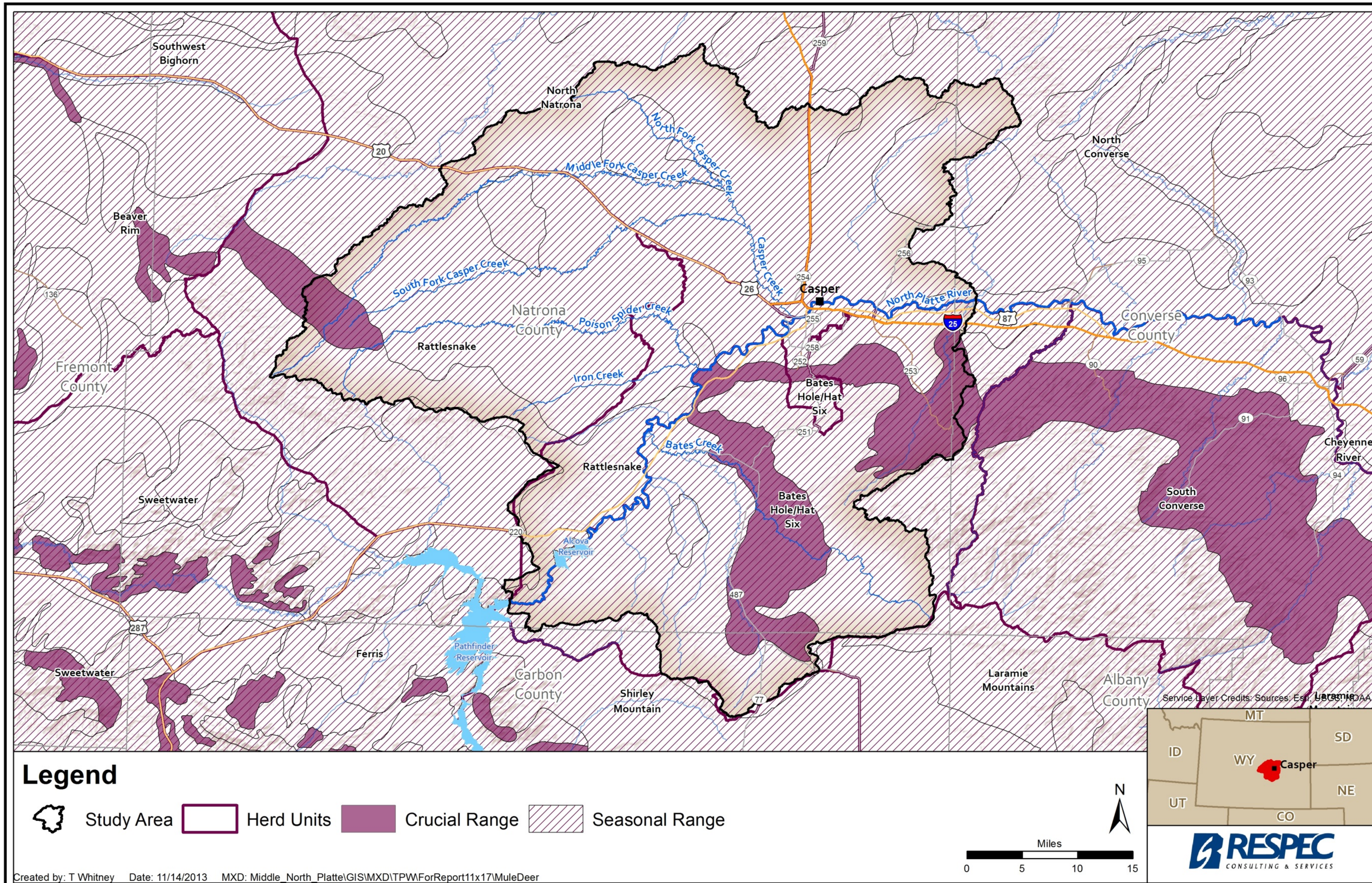

Figure 3.16. Mule Deer Habitat Within the Middle North Platte Watershed.

3.4.8.2 Species of Concern

The Wyoming Natural Diversity Database (WYNDD) records and maintains a list of species in Wyoming that are thought to be rare or sensitive. Tracked species are those vulnerable to extirpation because of rarity, inherent vulnerability, or habitat threats. Watched species are those that appear to be presently secure but have limited distribution. Table 3.10 lists the tracked or watched species of amphibians, birds, crustaceans, fish, mammals, mollusks, and reptiles found within the study area [Wyoming Natural Diversity Database, 2013]. The list shows that there is one endangered species known to have occurred in the study area: the black-footed ferret (*Mustela nigripes*). Two threatened species occur within the study area: piping plover (*Charadrius melodus*) and the Canada lynx (*Lynx canadensis*).

Also shown in Table 3.10, the sage grouse is listed as “candidate species; warranted but precluded” because existing information supports a proposal to list the sage grouse as endangered or threatened, but developing a proposed listing is precluded by higher priority listing activities. In 2011, the Governor of Wyoming issued an executive order aimed at protecting and enhancing sage grouse populations and habitat within and outside the core areas. The order requires state agencies to focus management to the greatest extent possible to prevent the sage grouse from being listed on the endangered species list. The core areas for sage grouse cover approximately 820,282 acres or 55 percent of the study area and are shown in Figure 3.17.

3.4.8.3 Habitat Priority Areas

As a part of the 2009 Strategic Habitat Plan (SHP), the WGFD has classified areas within the state as Crucial Habitat Priority Areas and Enhancement Habitat Priority Areas. Priority areas were further divided into riparian, aquatic, terrestrial, and combined habitats. Figure 3.18 displays the Habitat Priority Areas within the study area. Crucial, Enhancement, and Combined Habitat Priority Areas are defined by the WGFD [Wyoming Game and Fish Department, 2013d] as follows:

> *Crucial Habitat Priority Areas are based on significant biological or ecological values. These are areas that need to be protected or managed to maintain viable healthy populations of terrestrial and aquatic wildlife for the present and future. They represent habitat values and identify where those values occur on the landscape. Examples of values include crucial winter range, sage grouse core area seasonal habitats, Species of Greatest Conservation Need (SGCN) diversity and uniqueness, quality and condition of vegetative communities, movement corridors, quality of watershed hydrologic function, etc. The Department will concentrate habitat protection and management activities in these areas.*

Portions of one riparian and five terrestrial Crucial Habitat Priority Areas are within the watershed. The WGFD composed narratives that include habitat value, reason for selection, area description, affected species, and actions/solutions. The following summaries are quotes from the WGFD for each of the areas [Wyoming Game and Fish Department, 2013c].

Table 3.10. Wyoming Natural Diversity Database: Wildlife Species in the Study Area (Page 1 of 4)

Scientific Name	Common Name	Listing Status	Tracking Status
Amphibian			
Ambystoma mavortium	Tiger Salamander		Watched
Lithobates pipiens	Northern Leopard Frog	Not Warranted for Listing	Tracked
Bird			
Egretta thula	Snowy Egret		Watched
Nycticorax nycticorax	Black-crowned Night-Heron		Watched
Cygnus columbianus	Tundra Swan		Watched
Aythya collaris	Ring-necked Duck		Watched
Bucephala clangula	Common Goldeneye		Watched
Bucephala albeola	Bufflehead		Watched
Pandion haliaetus	Osprey		Watched
Aquila chrysaetos	Golden Eagle		Watched
Falco columbarius	Merlin		Watched
Rallus limicola	Virginia Rail		Watched
Grus canadensis	Sandhill Crane		Watched
Charadrius melodus	Piping Plover	Listed Threatened	Watched
Himantopus mexicanus	Black-necked Stilt		Watched
Recurvirostra americana	American Avocet		Watched
Phalaropus lobatus	Red-necked Phalarope		Watched
Larus delawarensis	Ring-billed Gull		Watched
Larus californicus	California Gull		Watched
Larus argentatus	Herring Gull		Watched
Sterna hirundo	Common Tern		Watched
Tyto alba	Barn Owl		Watched
Megascops asio	Eastern Screech-Owl		Watched
Chaetura pelagica	Chimney Swift		Watched
Sayornis phoebe	Eastern Phoebe		Watched
Myiarchus cinerascens	Ash-throated Flycatcher		Watched
Catherpes mexicanus	Canyon Wren		Watched
Troglodytes hiemalis	Winter Wren		Watched
Cinclus mexicanus	American Dipper		Watched
Regulus satrapa	Golden-crowned Kinglet		Watched
Sialia sialis	Eastern Bluebird		Watched

Table 3.10. Wyoming Natural Diversity Database: Wildlife Species in the Study Area (Page 2 of 4)

Scientific Name	Common Name	Listing Status	Tracking Status
Oreoscoptes montanus	Sage Thrasher		Watched
Vireo olivaceus	Red-eyed Vireo		Watched
Setophaga townsendi	Townsend's Warbler		Watched
Pheucticus ludovicianus	Rose-breasted Grosbeak		Watched
Passerina caerulea	Blue Grosbeak		Watched
Passerina cyanea	Indigo Bunting		Watched
Spizella pallida	Clay-colored Sparrow		Watched
Spizella breweri	Brewer's Sparrow		Watched
Ammodramus savannarum	Grasshopper Sparrow		Watched
Junco hyemalis aikeni	White-winged Junco		Watched
Gavia immer	Common Loon		Tracked
Aechmophorus clarkii	Clark's Grebe		Tracked
Pelecanus erythrorhynchos	American White Pelican		Tracked
Plegadis chihi	White-faced Ibis		Tracked
Cygnus buccinator	Trumpeter Swan	Not Warranted for Listing	Tracked
Haliaeetus leucocephalus	Bald Eagle	Delisted, formally monitored	Tracked
Accipiter gentilis	Northern Goshawk	Not Warranted for Listing	Tracked
Buteo regalis	Ferruginous Hawk		Tracked
Falco peregrinus	Peregrine Falcon	Delisted, formally monitored	Tracked
Lagopus leucura	White-tailed Ptarmigan	Petition Under Review	Tracked
Centrocercus urophasianus	Greater Sage-Grouse	Warranted but Precluded	Tracked
Charadrius nivosus	Snowy Plover		Tracked
Charadrius montanus	Mountain Plover	Not Warranted for Listing	Tracked
Numenius americanus	Long-billed Curlew		Tracked
Hydroprogne caspia	Caspian Tern		Tracked
Sterna forsteri	Forster's Tern		Tracked
Chlidonias niger	Black Tern		Tracked
Coccyzus erythropthalmus	Black-billed Cuckoo		Tracked
Coccyzus americanus	Yellow-billed Cuckoo		Tracked
Glaucidium gnoma	Northern Pygmy-Owl		Tracked
Athene cunicularia	Burrowing Owl		Tracked

Table 3.10. Wyoming Natural Diversity Database: Wildlife Species in the Study Area (Page 3 of 4)

Scientific Name	Common Name	Listing Status	Tracking Status
Asio flammeus	Short-eared Owl		Tracked
Selasphorus calliope	Calliope Hummingbird		Tracked
Melanerpes lewis	Lewis's Woodpecker		Tracked
Picoides arcticus	Black-backed Woodpecker		Tracked
Picoides dorsalis	American Three-toed Woodpecker		Tracked
Aphelocoma californica	Western Scrub-Jay		Tracked
Baeolophus ridgwayi	Juniper Titmouse		Tracked
Psaltriparus minimus	Bushtit		Tracked
Sitta pygmaea	Pygmy Nuthatch		Tracked
Lanius ludovicianus	Loggerhead Shrike		Tracked
Oreothlypis virginiae	Virginia's Warbler		Tracked
Setophaga nigrescens	Black-throated Gray Warbler		Tracked
Artemisiospiza nevadensis	Sagebrush Sparrow		Tracked
Ammodramus bairdii	Baird's Sparrow		Tracked
Rhynchophanes mccownii	McCown's Longspur		Tracked
Calcarius ornatus	Chestnut-collared Longspur		Tracked
Dolichonyx oryzivorus	Bobolink		Tracked
Leucosticte atrata	Black Rosy-Finch		Tracked
Crustacean			
Branchinecta lindahli	Versatile Fairy Shrimp		Tracked
Branchinecta paludosa	Circumpolar Fairy Shrimp		Tracked
Branchinecta lateralis	Pocket Pouch Fairy Shrimp		Tracked
Fish			
Luxilus cornutus	Common Shiner		Watched
Etheostoma exile	Iowa Darter		Watched
Hiodon alosoides	Goldeye		Tracked
Mammal			
Myotis lucifugus	Little Brown Myotis	Petition Under Review	Watched
Myotis evotis	Long-eared Myotis		Watched
Myotis volans	Long-legged Myotis		Watched
Myotis ciliolabrum	Western Small-footed Myotis		Watched
Lasionycteris noctivagans	Silver-haired Bat		Watched
Lasiurus cinereus	Hoary Bat		Watched

Table 3.10. Wyoming Natural Diversity Database: Wildlife Species in the Study Area (Page 4 of 4)

Scientific Name	Common Name	Listing Status	Tracking Status
Sylvilagus floridanus	Eastern Cottontail		Watched
Urocitellus elegans	Wyoming Ground Squirrel		Watched
Urocyon cinereoargenteus ocythous	Prairie Gray Fox	Petition Under Review	Watched
Ovis canadensis	Bighorn Sheep		Watched
Corynorhinus townsendii	Townsend's Big-eared Bat		Tracked
Antrozous pallidus	Pallid Bat		Tracked
Cynomys ludovicianus	Black-tailed Prairie Dog	Not Warranted for Listing	Tracked
Cynomys leucurus	White-tailed Prairie Dog	Not Warranted for Listing	Tracked
Canis lupus	Gray Wolf	Proposed for Delisting	Tracked
Vulpes velox	Swift Fox	Not Warranted for Listing	Tracked
Mustela nigripes	Black-footed Ferret	Listed Endangered	Tracked
Lontra canadensis	Northern River Otter		Tracked
Lynx canadensis	Canada Lynx	Listed Threatened	Tracked
Bos bison bison	Plains Bison	Not Warranted for Listing	Tracked
Mollusc			
Lampsilis cardium	Plain Pocketbook		Tracked
Lampsilis siliquoidea	Fatmucket		Tracked
Fossaria parva	Pygmy Fossaria		Tracked
Physa acuta	Pewter Physa		Tracked
Gyraulus parvus	Ash Gyro		Tracked
Reptile			
Apalone spinifera	Spiny Softshell		Watched
Coluber constrictor flaviventris	Eastern Yellowbelly Racer		Watched
Lampropeltis triangulum multistriata	Pale Milksnake		Watched
Pituophis catenifer sayi	Bullsnake		Watched
Thamnophis sirtalis parietalis	Red-sided Gartersnake		Watched
Opheodrys vernalis	Smooth Greensnake		Tracked

North Platte Corridor (riparian)

Productive sport fishery, cottonwood gallery forest, riparian wetlands The Miracle Mile and Grey Reef sections of the North Platte River are renowned "blue ribbon" sport fisheries and Seminoe, Pathfinder and Alcova Reservoirs annually provide over 100,000 angler days.

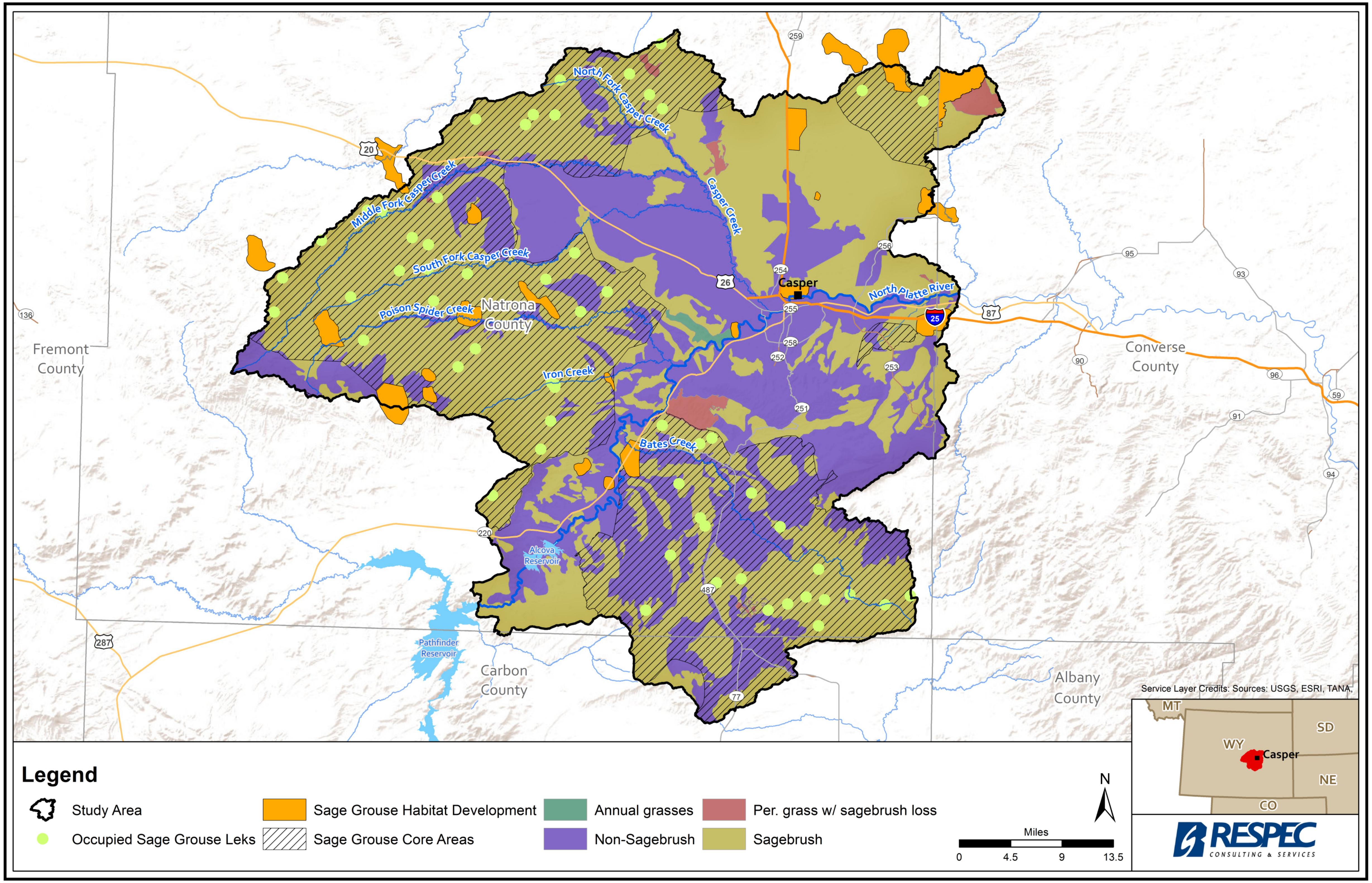

Figure 3.17. Sage Grouse Distribution and Core Areas Within the Study Area.

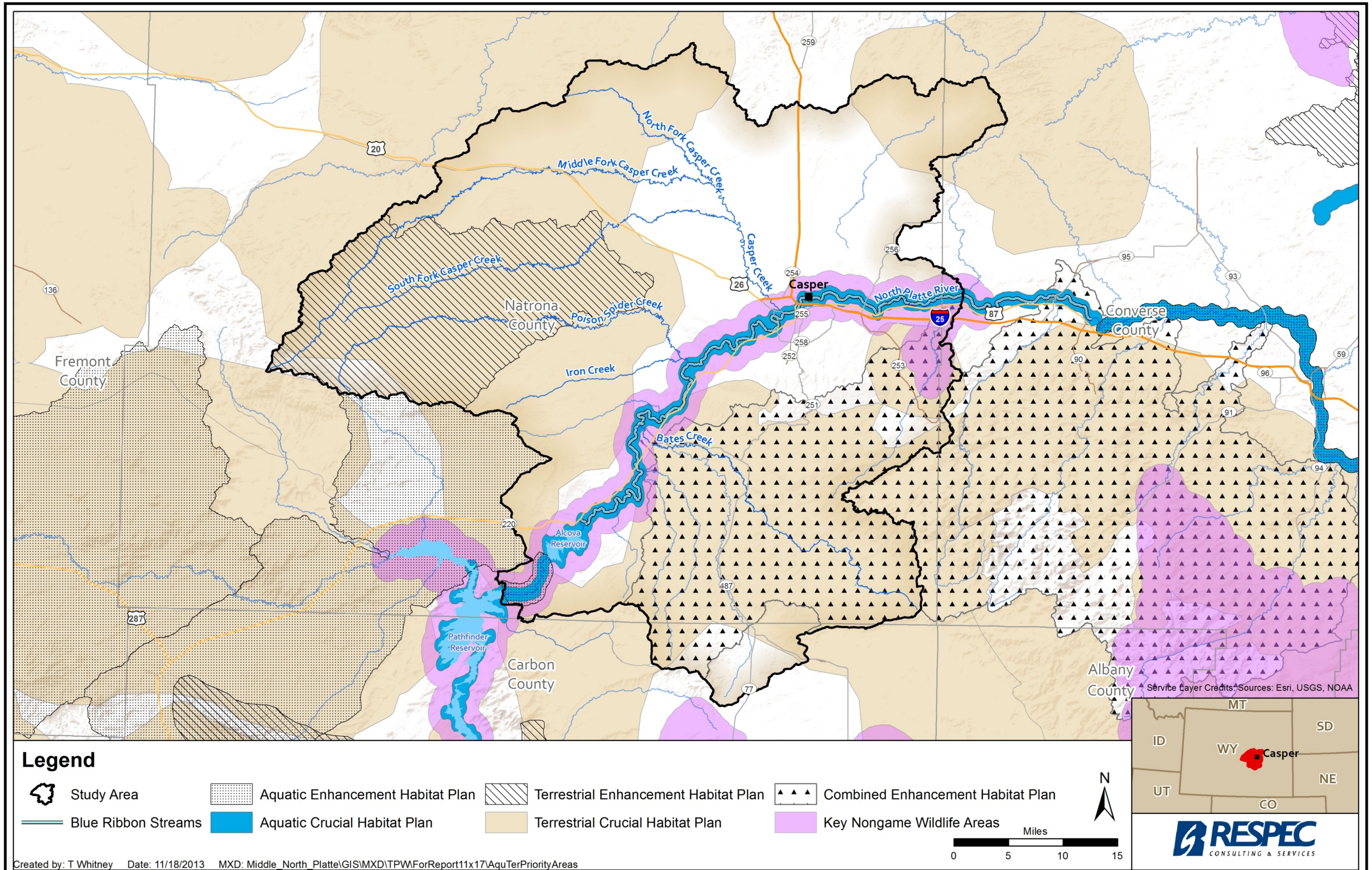

Figure 3.18. Aquatic and Terrestrial Habitat Within the Watershed.

- *Table 3.6. Predominant Ecological Sites, Descriptions, and Areas Within Study*

- *The river and reservoir fisheries are directly dependent on water management decisions (flow release timing, and quantity) and requirements made by the Bureau of Reclamation.*

- *Limited spawning habitat and fine sediment intrusion limit the spawning habitat quality. Limited spawning gravels in the Cardwell reach below Pathfinder Reservoir inhibit trout recruitment. Water temperatures in downstream areas limit trout numbers.*

- *Includes several Commission public access areas.*

Bates Hole (terrestrial)

- *The habitat values that contributed in selecting this area include big game crucial winter ranges, big game parturition areas, Governor's sage grouse core habitat areas, quality and condition of big sagebrush/grassland, aspen, riparian and true mountain mahogany communities, quality of watershed hydrologic function, and quantity of stream flow.*

- *Implement prescribed fire, chemical and mechanical treatments to restore degraded big sagebrush, aspen, riparian and true mountain mahogany communities.*

Hat Six (terrestrial)

- *The habitat values that contributed in selecting this area include big game crucial winter-yearlong ranges, Governor's sage grouse core habitat areas, quality and condition of big sagebrush/grassland, riparian and true mountain mahogany communities.*

Dry Creek-Rattlesnake Hills (terrestrial)

- *The habitat values that contributed in selecting this area include mule deer winter-yearlong ranges, Governor's sage grouse core habitat areas, quality and condition of big sagebrush/grassland, and riparian-willow communities.*

Ormsby (terrestrial)

- *Pronghorn winter-yearlong ranges, Governor's sage grouse core habitat areas, and big sagebrush/grassland, and riparian cottonwood communities.*

North Natrona (terrestrial)

- *Big game crucial winter-yearlong ranges, Governor's sage grouse core habitat areas, watershed hydrologic function, and stream flow.*

- *Implement prescribed fire, chemical and mechanical treatments to restore degraded big sagebrush, aspen, and riparian communities.*

3.4.9 Cultural Resources

Cultural resources are any prehistoric or historic district, site, building, structure, or object considered important to a culture, subculture, or community for scientific, traditional, religious, or other purposes [Bureau of Land Management, 2007]. Historic era resources include trails, wagon roads, stage roads, transmission lines, irrigation canals, urban buildings, homesteads and ranches, stock-herding camps, cairns, oilfields, bridges, mines, Civilian Conservation Corps camps, and World War II bombing ranges [Bureau of Land Management, 2007].

The Wyoming State Historic Preservation Office (SHPO) maintains a database of inventoried historic sites within the state. The SHPO makes available a spatial data file that generalizes the cultural resource inventory to the section level. This level of locating archaeological data protects the sites from unauthorized disturbance. The attributes recorded for each section include site count, inventory acres, report numbers, and eligible site number. Figure 3.19 displays the results of the data retrieval graphically. Each section within the study area has been color coded based upon the number of sites within it determined to be eligible for inclusion in the National Register of Historic Places (Register).

3.4.9.1 National Historic Trails

Portions of four national historic trails (NHTs) and other historic sites of regional and national importance within the study area. The four NHTs are formally known as the "Oregon–California–Mormon Pioneer–Pony Express Trail," but generically as the Oregon Trail because the routes overlap in many areas [Bureau of Land Management, 2007]. The NHTs are associated with sites such as Fort Caspar and are routes, along with the Bozeman and Bridger trails, which were major thoroughfares for westward expansion, military campaigns, and to the gold fields of California, Idaho, and Montana [Bureau of Land Management, 2007]. Tourists visit NHTs within the watershed via vehicles, hiking, and horseback and visit numerous historical markers and interpretive displays at Fort Casper, Bessemer Bend, Emigrant Gap, and Ryan Hill, and the National Historic Trails Interpretive Center in Casper.

3.4.9.2 Management Considerations

Because cultural resources warrant special consideration within the study area, guidelines have been developed by local historic organizations and state and federal agencies to preserve and protect these resources based on the historical significance and integrity of the resource site and setting. There is a significant amount of literature regarding the historic and cultural resources in the watershed. The documents consist of inventories, evaluations, and plans for protecting the sites from adverse impacts from natural or human-caused deterioration, reducing conflicts with other uses, and preserving the significant cultural, scientific, and recreational values of the sites. These guidelines contain actions or measures that may prohibit surface development and surface disturbance depending on the specific site characteristics.

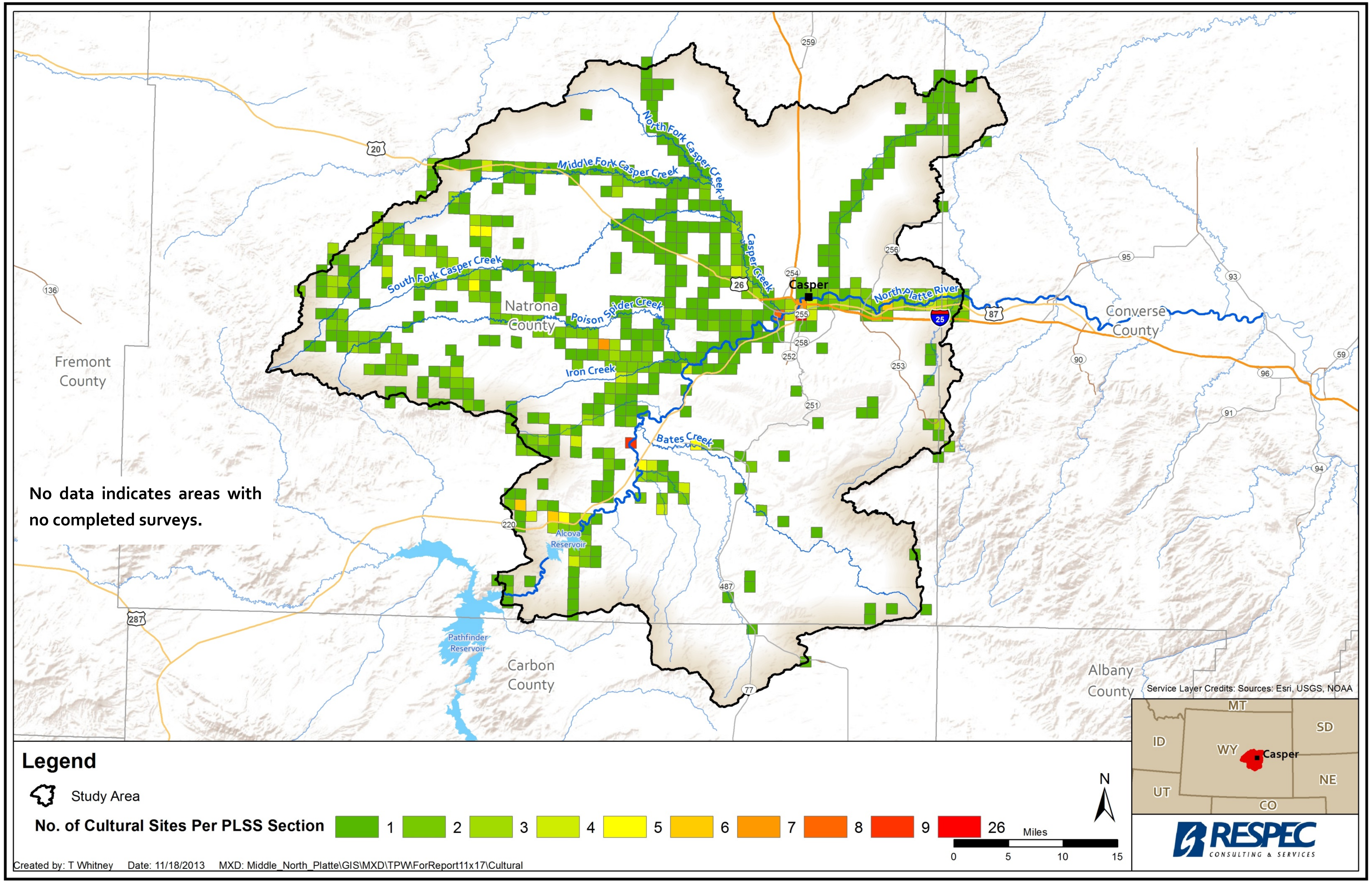

Figure 3.19. Cultural Sites per PLSS Section Within the Study Area.

3.5 SETTING AND ENVIRONMENT

The setting and environment for the for the Middle North Platte Watershed are discussed in the following sections.

3.5.1 Topography

The Middle North Platte Watershed covers parts of the Wyoming Basin, Southern Rockies, and Northwestern Great Plains land regions and has a varied topography with mountains, mountains valleys, foothills and steppes, river breaks and valleys, alluvial fans, rolling plains, playas, and sand dunes. Elevations in the study area range from 5,005 feet above mean sea level (msl) where Cole Creek enters the North Platte River, approximately 2 miles downstream of the Natrona/Converse county line, to over 8,460 feet msl in the Deer Creek Range on the divide between East Fork Bates Creek and the Deer Creek drainage. Other elevations within the watershed include Casper Mountain summit at 7,848 feet msl, Muddy Mountain at 8,271 feet msl, Ice Cave Mountain at 7,707 feet msl, Pine Mountain at 6,749 feet msl, Bear Mountain at 7,503 feet msl in Bates Hole, and Garfield Peak at 8,238 feet msl in the Rattlesnake Hills.

The Middle North Platte Watershed is approximately 60 miles long and 60 miles wide and is bounded on the north by the Powder Basin Salt Creek drainage and the northeast by the Dry Fork Cheyenne drainage. On the northwest, the study area is bounded by the South Fork Powder River drainage. On the southwest, the watershed is bounded by the Sweetwater River drainage and the Rattlesnake Hills. On the south, the study area boundary is the Pathfinder Dam and Reservoir, Little Medicine Bow River drainage, and the Shirley Basin and Rim. On the east, the watershed is bounded by the Deer Creek Range of the Laramie Mountains. The Casper Arch is a structural arch and northwest-trending uplifted area north of Casper Mountain dissecting the northern portion of the study area and serves as a transition area from the Northern Great Plains and the Wyoming Basin.

3.5.2 Climate

The wide-ranging topography of the watershed results in a variable climate but is generally consistent throughout the study area with typical annual precipitation is between 10 and 15 inches per year. The southeastern portion of the study area has higher elevations and generally receives 16 inches or more per year. Maximum precipitation occurs in the spring and early summer months. The watershed has a relatively cool climate, including late-spring and early-fall freezing with a relatively short growing season of 125 days. The highest temperatures typically occur in July and range between 75°F and 90°F. Low temperatures in January and range from 5°F to 15°F within the watershed.

Figure 3.20 displays Isohyetals of average annual precipitation throughout the study area. Data used to produce this plot was obtained from **Parameter-Elevation Regressions on Indepentent Slopes Model (PRISM)**, which summarized data from 1981 to 2010, listed in Table 3-11. As shown in the

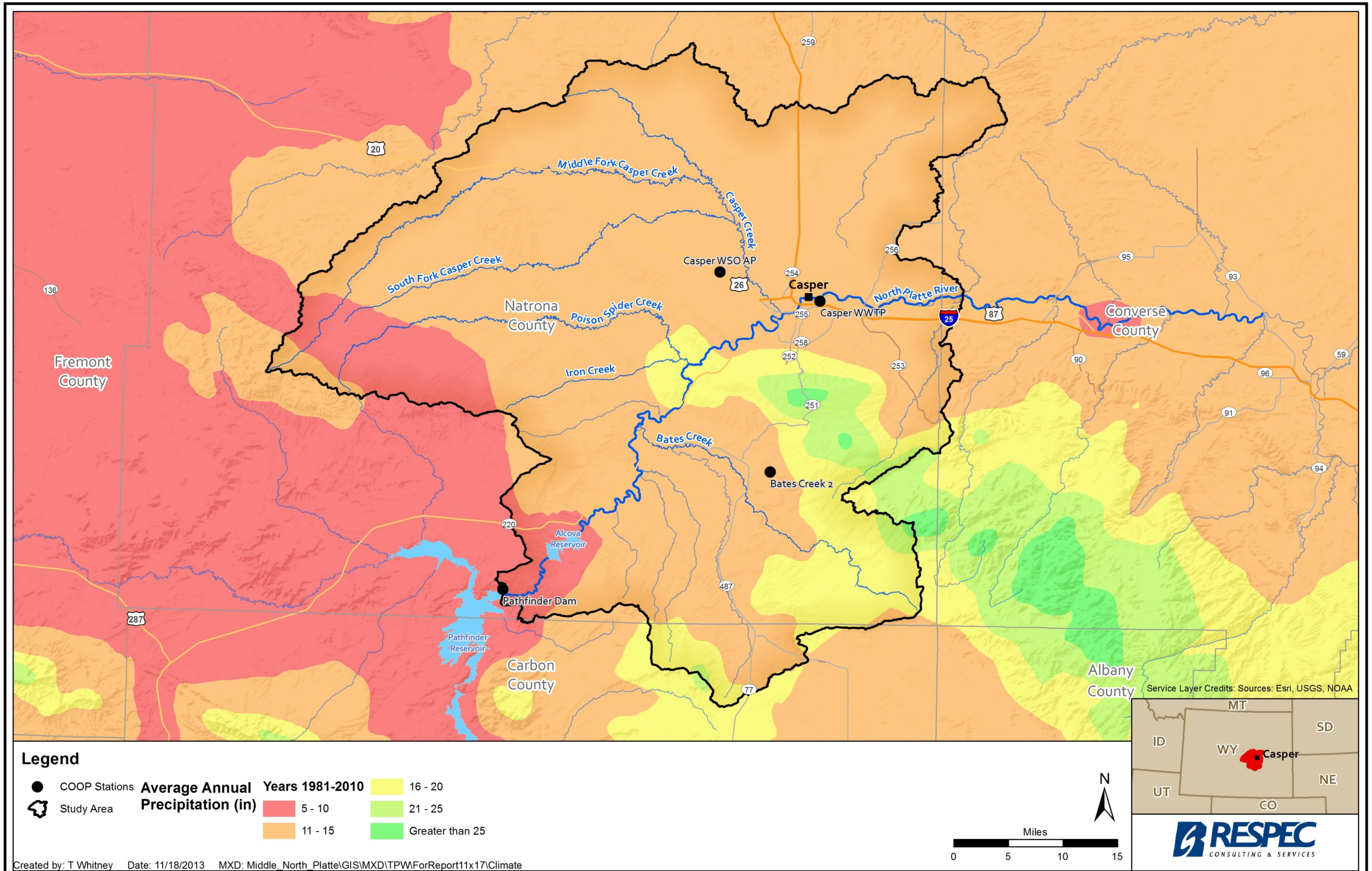

Figure 3.20. Average Annual Precipitation Isohyetals Throughout the Study Area.

Table 3.11. Summary of Monthly Climatic Data for Weather Stations Near Casper, Bates Creek, and Alcova, Wyoming

Bates Creek 2, Wyoming (480552) 1969-2012												
Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Average Maximum Temperature (F)	34.4	37.1	45.7	54.3	64.7	75.8	84.0	82.5	71.9	58.6	44.0	35.3
Average Minimum Temperature (F)	11.8	14.4	22.5	29.7	38.4	47.0	54.2	52.7	43.1	32.3	21.5	13.4
Average Precipitation (inches)	0.62	0.67	1.04	1.63	2.2	1.41	1.02	0.83	0.85	1.26	0.7	0.61
Casper 2E, Wyoming (481565) 1900-1981												
Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Average Maximum Temperature (F)	36.4	40.2	47.0	57.6	68.6	79.5	88.8	86.7	76.3	63.1	47.9	39.0
Average Minimum Temperature (F)	15.9	18.5	23.6	30.9	40.0	48.3	55.1	52.9	43.0	34.0	25.0	18.9
Average Precipitation (inches)	0.58	0.57	0.98	1.89	2.34	1.51	1.11	0.77	0.94	1.06	0.73	0.60
Casper WSO AP, Wyoming (481570) 1948-2012												
Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Average Maximum Temperature (F)	33.8	37.7	46.1	56.2	66.6	78.6	87.7	85.9	74.5	60.5	44.6	35.1
Average Minimum Temperature (F)	13.1	16.3	21.8	29.3	38.3	46.9	54.1	52.5	42.4	32.5	22.2	15.0
Average Precipitation (inches)	0.51	0.56	0.88	1.39	2.1	1.41	1.22	0.71	0.94	1.02	0.7	0.56
Alcova 17 NW, Wyoming (480091) 1961-1987												
Parameter	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Average Maximum Temperature (F)	28.3	31.5	38.5	47.1	60.2	71.1	81.8	77.9	68.3	54.6	38.1	30.0
Average Minimum Temperature (F)	13.0	16.5	21.2	27.8	38.2	47.7	56.4	53.1	43.9	35.0	22.2	14.2
Average Precipitation (inches)	0.41	0.64	0.70	1.39	1.82	1.60	0.79	0.74	0.82	1.10	0.87	0.45

table, average annual precipitation can vary significantly throughout the study area. Locations in the western region of the study area have as little precipitation as 5 inches per year, while locations in the western region of the study area have in excess of 25 inches per year. Historical climatic data were obtained from four meteorological stations within the study area.

Three of the meteorological stations are operated and maintained through cooperative agreements with the National Weather Service; the other is operated by the Casper Natrona County Airport. Locations of these meteorological stations are displayed in Figure 3.20. Figures 3.21 through 3.24 display historic annual precipitation totals for the Bates Creek No. 2 and Casper 2E and Casper WSO AP and Alcova 17 NW meteorological stations, respectively. Temperature data at the four meteorological stations are also shown in Figures 3.21 through 3.24. To gain insight about the seasonality of temperature and precipitation patterns, corresponding monthly mean precipitation values are displayed on these plots as well.

3.5.3 Land Cover

Table 3.12 is a summary of land cover using the National Land Cover Dataset (NLCD). The NLCD is a 16-category land cover classification method that is applied across the United States. The NLCD uses data derived from Landsat imagery and ancillary data. Approximately 90 percent or 1,341,124 acres of land cover within the study area is comprised of shrub/scrub and grassland/herbaceous vegetative cover. The remaining areas consist of forests, pasture and hay, and other small land cover classes. Shrub/scrub covers approximately 943,981 acres or over 63 percent; grassland/herbaceous covers 397,143 acres or over 26 percent of the watershed. An estimated 8 square miles of water exists, which is 0.3 percent of the study area.

3.5.4 Vegetation

Vegetative cover within the watershed was evaluated using data obtained through the NatureServer developed *Terrestrial Ecological Systems Classification* framework which "defines groups of plant community types that tend to co-occur within the landscapes with similar ecological processes, substrates and /or environmental gradients" [Comer et al., 2003]. These classifications have been done at various levels from Class (7 levels) to Ecological System (556 levels). There were 49 classifications within the study area but only 15 classifications that were 1 percent or more of the total study area.

The NatureServe vegetative classification data within the study was summarized because the NatureServe data including species, distribution and classification provides the basis for **LANDFIRE** vegetation geospatial data products. **LANDFIRE** is a vegetation, fire, and fuel mapping program sponsored by the USDI and USDA to create fuel and fire regimes datasets and geospatial layers. A summary of the NatureServe vegetative classifications that were 1 percent or more within the study area is shown in Table 3.13

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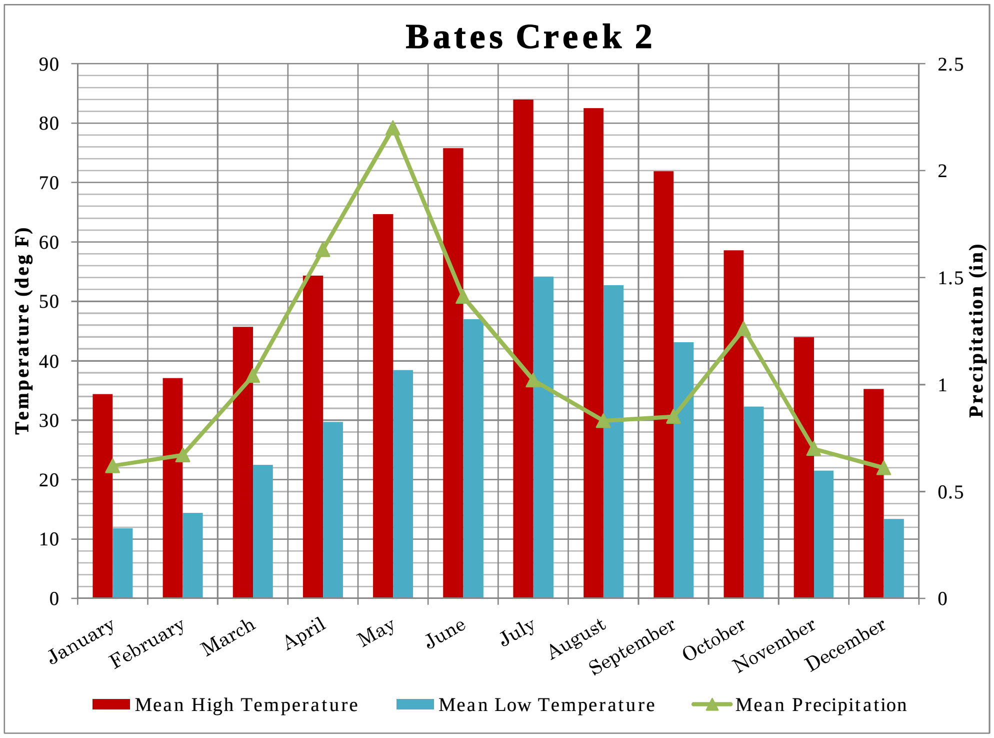

Figure 3.21. Bates Creek 2 Monthly Mean Temperature and Precipitation.

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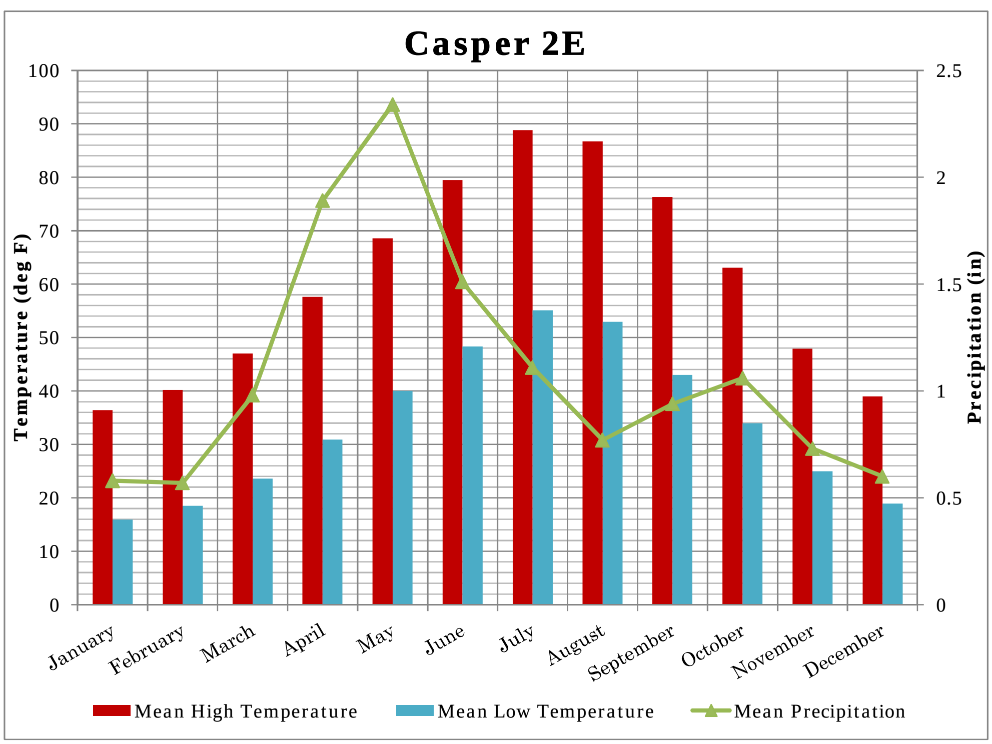

Figure 3.22. Casper 2E Monthly Mean Temperature and Precipitation.

RSI-2129-14-025

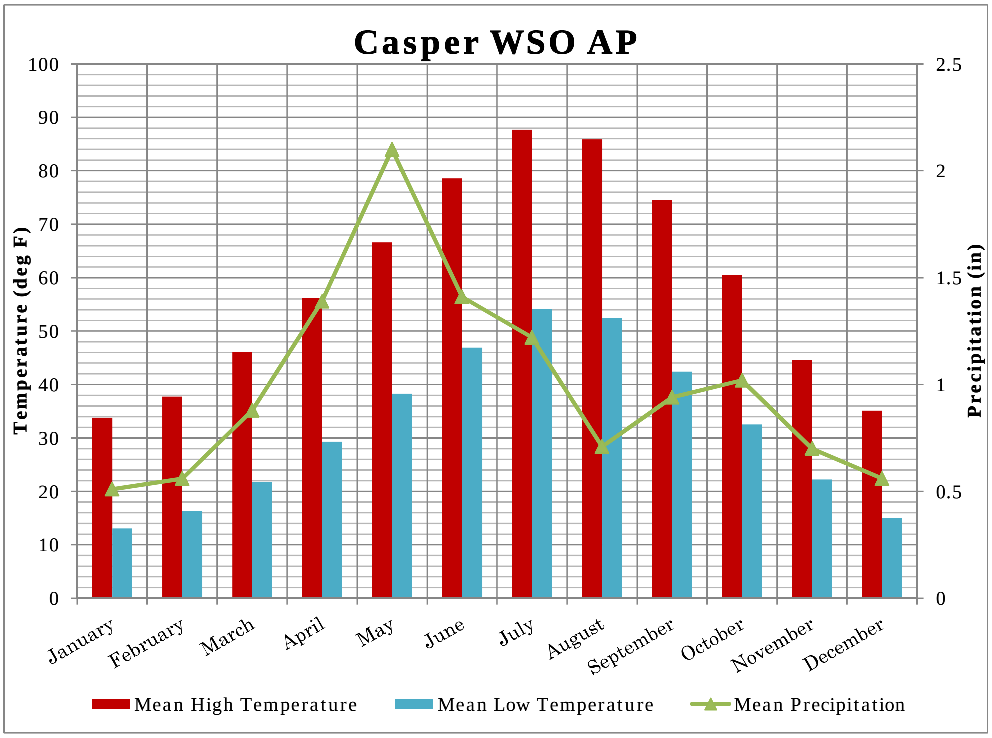

Figure 3.23. Casper WSO AP Monthly Mean Temperature and Precipitation.

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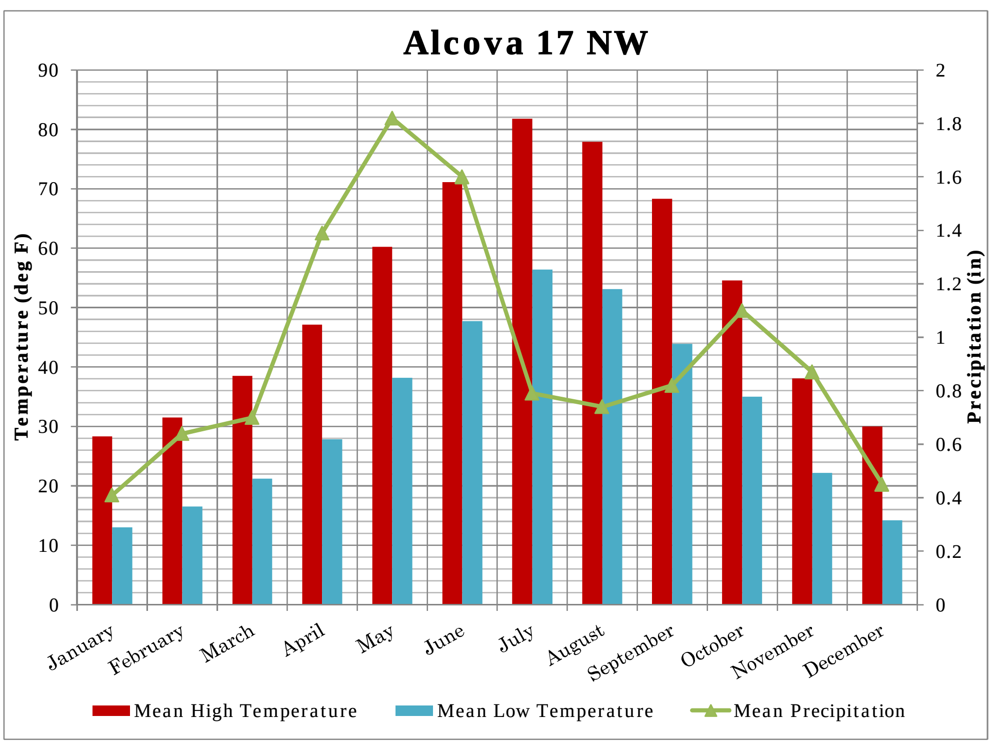

Figure 3.24. Alcova 17 NW Monthly Mean Temperature and Precipitation.

Table 3.12. National Land Cover Dataset Classifications in the Study Area

Classification	Description	Area (Acres)	Percent of Area
Shrub and Scrub	Shrubs less than 16 feet tall with canopy typically greater than 20% of total vegetation. This class includes shrubs and trees in early successional stages or stunted from environmental conditions.	943,981	63.5
Grassland and Herbaceous	Gramanoid or herbaceous vegetation, generally greater than 80 percent of total vegetation. These areas are not subject to intensive management such as tilling, but can be used for grazing.	397,143	26.7
Evergreen Forest	Trees greater than 16 feet tall, and greater than 20 percent of total vegetation cover. More than 75 percent of the tree species maintain their leaves all year. Canopy is never without green foliage.	53,073	3.6
Pasture and Hay	Grasses, legumes, or mixtures planted for livestock grazing or the production of seed or hay crops on a perennial cycle. Pasture/hay vegetation accounts for greater than 20 percent of total vegetation.	24,697	1.6
Developed, Open Space	A mixture of some constructed materials, but mostly vegetation in the form of lawn grasses. Impervious surfaces account for less than 20 percent of cover. These areas commonly include large-lot single-family housing units, parks, golf courses, and vegetation planted in developments for recreation, erosion control, or aesthetic purposes.	16,971	1.1
Woody Wetlands	Forests or shrublands accounts for greater than 20 percent of total and the soil is periodically saturated or covered with water.	11,332	0.8
Emergent Herbaceous Wetlands	Perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically saturated with or covered with water.	10,061	0.7
Developed, Low Intensity	A mixture of constructed materials and vegetation. Impervious surfaces account for 20 percent to 49 percent of total cover. These areas most commonly include single-family housing units.	8,182	0.6
Barren Land (Rock/Sand/Clay)	Bedrock, desert pavement, scarps, talus, slides, volcanic material, glacial debris, sand dunes, strip mines, gravel pits and other earthen material. Vegetation accounts for less than 15% of total.	6,897	0.5
Open Water	Open water, usually less than 25 percent cover of vegetation or soil.	5,110	0.3
Developed, Medium Intensity	A mixture of constructed materials and vegetation. Impervious surfaces account for 50 percent to 79 percent of the total cover. These areas most commonly include single-family housing units.	4,393	0.3
Cultivated Crops	Production of annual crops and also perennial woody crops. Crops accounts for greater than 20 percent of total vegetation. This class also includes all land being actively tilled.	2,603	0.2
Other	Areas with less than 0.01 percent of the study area.	2,305	0.1
Total		**1,486,748**	**100.0**

Table 3.13. National Vegetation Classifications Within the Study Area

National Vegetation Classification	Area (acres)	Percent of Total
Intermountain Basins Big Sagebrush Steppe	734,605	49.4
Northwestern Great Plains Mixedgrass Prairie	159,987	10.8
Inter-Mountain Basins Active and Stabilized Dune	107,057	7.2
Inter-Mountain Basins Mat Saltbush Shrubland	92,612	6.2
Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	73,303	4.9
Rocky Mountain Foothill Limber Pine-Juniper Woodland	43,210	2.9
Inter-Mountain Basins Greasewood Flat	35,401	2.4
Pasture/Hay	30,855	2.1
Northwestern Great Plains - Ponderosa Pine Woodland and Savanna	28,303	1.9
Inter-Mountain Basins Montane Sagebrush Steppe	21,401	1.4
Western Great Plains Riparian Woodland and Shrubland	19,480	1.3
Inter-Mountain Basins Big Sagebrush Shrubland	17,319	1.2
Developed, Open Space	16,634	1.1
Western Great Plains Saline Depression Wetland	15,874	1.1
All other classes less than 1 each	90,707	6.1
Total	**1,486,748**	**100.0**

3.5.4.1 Existing Vegetation Cover

Existing vegetative cover in the watershed was evaluated using data obtained through the LANDFIRE program [U.S. Geological Survey, 2010]. LANDFIRE vegetation maps are mostly derived from the NatureServe ecological classifications. Other data are derived from NLCD, National Vegetation Classification Standard (NVCS) Alliances, and LANDFIRE specific types. The LANDFIRE data delineates several attributes relevant to this study, including: existing vegetation type (EVT), existing vegetation height (EVH), and existing vegetation cover (EVC).

The EVT layer represents the species composition currently present at a given site and are created using decision models, field data, Landsat imagery, elevation, and biophysical gradient data to collect the data necessary to develop wildland fire models [U.S. Geological Survey, 2010]. The LANDFIRE existing vegetation data specify 73 different vegetation classes on approximately 98.2 percent of the total study area. Table 3.14 summarizes the distribution of the wetland and riparian vegetation types in the watershed. The LANDFIRE EVT data were analyzed and all of the classifications summarized in Table 3.15. The dominant existing vegetation types covering almost 65 percent of the watershed include the Inter-Mountain Basins Big Sagebrush Steppe covering approximately 513,844 acres or 34.6 percent, Inter-

Mountain Basins Big Sagebrush Shrubland occurring on approximately 267,869 acres or 18.0 percent, and the Northwestern Great Plains Mixedgrass Prairie covering approximately 178,379 acres or 12.0 percent of the study area. The remaining 1.8 percent of the watershed was classified as nonvegetative or no dominant type.

Table 3.14. Existing Riparian and Wetland Vegetation Types Within the Study Area

Existing Vegetation Type	Area (acres)	Percent of Study Area
Western Great Plains Floodplain Systems	11,659	0.784
Herbaceous Wetlands	10,530	0.708
Rocky Mountain Montane Riparian Systems	5,611	0.377
Rocky Mountain Subalpine/ Upper Montane Riparian Systems	2,316	0.156
Western Great Plains Depressional Wetland Systems	65	0.004
Total	**30,182**	**2.030**

Although data from LANDFIRE can be used to gain a better understanding about the condition of the watershed, proper mapping presentation of LANDFIRE data is challenging because the vegetation classifications are plotted on a 30 meter by 30 meter grid. Therefore, Wyoming Gap Analysis Program (GAP) data are shown in Figure 3.25. The LANDFIRE datasets are contained within the study's GIS and can be used in future mapping projects. The WYNDD, which was discussed in Section 3.4.8.2, includes vegetative species along with wildlife species. Table 3.16 summarizes the plant species of concern within the study area.

3.5.4.2 Vegetative Communities

Vegetative communities within the study area include sagebrush, forb, and grass communities; cottonwood and willow communities; and willow, sedge, and rush communities. Upland plant communities are dominated by grass and sagebrush species. Pine forests and other woodlands are present on a small portion of the watershed. In general, the desirable grass species in the watershed include rhizomatous wheatgrass, needleandthread, bluebunch wheatgrass, western wheatgrass, bottlebrush squirreltail, Sandberg bluegrass, prairie sandreed, little bluestem, and Indian ricegrass. The following plant community overviews are quoted from the BLM Casper Field Office's RMP and included to describe the diverse communities within the study area [Bureau of Land Management, 2007].

Table 3.15. Existing Vegetation Types (LANDFIRE) Within the Study Area (Page 1 of 2)

Existing Vegetation Type	Area (acres)	Percent of Study Area
Inter-Mountain Basins Big Sagebrush Steppe	513,844	34.6
Inter-Mountain Basins Big Sagebrush Shrubland	267,869	18.0
Northwestern Great Plains Mixedgrass Prairie	178,379	12.0
Inter-Mountain Basins Montane Sagebrush Steppe	70,192	4.7
Northern Rocky Mountain Lower Montane-Foothill-Valley Grassland	63,189	4.3
Inter-Mountain Basins Semi-Desert Grassland	35,518	2.4
Artemisia tridentata ssp. vaseyana Shrubland Alliance	34,706	2.3
Inter-Mountain Basins Mat Saltbush Shrubland	27,216	1.8
Inter-Mountain Basins Semi-Desert Shrub-Steppe	25,463	1.7
Rocky Mountain Foothill Limber Pine-Juniper Woodland	22,144	1.5
Wyoming Basins Dwarf Sagebrush Shrubland and Steppe	18,845	1.3
Introduced Upland Vegetation-Annual Grassland	15,964	1.1
Rocky Mountain Lodgepole Pine Forest	13,181	0.9
Rocky Mountain Lower Montane-Foothill Shrubland	12,743	0.9
Agriculture-Pasture and Hay	12,118	0.8
Western Great Plains Floodplain Systems	11,659	0.8
Herbaceous Wetlands	10,530	0.7
NASS-Close Grown Crop	10,305	0.7
Southern Rocky Mountain Ponderosa Pine Woodland	10,215	0.7
Inter-Mountain Basins Curl-leaf Mountain Mahogany Wood/Shrubland	10,046	0.7
Existing Vegetation Types covering less than 1 percent of study area	9,974	0.7
Southern Rocky Mountain Dry/Mesic Montane Mixed Conifer Forest	8,571	0.6
Western Great Plains Sand Prairie	7,675	0.5
Introduced Upland Vegetation-Annual and Biennial Forbland	7,621	0.5
Herbaceous Semi-dry	7,255	0.5
Rocky Mountain Aspen Forest and Woodland	6,462	0.4
Developed-Upland Shrubland	6,409	0.4
Southern Rocky Mountain Ponderosa Pine Savanna	6,116	0.4

Table 3.15. Existing Vegetation Types (LANDFIRE) Within the Study Area (Page 2 of 2)

Existing Vegetation Type	Area (Acres)	Percent of Study Area
Inter-Mountain Basins Greasewood Flat	6,088	0.4
Rocky Mountain Montane Riparian Systems	5,611	0.4
Developed-Upland Herbaceous	5,192	0.3
Middle Rocky Mountain Montane Douglas-fir Forest/Woodland	4,629	0.3
Introduced Riparian Vegetation	2,734	0.2
Rocky Mountain Subalpine/Upper Montane Riparian Systems	2,316	0.2
Inter-Mountain Basins Aspen-Mixed Conifer Forest/Woodland	2,261	0.2
Rocky Mountain Subalpine-Montane Mesic Meadow	1,964	0.1
Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest/Woodland	1,796	0.1
Western Great Plains Sparsely Vegetated Systems	1,646	0.1
Total	**1,458,448**	**98.2**

Woodland Communities

Woodlands range from small monotypic to larger mixed stands of quaking aspen, limber pine, and Rocky Mountain juniper. Inventory data are not available for woodland communities in the planning area; however, in general, distribution of quaking aspen has decreased while limber pine and juniper stands have increased. Woodland species occasionally are used for firewood, decorative, and hobby applications, but are not important commercially at this time. On the other hand, woodland communities are important ecologically, especially as wildlife habitat.

Aspen are scattered throughout the planning area, although most stands are maturing and distribution is declining. Aspen stands also appear to be declining throughout the interior west due to age and conifer invasion (Bartos and Campbell 1998; Kulakowski et al. 2004; Knight 2001; WSFD 2001). Many of these stands have declined due to the lack of fire to control competition and stimulate regeneration, ungulate use, and advanced age. Aspen stands typically exhibit a diversity of understory vegetation, are used by wildlife and livestock, can serve as a natural fire break, and often occur as part of an important riparian and wetland component in the forest system. According to a report on forest health published by the WSFD, the average age of aspen forests is 68 years (WSFD 2001). Older aspen stands on Muddy Mountain, Casper Mountain, and the foothills of the South Bighorns are showing signs of increased cankers, conks, and decay in the boles.

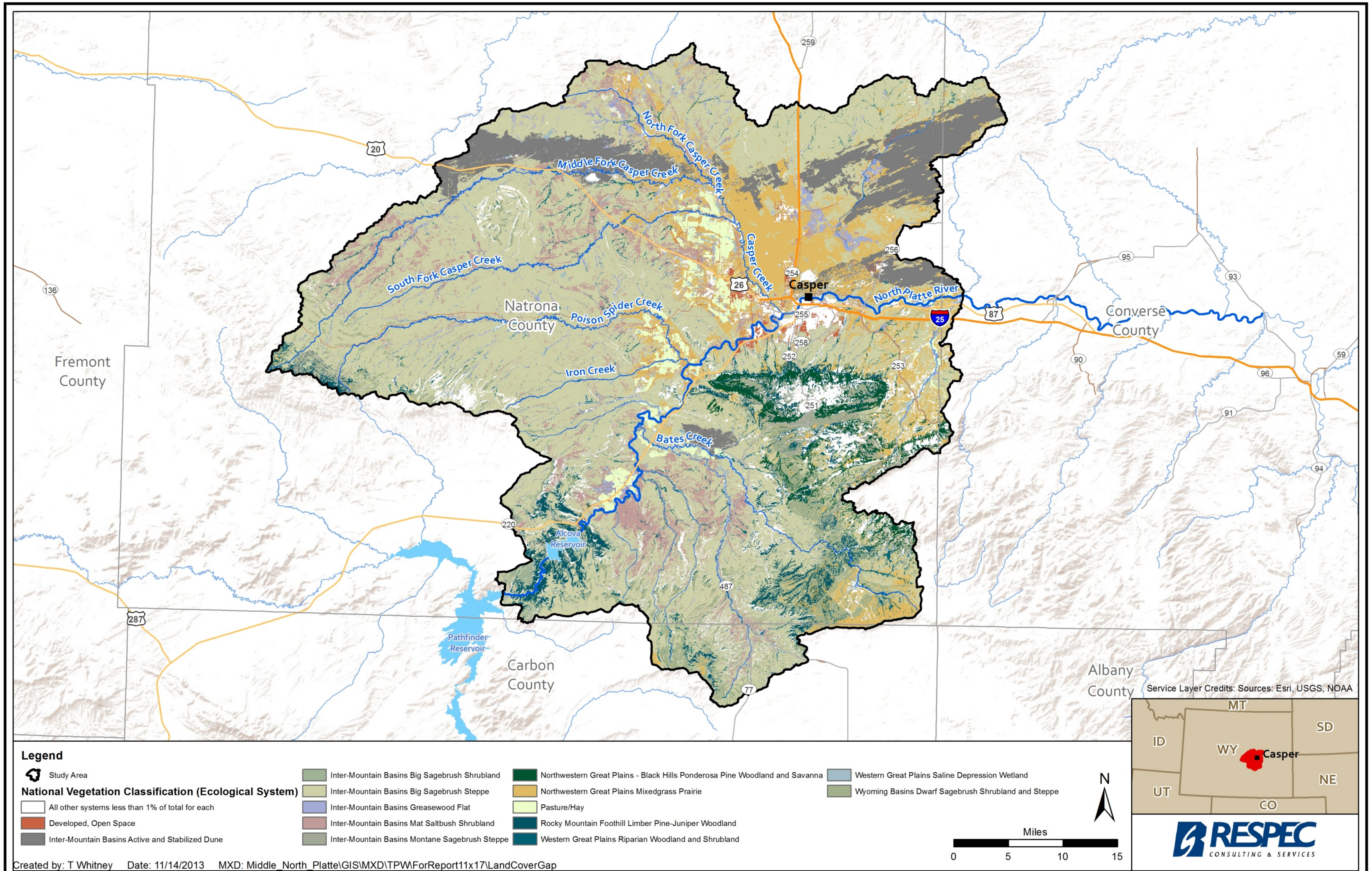

Figure 3.25. Land Cover GAP Analysis Within the Middle North Platte Watershed.

Table 3.16. Wyoming Natural Diversity Database: Plants Within the Study Area

Scientific Name	Common Name	Listing Status	Tracking Status
Artemisia porteri	Porter's sagebrush		Tracked
Astragalus barrii	Barr's milkvetch		Watched
Astragalus nelsonianus	Nelson's milkvetch		Watched
Boechera pendulina var. russeola	Daggett rockcress		Watched
Cirsium aridum	Cedar Rim thistle		Tracked
Cryptantha stricta	Erect cryptantha		Watched
Eustoma grandiflorum	Showy prairie-gentian		Tracked
Filago prolifera	Rabbit tobacco		Tracked
Mimulus rubellus	Ciliolate-toothed monkey flower		Tracked
Oonopsis wardii	Ward's goldenweed		Watched
Oxytropis nana	Wyoming locoweed		Watched
Penstemon paysoniorum	Payson Beardtongue		Watched
Physaria eburniflora	Devil's Gate twinpod		Watched
Physaria saximontana var. saximontana	Rocky Mountain twinpod		Watched
Puccinellia cusickii	Cusick's alkali-grass		Tracked
Sphaeromeria simplex	Laramie false sagebrush		Tracked
Sullivantia hapemanii var. hapemanii	Hapeman's sullivantia		Watched

Juniper woodlands typically comprise Rocky Mountain juniper stands sometimes mixed with Utah juniper and limber pine located on steep slopes and ridge tops. After long periods without fire, juniper species encroach into and dominate sagebrush communities. The existing plan does not specifically identify actions for treating woodland encroachment. The most notable juniper woodlands are in Natrona County adjacent to the Alcova Reservoir, Cedar Ridge, and the west slope of Casper Mountain (BLM 2003f). Limber pine is another vegetative type comprising woodland communities. Although not considered a commercial species, limber pine is an important food and cover source for birds and other wildlife. Limber pine has been plagued by a blister rust in many locales of the planning area.

Grasslands

Mixed-grass prairie grasslands occur primarily at lower elevations and on rolling plains and foothills in a small part of eastern Natrona County. This vegetative type primarily includes grasses and forbs, but does contain some shrub species. Grass and grass-like plants that are common to this type include western *wheatgrass, needle-and-thread, prairie Junegrass, Indian ricegrass, blue grama, Sandberg bluegrass, sand dropseed, threeawn, little bluestem, and threadleaf sedge. The most common shrubs are Wyoming big sagebrush, silver sagebrush, sand sagebrush, snowberry, and Douglas rabbitbrush. Common forbs include fringed sagewort, scurfpea, prairie clover, milkvetch, American vetch, yarrow, buckwheat, and prickly pear cactus. The mixed-grass prairie vegetation type predominantly is used for livestock and wildlife grazing. Other grassland communities present within the planning area inhabit shallow soil sites that are too dry to support many shrubs or trees. These grasslands comprise short- to mid-size grass species and numerous mat-forming forbs. These communities are found primarily in Natrona County in the southern foothills of the South Bighorns.*

Shrublands

Shrubland communities occur throughout the planning area and dominate the majority of the public land surface administered by the BLM. These communities are diverse and primarily include three vegetative types: desert shrub and saltbush-greasewood flats, mountain shrub, and sagebrush. Greasewood-dominated shrublands occur primarily on lowland positions adjacent to streams, playas, lakes, and ponds. They usually occur in areas that receive lower amounts of precipitation and on soils that contain at least moderate amounts of salinity or alkalinity. Greasewood is a halophyte that does well in very saline soils; however, it needs more soil moisture to survive than does saltbush. A good example of this vegetation community is located along the floodplain of lower Bates Creek in south central Natrona County.

Where greasewood is the dominant shrub, subdominant shrubs include Gardner saltbush, shadscale, rubber rabbitbrush, Wyoming big sagebrush, and basin big sagebrush. The understory is limited to salt- tolerant herbaceous vegetation, such as inland saltgrass, western wheatgrass, alkali sacaton, bottlebrush squirreltail, Sandberg bluegrass, biscuit root, Hood's phlox, pepperweed, and sea blight. In places, cheatgrass is a substantial component of the understory vegetation. Although greasewood is not considered very palatable to livestock or big game wildlife, pronghorn and sheep will eat the spiny stems and leaves in the spring and early summer. Cattle use greasewood in the summer and fall as a source of salt. Greasewood contains soluble oxalates that can be poisonous to both sheep and cattle. Greasewood communities are important for providing cover to wildlife and livestock and important spring habitat for mule deer.

Salt desert shrubland is perhaps the most arid vegetation type in the Intermountain West (Knight 1994). Gardner saltbush dominates this community type in the planning area and, in some instances, makes up 90 percent of the vegetative cover. These areas are characterized by accumulations of salt in soils developed primarily from sodic shale. Soils of these areas usually have a potential of hydrogen (pH) of 7.8 to 9, which restricts the uptake of soil minerals and nutrients. The soils in these areas restrict the uptake of water and soil nutrients *by all but the most tolerant of plants, usually halophytes. Gardner saltbush normally grows no higher than 12 inches, and may grow along the ground forming a mat. Subdominant shrubs in areas dominated by Gardner saltbush include birdfoot sage, bud sage, spiny hopsage, broom snakeweed, shadscale, and Douglas rabbitbrush. Some greasewood also may be found in this community.*

Grasses associated with these sites include Indian ricegrass, bottlebrush squirreltail, Sandberg bluegrass, and western wheatgrass. Forbs found in these areas include wild onion, biscuitroot, woody aster, winterfat, Hood's phlox, globemallow, and prickly pear cactus. Saltbush communities within the planning area occur on relatively flat to steep, highly eroded hills at lower elevations, usually in areas of low precipitation. Examples of this vegetative type can be found in the Bates Hole and Anderson Draw areas west and southwest of Casper. Gardner saltbush is a valuable forage species on winter and spring ranges for wildlife and livestock. In the spring, when Gardner saltbush is green, its protein content can be higher than late-season alfalfa, and is a preferred livestock forage for lambing sheep and calving cattle.

Mountain Shrublands

Mesic Upland Shrub Steppe - *Chokecherry is the primary shrub in this community, often growing in conjunction with snowberry, currant, Wood's rose, serviceberry, and Rocky Mountain maple. Mesic Upland Shrub Steppe is usually found at low to mid elevations in areas that receive greater moisture due to snow accumulation, runoff, or subsurface flow. These areas include drainage bottoms, north slopes, and the leeward side of hills. This community usually exists as dense but scattered stands of shrubs and is often adjacent to aspen and willow communities. Chokecherry, serviceberry and maple in these areas may grow to be 15-feet high. Herbaceous understory vegetation includes basin wildrye, green needlegrass, Columbia needlegrass, bluebell, columbine, aster, yarrow, and violet. Although the Mesic Upland Shrub Steppe is found across the planning area, individual stands are seldom more than ½ acre in size. This community provides hiding and thermal cover for deer, elk, and other wildlife species. The dominant shrubs provide excellent forage for browsing animals when their softer leaves and shoots are within reach. These shrubs reestablish following fire, often in less dense patches, making them more accessible to wildlife and livestock. The new growth is highly palatable and is sought out by browsing animals.*

Xeric Upland Shrub Steppe - *True and curl-leaf mountain mahogany dominate this plant community. True mountain mahogany is found in the southern portions of the planning area along the foothills of the Laramie Range. Curl-leaf mountain mahogany is found in the northwestern part of the planning area on the southern slopes of the South Bighorns. Both species grow on dry sites, usually rocky slopes and ridges with shallow soils. Mountain mahogany usually occurs as the dominant shrub but sometimes grows in conjunction with juniper, antelope bitterbrush, currant, snowberry, Douglas rabbitbrush, and Wyoming and* *mountain big sagebrush. Grass species found in the understory include bluebunch wheatgrass, Indian ricegrass, Sandberg bluegrass, mutton bluegrass, and western wheatgrass. Forb species found in the understory include phlox, buckwheat, locoweed, Hooker sandwort, goldenweed, and milkvetch. Cheatgrass is a dominant component of the understory vegetation within some true mountain mahogany communities. Mountain mahogany may grow to a height of 5 to 7 feet, depending on the extent of browsing and depth of soil. Many of these communities consist of mature and often decadent plants with little recruitment of young plants. Fire generally lessens the density of the shrub stands, allowing grasses and other herbaceous plants to increase, while still providing wildlife browse. Mountain mahogany is an important fall and winter forage species for deer and elk and is utilized by livestock. Mountain mahogany communities within the planning area usually provide crucial winter range for mule deer.*

Sagebrush - *Sagebrush-dominated communities are the most common vegetative type in the planning area. These communities include Wyoming big sagebrush and grassland, mountain big sagebrush and grassland, silver sagebrush and grassland, basin big sagebrush shrubland, and the low sages—birdfoot and Wyoming threetip sagebrush and grassland. Fire is an important component of all sagebrush-dominated plant communities. It can create a mosaic of seral stages across the landscape that benefits numerous species of wildlife. Depending on the nature of the site, the fire-return interval can be between 25 and 100 years (Knight 1994). Following a stand replacement fire, it can take more than 20 years for sagebrush to return to pre-burn densities. The return interval for sagebrush is based on several factors, including fire intensity, species of sagebrush, soil, precipitation, percent slope, aspect, and availability of seed source. Sagebrush communities are important sources of food and cover for numerous wildlife species found in Wyoming. Sagebrush obligate species include the sage sparrow, Brewer's sparrow, sage thrasher, greater sage-grouse, sagebrush vole, sagebrush lizard, and pronghorn.*

Wyoming Big Sagebrush and Grassland - *Wyoming big sagebrush and grassland is the most common community in south-central Wyoming. It occurs primarily in the western half of the planning area on shallow to deep soils at elevations below 7,000 feet. Between 6,000 and 7,000 feet, Wyoming big sagebrush grows in conjunction with mountain big sagebrush. In these areas, Wyoming big sagebrush usually is found on drier sites, while mountain big sagebrush is found on deeper soils and in areas receiving greater moisture, such as drainage bottoms. Shrub height varies from as little as 8-inches tall on shallow soils to around 30-inches tall on deeper soils. The canopy cover for Wyoming big sagebrush communities usually does not exceed 30 percent.*

Wyoming big sagebrush often is the dominant plant in mosaic communities intermixed with other shrubs and open grasslands. On shallow or rocky to gravelly soils, Wyoming big sagebrush may be co-dominant with black sagebrush *and Douglas rabbitbrush. On lighter textured soils, such as sandy loams, Wyoming big sagebrush may be co-dominant with silver sagebrush, Douglas rabbitbrush, and winterfat. Grass and forb species vary depending on soil texture, aspect, and slope. Common grass and grass-like species include bluebunch wheatgrass, western wheatgrass, Sandberg bluegrass, mutton bluegrass, Indian ricegrass, needle-and-thread, green needlegrass, prairie June grass, threadleaf sedge, and bottlebrush squirreltail. Common forbs include phlox, sandwort, buckwheat, penstemon, Indian paintbrush, globemallow, astragalus, and prickly pear cactus.*

Wyoming big sagebrush is the most frequently consumed sagebrush by wildlife and is a staple for pronghorn, mule deer, and the greater sage-grouse. In the planning area, Wyoming big sagebrush is generally the dominant species found on pronghorn and mule deer crucial winter ranges. Many of the Wyoming big sagebrush communities in the planning area have even-aged stands of mature and often decadent plants, which presents a problem on crucial mule deer and pronghorn winter ranges due to the poor forage quality of older plants and lack of new young plants.

Mountain Big Sagebrush and Grassland - *Mountain big sagebrush is located on shallow to deep soils at elevations above 7,000 feet. In areas where mountain big sagebrush grows in conjunction with Wyoming big sagebrush, mountain big sagebrush generally grows on the deeper soils and in areas receiving good moisture, either through runoff or snow accumulation. At higher elevations, mountain big sagebrush occurs as smaller plant communities in mountain areas and is often intermixed with aspen and conifer woodlands. Shrub height varies from 10 to 30 inches, with canopy cover reaching 50 to 60 percent. Other shrubs found in mountain big sagebrush communities are antelope bitterbrush, serviceberry, threetip sagebrush, and snowberry. Associated grasses include Idaho fescue, king spike fescue, green needlegrass, Colombia needlegrass, mutton bluegrass, big bluegrass, western wheatgrass, basin wildrye, and elk sedge. Common forbs found in these areas include Indian paintbrush, lupine, larkspur, penstemon, violet, and Oregon grape. Mountain big sagebrush is palatable to wildlife, although browsing is sometimes limited when the higher elevation habitats become unavailable due to snow accumulation. Mountain big sagebrush provides hiding and nesting cover for various wildlife species. Following fire, mountain big sagebrush reestablishes as the dominant species more quickly than other sagebrush types, often resuming dense canopy cover after 20 to 30 years. The natural fire-return interval in this sagebrush type is 20 to 75 years.*

Silver Sagebrush and Grassland - *Silver sagebrush and grasslands have two subtypes occupying distinctly different habitats in the planning area. The more common subtype is found on deep sandy-textured soils where silver sagebrush is the dominant shrub, but other shrubs (including Wyoming big sagebrush, Douglas rabbitbrush, and rubber rabbitbrush) are usually present. In sand dune* *areas, silver sagebrush may be the only shrub present. Associated herbaceous species include needle-and-thread, Indian ricegrass, threadleaf sedge, blue grama, prairie sandreed, sand dropseed, scurfpea, buckwheat, and prickly pear cactus. The second subtype of silver sagebrush and grassland is not abundant and is located in drainage bottoms and riparian areas above the wet sedge and rush zone found along the streambank. Other vegetation found in this subtype include basin wildrye, Kentucky bluegrass, redtop, streambank wheatgrass, Baltic rush, clover, dandelion, aster, and, occasionally, cottonwood and willow. Silver sagebrush is desirable forage for both livestock and big game species because it provides important habitats for various wildlife species. Silver sagebrush responds well to fire, as it has the capability to send up new stems from root crowns after burning.*

Basin Big Sagebrush Shrubland - *Basin big sagebrush shrubland is found in moderately deep to deep soils of all soil textures in zones of 10 to 16 inches of annual precipitation. It occurs as pockets within Wyoming big sagebrush, Gardner saltbush, and greasewood communities as the dominant shrub type along valley bottoms, canyons, and isolated ephemeral washes. This subspecies of big sagebrush may reach 12 feet in height, with canopy cover reaching 70 percent. Basin big sagebrush shrubland is not abundant within the planning area on BLM-administered land. In addition, basin big sagebrush shrubland is not very palatable forage, usually serving as little to no use as a food source, even in extreme winters when use levels of other plants are severe. It is important, however, as cover for mule deer and elk, and as habitats for other wildlife species. Basin big sagebrush shrubland also may be important to greater sage-grouse in severe winters. Basin big sagebrush shrubland can increase in density and cover with poor livestock management and interruptions in the fire cycle.*

Birdfoot and Wyoming Threetip Sagebrush and Grassland - *Birdfoot sagebrush is found at elevations below 7,000 feet on clay to dense-clay alkaline soils where pH ranges from 8.5 to 11. At lower pH levels, Gardner saltbush is often found growing in birdfoot sagebrush communities along with a variety of grasses and forbs. Grasses that are present include western wheatgrass, Indian ricegrass, Sandberg bluegrass, and bottlebrush squirreltail. Forbs that are present include woody aster, Hood's phlox, biscuitroot, and wild onion. At higher pH levels, birdfoot sagebrush occurs as a monoculture. Most of the birdfoot sagebrush communities are found in the western part of the planning area in Natrona County. Wyoming threetip sagebrush occurs at elevations above 7,000 in the foothills of the various mountain ranges on shallow to moderately deep, well-drained soils. It normally grows to between 4- and 15-inches tall and is found intermixed with mountain big sagebrush and black sagebrush. Grasses and forbs found in this community include Idaho fescue, king spike fescue, Colombia needlegrass, mutton bluegrass, elk sedge, Indian paintbrush, mountain pea, larkspur, balsamroot, phlox, Hooker sandwort, and buckwheat. Wyoming threetip sagebrush does not appear very palatable to either livestock or wildlife in the* *summer or winter. Its location on windswept ridges and knolls may cause it to be used as emergency winter forage, especially for big game. This community responds well to low- intensity fires, but may be set back by high-intensity fires. Large fires rarely occur in this type due to the lack of fuel needed to carry the fire through it. The ability of Wyoming threetip sagebrush to stump sprout and layer makes its control difficult.*

Riparian and Wetland Communities
Riparian and wetland communities exhibit persistent water or obligate vegetation reflecting the availability of surface or groundwater. Vegetation found in these communities typically is adapted to flooding disturbances or saturated soils. Typical plant species found in riparian and wetland communities in the planning area include cottonwoods, willows, rushes, sedges, redtop, bluegrass, saltgrass, horsetail, dock species, iris, wild licorice, arrowgrass, bulrushes, and cattails.

3.5.4.3 Targeted Vegetation

Twenty-five designated and prohibited noxious weeds are on the state of Wyoming Weed and Pest Control Act Designated List as shown in Table 3.17 [Wyoming Weed and Pest Council, 2013]. The plants are problematic because they affect desirable plants, land uses, and existing habitats.

"Declared weeds" are listed by weed control districts in Carbon County, Converse County, and Natrona County in accordance with Declared Pest and Declared Weed Program Participation W.S. 11-5-102(a)(vii). Tables 3.18 through 3.20 lists the 7 declared weeds in Carbon County, 12 declared weeds in Natrona County, and 46 declared weeds in Converse County [Wyoming Weed and Pest Council, 2013].

3.5.4.4 Natrona County Weed and Pest District

Weed information and mapping data within the watershed were obtained from the Natrona County Weed and Pest District (NCWP). The NCWP is a special purpose district supervised by seven volunteer board members from different areas of the county. Using best management practices (BMP) and integrated weed management (IWM), the NCWP works to control the 25 state designated weeds, 6 state designated pests, 12 county declared weeds, along with early detection and rapid response duties [Natrona County Weed and Pest District, 2013].The NCWP provides cost-share, which allows landowners or managers to purchase products at a discount but must be applied to state designated weeds or pests. The NCWP uses GPS units and ArcGIS to conduct inventories, track applications, and make adjustments. From 2003 through 2008, the NCWP has mapped 678 weed areas covering 1,365 acres within the study area. This information is summarized in Table 3.21.

Table 3.17. State of Wyoming Designated and Prohibited Noxious Weeds

Common Name	Scientific Name
Canada thistle	*Cirsium arvense L.*
Common burdock	*Arctium minus Hill Bernh.*
Common St. Johnswort	*Hypericum perforatum*
Common Tansy	*Tanacetum vulgare*
Dalmatian toadflax	*Linaria dalmatica L. Mill.*
Diffuse knapweed	*Centaurea diffusa Lam.*
Dyers woad	*Isatis tinctoria L.*
Field bindweed	*Convolvulus arvensis L.*
Hoary cress (whitetop)	*Cardaria draba and Cardaria pubescens L. Desv.*
Houndstongue	*Cynoglossum officinale L.*
Leafy spurge	*Euphorbia esula L.*
Musk thistle	*Carduus nutans L.*
Ox-eye daisy	*Chrysanthemum leucanthemum L.*
Perennial pepperweed	*Lepidium latifolium L.*
Perennial sowthistle	*Sonchus arvensis L.*
Plumeless thistle	*Carduus acanthoides L.*
Purple loosestrife	*Lythrum salicaria L.*
Quackgrass	*Agropyron repens L. Beauv.*
Russian knapweed	*Centaurea repens L.*
Russian olive	*Elaeagnus angustifolia L.*
Saltcedar	*Tamarix spp.*
Scotch thistle	*Onopordum acanthium L.*
Skeletonleaf bursage	*Franseria discolor Nutt.*
Spotted knapweed	*Centaurea maculosa Lam.*
Yellow toadflax	*Linaria vulgaris L.*

The NCWP targets one or two small acreage developments per season for noxious weed control. Additionally, the NCWP and the city of Casper are taking inventory of native and nonnative vegetation along the North Platte River to develop a plan to restore desirable plants and remove nonnative species, such as Russian olive, which has invaded the corridor. Partnering with the BLM and landowners, the NCWP treated over 13,000 acres of cheatgrass, which is an invasive annual grass that leads to a fire regime harmful to native vegetation.

Table 3.18. Carbon County Declared Weeds

Common Name	Scientific Name
Black henbane	*Hyoscyamus niger L.*
Common cocklebur	*Xanthium strumarium L.*
Halogeton	*Halogeton glomeratus (M. Bieb.) C.A. Mey.*
Mosquito	*Culicidae spp.*
Plains larkspur/Geyer larkspur	*Delphinium geyeri Green*
Plains pricklypear	*Opuntia polyacantha Haw.*
Wyeth lupine	*Lupinus wyethii S. Watson.*

Table 3.19. Natrona County Declared Weeds

Common Name	Scientific Name
Black henbane	*Hyoscyamus niger L.*
Black medic	*Medicago lupulina*
Buffalobur	*Solanum rostratum Dunal*
Cheatgrass / downy brome	*Bromus tectorum L.*
Curlycup gumweed	*Grindelia squarrosa (Pursh) Dunal*
Foxtail barley	*Hordeum jubatum L.*
Halogeton	*Halogeton glomeratus (M. Bieb.) C.A. Mey.*
Mosquito	*Culicidae spp.*
Puncturevine	*Tribulus terrestris L.*
Showy milkweed	*Asclepias speciosa Torr.*
Wild licorice	*Glycyrrhiza lepidota Pursh*
Yellow starthistle	*Centaurea solstitialis*

The NCWP uses biological control to help "bio-control" weed infested areas and works to ensure the agents do not attack native flora or desirable crops and the USDA Animal and Plant Health Inspection Service (APHIS) regulates insect host research. The NCWP has released 18 species of bio-control insects on eight noxious weed species throughout the county. The NCWP has an ongoing cooperative agreement with the USBR to control salt cedar around both the Pathfinder and Alcova reservoirs. The amount of salt cedar on both reservoirs has been reduced by more than 85 percent.

Table 3.20. Converse County Declared Weeds (Page 1 of 2)

Common Name	Scientific Name
Absinth wormwood	*Artemisia absinthium L.*
Alfalfa weevil	*Hypera postica Gyllenhal*
Baby's breath	*Gypsophila paniculata L.*
Black henbane	*Hyoscyamus niger L.*
Buffalobur	*Solanum rostratum Dunal*
Bull thistle	*Cirsium vulgare (Savi) Ten.*
Bur buttercup	*Ceratocephala testiculata (Crantz) Roth*
Chamomile	*Matricaria perforata Merat.*
Cheatgrass / downy brome	*Bromus tectorum L.*
Chicory	*Cichorium intybus L.*
Common cocklebur	*Xanthium strumarium L.*
Common crupina	*Crupina vulgaris Cass.*
Common mullein	*Verbascum thapsus L.*
Common sunflower	*Helianthus annuus L.*
Curly dock	*Rumex crispus L.*
Curlycup gumweed	*Grindelia squarrosa (Pursh) Dunal*
Dames rocket	*Hesperis matronalis L.*
Goatsrue	*Galega officinalis L.*
Gorse	*Ulex europaeus L.*
Greene Purple starthistle	*Centaurea calcitrapa L.*
Halogeton	*Halogeton glomeratus (M. Bieb.) C.A. Mey.*
Iberian starthistle	*Centaurea iberica Trev. ex Spreng.*
Italian thistle	*Carduus pycnocephalus L.*
Jointed goatgrass	*Aegilops cylindrica Host.*
Meadow knapweed	*Centaurea pratensis Thuill.*
Medusahead	*Taeniatherum caput-medusae (L.) Nevski*
Mosquito	*Culicidae spp..*
Musk mustard	*Chorispora tenella (Pallas) DC.*

Table 3.20. Converse County Declared Weeds (Page 2 of 2)

Common Name	Scientific Name
Orange hawkweed	*Hieracium aurantiacum L.*
Plains larkspur/Geyer larkspur	*Delphinium geyeri*
Poison hemlock	*Conium maculatum L.*
Puncturevine	*Tribulus terrestris L.*
Redstem filaree	*Erodium cicutarium (L.) L'Her.ex Ait*
Rush skeletonweed	*Chondrilla juncea L.*
Sandbur	*Cenchrus incertus Curtis Scentless*
Scotch broom	*Cytisus scoparius (L.) Link*
Showy milkweed	*Asclepias speciosa Torr.*
Squarrose knapweed	*Centaurea virgata Lam. ssp. Squarrosa (Willd.) Gugler*
Sulfur cinquefoil	*Potentilla recta L.*
Syrian beancaper	*Zygophyllum fabago L.*
Tansy ragwort	*Senecio jacobaea L.*
Teasel	*Dipsacus fullonum L.*
Wavyleaf thistle	*Cirsium undulatum (Nutt.) Spreng.*
Western sticktight	*Lappula occidentalis (S. Wats.) Greene*
Wild licorice	*Glycyrrhiza lepidota Pursh*
Yellow hawkweed	*Hieracium fendleri Sch. Bip.*

In 2013, the NCWP and the CAID agreed to map weed locations on the Casper Canal. NCWP staff identified approximately 496 weed locations covering approximately 700 acres of the state's 25 designated weeds along the CAID easements and marked the locations using a GPS unit. The weeds identified by NCWP crews included salt cedar (*Tamarisk spp.*), Russian olive, Canada thistle, perennial sowthistle, Russian knapweed, and perennial pepperweed. Although not inventoried, laterals and ditches were assumed to contain varying amounts of the same weed species identified on the Casper Canal. The NCWP and CAID have met to discuss the results and control actions.

3.5.5 Wetlands

The National Wetlands Inventory (NWI) was completed by the USFWS to map existing wetlands based on vegetative, hydrologic, and soil features using aerial imagery and field verification within the United States. Within the watershed, the NWI geospatial data identifies approximately 17,570 acres of all wetland types which cover approximately 1.2 percent of the study area. Most of these wetlands are located along the North Platte River corridor and in the Bolton Creek and Muddy Creek drainages mainly because of the amount of wetlands associated with lakes, ponds, rivers, and reservoirs in these areas. Additionally, there are approximately 4,142 wetland acres within the boundary of the Kendrick Project.

Table 3.21. Natrona County Weed and Pest District: Weeds Mapped Within the Study Area

Common Name	Scientific Name	Area (acres)
Canada thistle	*Cirsium arvense L.*	1,118.8
Leafy spurge	*Euphorbia esula L.*	86.7
Hoary cress (whitetop)	*Cardaria draba and Cardaria pubescens L. Desv.*	85.6
Saltcedar	*Tamarix spp.*	36.5
Musk thistle	*Carduus nutans L.*	17.7
Russian knapweed	*Centaurea repens L.*	13.4
Diffuse knapweed	*Centaurea diffusa Lam.*	5.6
Dalmatian toadflax	*Linaria dalmatica L. Mill.*	0.5
Scotch thistle	*Onopordum acanthium L.*	0.1
Total		**1,364.9**

The predominant wetland type is a freshwater emergent wetland, which is defined as an erect rooted herbaceous plant adapted to grow entirely or partly submerged in water, occurring on approximately 7,072 acres within the watershed. Figure 3.26 shows the distribution of wetland by type. The NWI wetlands within the watershed are listed in Table 3.22.

The NWI wetland areas are shown in Figure 3.27. However, because the NWI wetland areas are very small in size relative to the study area and are scarcely visible when presented at the watershed scale, the mapped wetland polygons were outlined with a thicker border to increase their visibility; NWI wetlands do not actually cover the amount of area indicated in the map. Consequently, site-specific wetland delineation and inventories were not part of the scope of this watershed and it is recommended that wetland delineation and inventories should be completed before planning future wetland projects.

Wetland creation and development projects within the study area should consider the concentration of selenium (Se) in the contributing surface water, groundwater, soil, and underlying geologic formation. Artificially creating a wetland area could result in high selenium concentrations in the wetland and its associated plants and animals. High selenium concentrations would be caused by evaporative and bioaccumulation conditions. Selenium can be toxic at high levels causing illness or mortality in livestock, wildlife, and humans and impairing reproduction for aquatic birds and fish.

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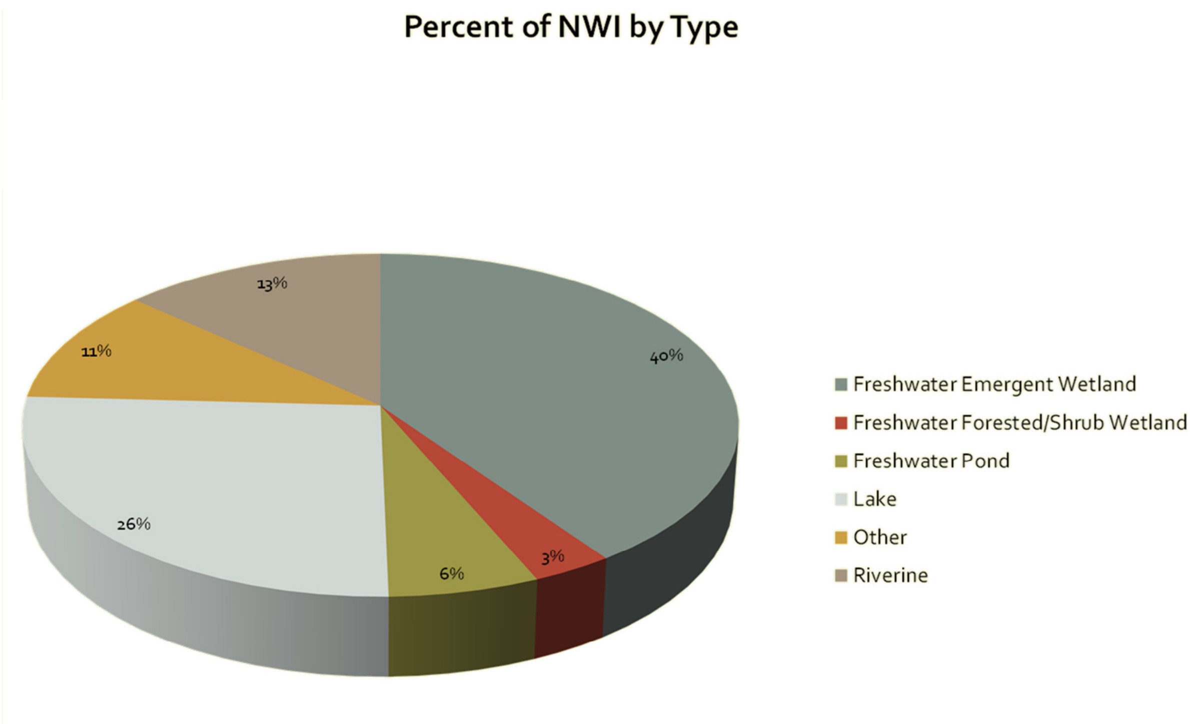

Figure 3.26. Percent Distribution of NWI Wetland Types Within the Study Area.

Table 3.22. Summary of Wetland Types Within the Study Area

Wetland Type	Area (Acres)	Percent of Study Area
Freshwater Emergent Wetland	7,072	0.47
Lake	4,598	0.31
Riverine	2,333	0.16
Other	1,912	0.13
Freshwater Pond	1,075	0.07
Freshwater Forested/Shrub Wetland	580	0.04
Total	**17,570**	**1.18**

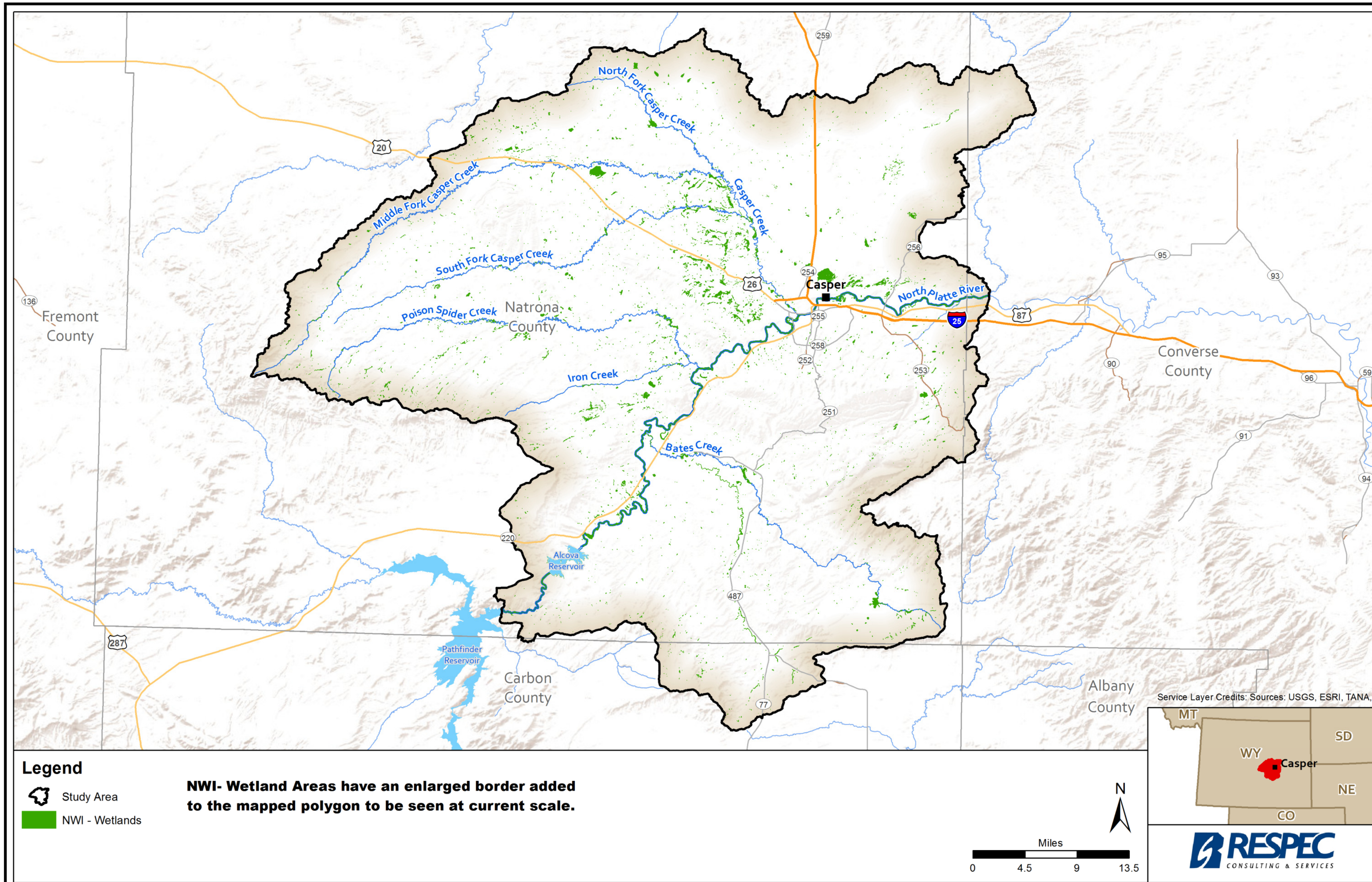

Figure 3.27. NWI Wetlands Located Within the Study Area.

In the late 1980s, the WGFD and USFWS delineated and prioritized wetland complexes in Wyoming. The later assessment was completed by The Nature Conservancy (TNC) in 2009 [Wyoming Joint Ventures Steering Committee, 2010]. Wetland complexes were delineated based on five spatial density criteria and resulted in identifying 222 individual wetland complexes throughout Wyoming. The prioritized complexes within the watershed are based on data from Copeland et al. [2010] and are shown in Figure 3.28. These complexes had a lower integrity score and were prioritized lower because of regulated flows, agricultural influences, and proximity to urban areas. However, the North Platte wetlands also support high species diversity, provide critical migration and dispersal corridors, and are used extensively by breeding waterfowl [Wyoming Joint Ventures Steering Committee, 2010].

The U.S. Army Corp of Engineers (USACE) has developed an approach for classifying wetlands that is based on the watershed level scale. This classification involves considerations founded upon hydrogeomorphic characteristics of the differing wetland types. The *USACE Wetlands Research Program Technical Report WRP-DE-9* provides the following regarding hydrogeomorphic wetland classifications [Smith, 1995]:

> *The hydrogeomorphic classification is based on three fundamental factors that influence how wetlands function, including geomorphic setting, water source, and hydrodynamics. Geomorphic setting refers to the landform of a wetland, its geologic evolution, and its topographic position in the landscape. For example, a wetland may occur in a depressional landform or a valley landform and may occur at the top, middle, or bottom of a watershed. Water source refers to the location of water just prior to entry into the wetland. All water on the land originates as precipitation, but in many cases the water will follow a circuitous path prior to entry into a wetland (Fetter 1988, pg 38).*
>
> *For example, water may enter the wetland directly as precipitation, follow a less direct path over the surface of the ground as overland flow or overbank flow, follow a subsurface path as interflow, throughflow, or baseflow, or any combination of these. Hydrodynamics refers to the energy level of moving water, and the direction that surface and near-surface water moves in the wetland. For example, the level of energy of an isolated wetland is generally lower than a wetland on a river floodplain, and the movement of water in a riverine wetland is generally unidirectional and downstream.*

This classification schema identifies seven wetland types: depressional, lacustrine fringe, tidal fringe, slope, riverine, mineral flat, and organic flat. Within the study area, depressional, lacustrine fringe, slope, and riverine wetlands are likely to be present and the following excerpt from the USACE report describes these four wetland types [Smith, 1995]:

> ***Depressional Wetlands***
>
> *Depressional wetlands occur in topographic depressions with a closed elevation contour that allows accumulation of surface water. Dominant sources of water are*

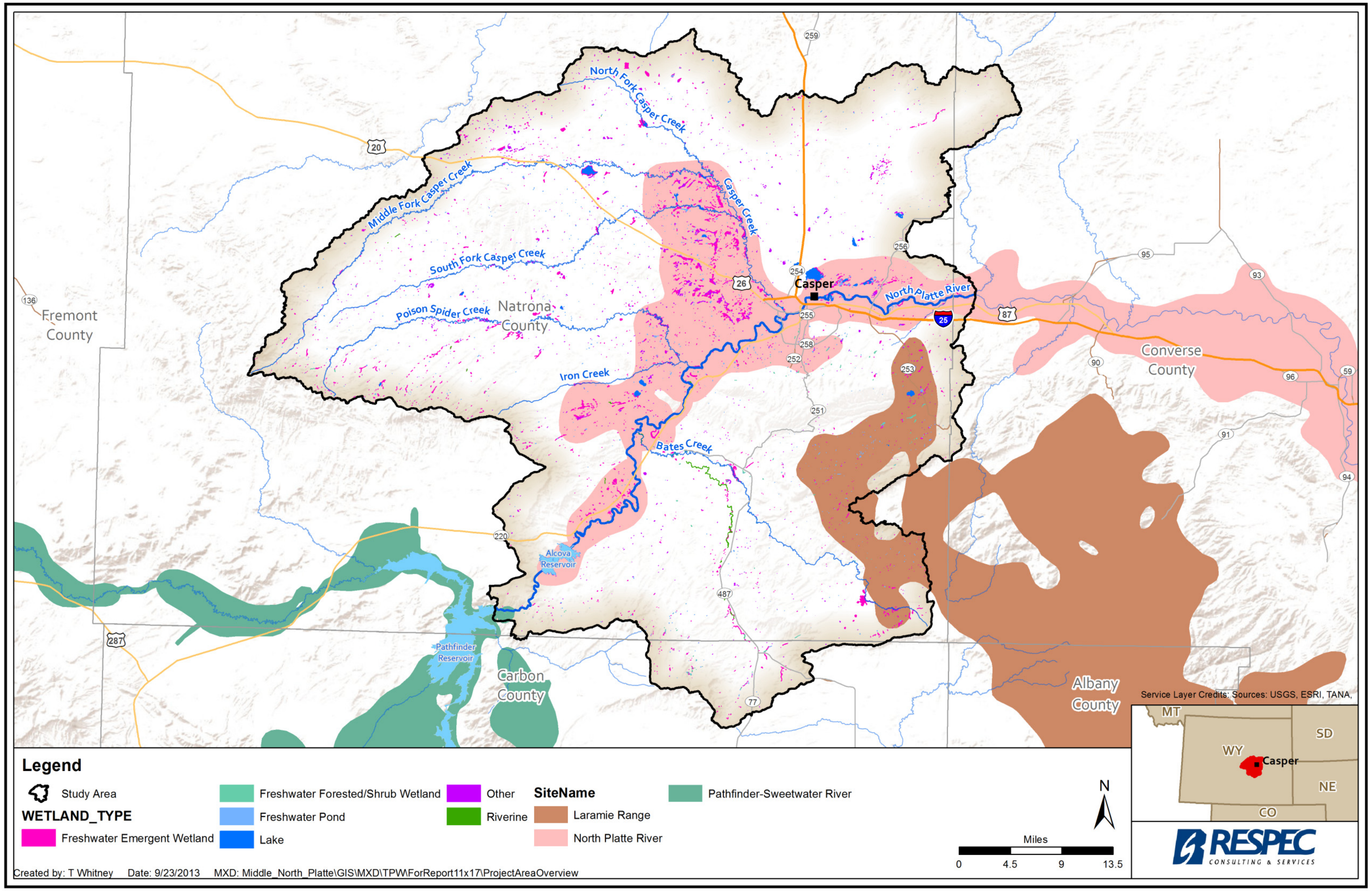

Figure 3.28. Wetland Complexes Within the Study Area [Copeland et al., 2010].

precipitation, groundwater discharge, and interflow from adjacent uplands. The direction of water movement is normally from the surrounding uplands toward the center of the depression. Depressional wetlands may have any combination of inlets and outlets or lack them completely.

Depressional wetlands may lose water through intermittent or perennial drainage from an outlet, by evapotranspiration, and, if they are not receiving groundwater discharge, may slowly contribute to groundwater. Dominant hydrodynamics are vertical fluctuations, primarily seasonal. Peat deposits may develop in depressional wetlands. Prairie potholes are a common example of depressional wetlands.

Lacustrine Fringe Wetlands

Lacustrine fringe wetlands are adjacent to lakes where the water elevation of the lake maintains the water table in the wetland. In some cases, they consist of a floating mat attached to land. Additional sources of water are precipitation and groundwater discharge, the latter dominating where lacustrine fringe wetlands intergrade with uplands or slope wetlands. Surface water flow is bidirectional, usually controlled by water level fluctuations such as seiches in the adjoining lake. Lacustrine fringe wetlands are indistinguishable from depressional wetlands where the size of the lake becomes so small relative to fringe wetlands that the lake is incapable of stabilizing water tables. Lacustrine wetlands lose water by flow returning to the lake after flooding, by saturation surface flow, and by evapotranspiration. Organic matter normally accumulates in areas sufficiently protected from shoreline wave erosion. Un-impounded marshes bordering the Great Lakes are a common example of lacustrine fringe wetlands.

Slope Wetlands

Slope wetlands normally are found where there is a discharge of groundwater to the land surface. They normally occur on sloping land; elevation gradients may range from steep hillsides to slight slopes. Slope wetlands are usually incapable of depressional storage because they lack the necessary closed contours. Principal water sources are usually groundwater return flow and interflow from surrounding uplands as well as precipitation. Hydrodynamics are dominated by downslope unidirectional water flow. Slope wetlands can occur in nearly flat landscapes if groundwater discharge is a dominant source to the wetland surface. Slope wetlands lose water primarily by saturation subsurface and surface flows and by evapotranspiration. Slope wetlands may develop channels, but the channels serve only to convey water away from the slope wetland. Fens are a common example of slope wetlands.

Riverine Wetlands

Riverine wetlands occur in floodplains and riparian corridors in association with stream channels. Dominant water sources are overbank flow from the channel or subsurface hydraulic connections between the stream channel and wetlands.

Additional water sources may be interflow and return flow from adjacent uplands, occasional overland flow from adjacent uplands, tributary inflow, and precipitation. When overbank flow occurs, surface flows down the floodplain may dominate hydrodynamics. At their headwater most extension, riverine wetlands often intergrade with slope or depressional wetlands as the channel (bed) and bank disappear, or they may intergrade with poorly drained flats or uplands. Perennial flow is not required.

Riverine wetlands lose surface water via the return of floodwater to the channel after flooding and through saturation surface flow to the channel during rainfall events. They lose subsurface water by discharge to the channel, movement to deeper groundwater (for losing streams), and evapotranspiration. Peat may accumulate in off-channel depressions (oxbows) that have become isolated from riverine processes and subjected to long periods of saturation from ground-water sources. Bottomland hardwood floodplains are a common example of riverine wetlands.

3.5.6 Geology

Geologic mapping information and data for the study area were obtained from the USGS and the WSGS. A variety of geological features and rocks from Precambrian metamorphics are exposed in the uplifts to Quaternary alluvium along creeks within the study area. The watershed is situated in the Wyoming Wind Corridor within the Great Divide Basin and along the Casper Arch.

North of Casper, the Quaternary-aged Casper dune fields are located in an east-west trending swath across the area. South of Casper, the Casper Mountain Fault has uplifted the Casper Mountain, the northernmost extent of the Laramie Range. An in-depth discussion of the watershed’s geology was beyond the scope of this study. The general geologic maps and column are presented to define the formations present which could potentially affect development of potential watershed improvement projects, and reservoir storage.

3.5.6.1 Surficial Geologic Units

The surficial geologic units within the watershed predominantly consist of residuum mixed, slopewash and colluvium, and eolian mixed covering approximately 74 percent of the watershed as shown in Figure 3.29. The remaining prominent units include alluvium, terrace deposits mixed, alluvial fan, bedrock, and landslide mixed. These geologic units influence the watershed by providing the parent material and morphology for the soil formations and plant communities within the study area.

3.5.6.2 Bedrock Geologic Units

The bedrock geologic units that underlie the watershed study area predominantly consist of Cody Shale, Wind River Formation, dune sand and loess, alluvium and colluvium, and the

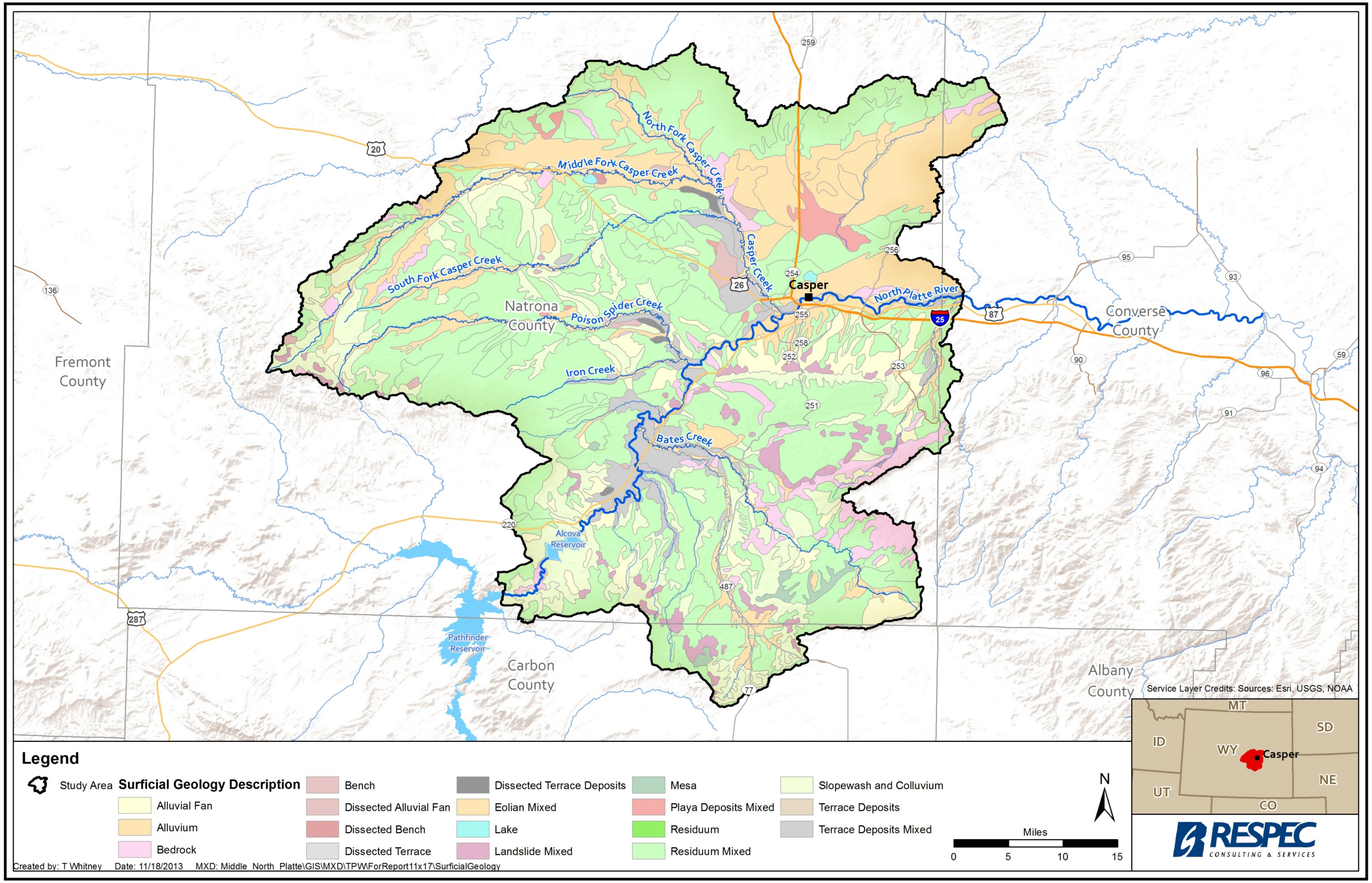

Figure 3.29. Surficial Geology of the Middle North Platte Watershed.

White River formation covering approximately 54 percent of the watershed as shown in Figure 3.30 and listed in Table 3.23. Remaining bedrock features include the Casper, Chugwater, Cloverly, Fox Hills, Fort Union, Frontier, Lance, Morrison, Niobrara and Sundance Formations along with the Mesaverde group, Mowry, Steele, and Thermoplis shales, and granitic rocks.

3.5.6.3 Hazardous Geological Features

Figure 3.31 displays the known faults and landslides within the watershed. Landslide deposits were present on the surficial geology and indicate that landslide activity has occurred in the areas surrounding Casper Mountain and Muddy Mountain and in the southern area of the study area near the Shirley Rim.

3.5.7 Soils

Soils are diverse within the study area because of the variable characteristics of the watershed's underlying geology, topography and elevation, climate and precipitation, and vegetation. Soils in the watershed vary considerably but usually are loams on 0 to 10 percent slopes, with over 70 percent of the study area categorized as loam soils with channery, cobbly, gravelly, sandy, and stony loam surface textures. Soils underlain by the selenium-bearing Cody Shale Formation are also highly variable with no specific predominant soils, although sandy and clay loams are common soil surface textures.

Soils information and data were obtained from the NRCS and compiled for the portions of the watershed within Natrona and Converse Counties. Three digitized soil surveys cover approximately 96 percent of the watershed. NRCS published the soil surveys in Natrona County, the northern part of Converse County, and the southern part of Converse County in 1997, 1988, and 2008, respectively. The soil survey in Carbon County has been initially mapped but is unpublished. For current soils information, landowners and managers should access the Web Soil Survey (WSS) at *http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm*, which provides soil maps and data for almost all counties in the United States and is updated regularly by the NRCS.

Over 240 soil map units are within the watershed. The Orpha loamy sand is the largest single map unit and covers 79,214 acres or 5.3 percent of the study area to the northwest, north, and east of Casper. Other major soil units include the Keyner-Absted-Slickspots, Theedle-Shingle-Kishona, Arvada-Absted-Slickspots, and the Hiland loams and sands complexes. Approximately 90 percent of the 24,248 acres of irrigated soils in the Kendrick Project are channery, cobbly, gravelly, and sandy loam soil textures. Figure 3.32 displays a general soils map of the study area prepared using data mapped at the 1:250,000 level of detail and obtained from the NRCS. Table 3.24 is a summary of hydric soil map units within the study area.

Soils rated as hydric by NRCS totaling more than 100 acres within the watershed are shown in Figure 3.33 and are underlain by Cretaceous Formations. More than 50 hydric soil map units

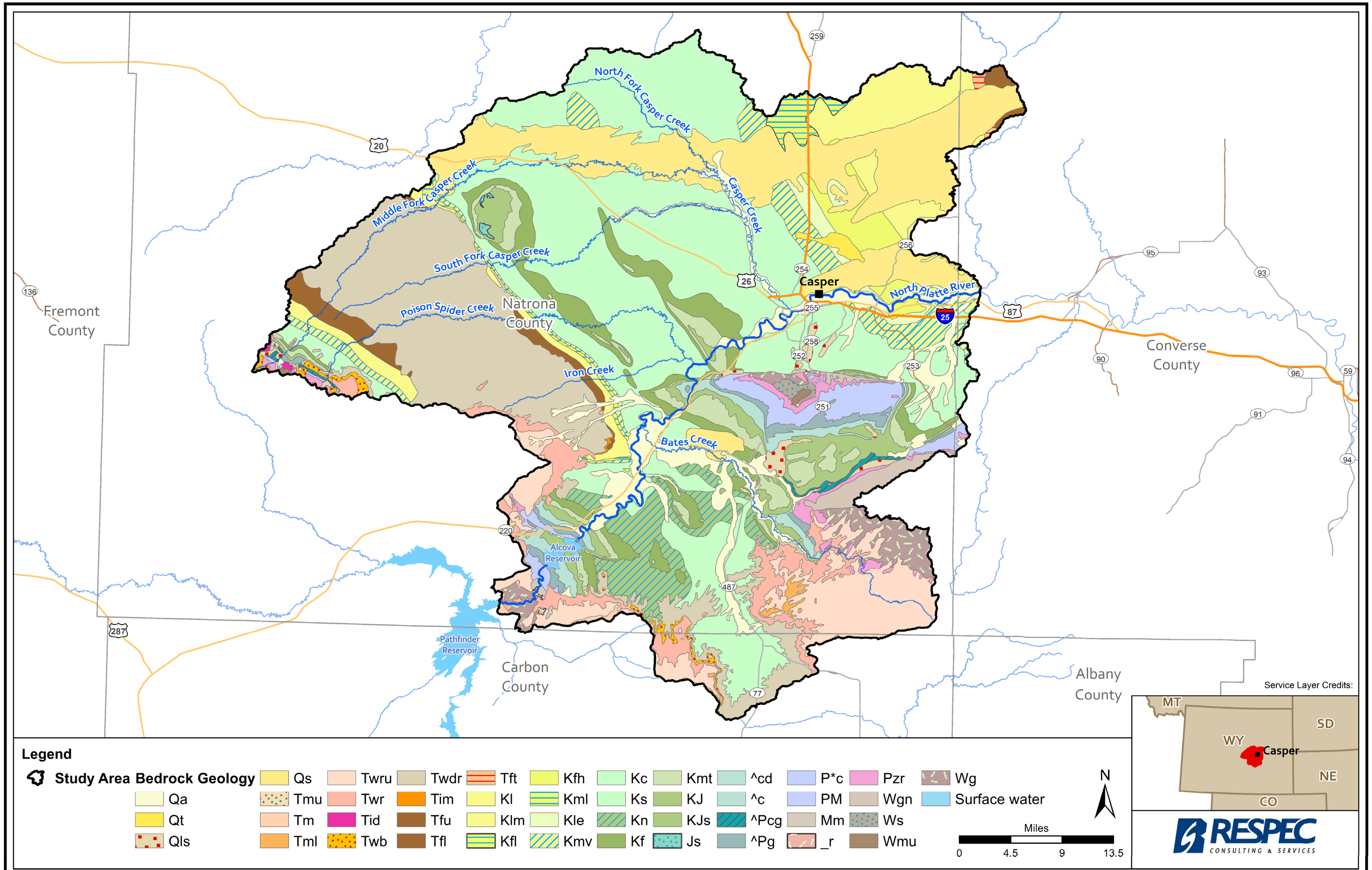

Figure 3.30. Bedrock Geology of the Middle North Platte Watershed.

Table 3.23. Bedrock Geologic Units Within the Study Area

Unit Symbol	Geologic Unit Name	Area (acres)	Study Area (percent)
Qa	Alluvium and colluvium	83,559	5.6
Qls	Landslide deposits	8,713	0.6
Qs	Dune sand and loess	169,712	11.4
Twru	Upper conglomerate member of White River Formation	78,632	5.3
Twr	White River Formation	44,604	3.0
Twdr	Wind River Formation - at base locally includes equivalent of Indian Meadows Formation	202,271	13.6
Tfu	Fort Union Formation	18,284	1.2
Kl	Lance Formation	52,687	3.6
Klm	Lance Formation, Fox Hills Sandstone, Meeteetse Formation, and Bearpaw and Lewis Shales	9,732	0.7
Kfl	Fox Hills Sandstone and Lewis Shale	9,812	0.7
Kfh	Fox Hills Sandstone	18,475	1.2
Kle	Lewis Shale	10,308	0.7
Kmv	Mesaverde Formation (N) or Mesaverde Group (S)	44,409	3.0
Kc	Cody Shale	353,231	23.8
Ks	Steele Shale	52,206	3.5
Kn	Niobrara Formation	43,624	2.9
Kf	Frontier Formation	62,605	4.2
Kmt	Mowry and Thermopolis Shales	38,422	2.6
KJs	Cloverly, Morrison, and Sundance Formations	32,780	2.2
^c	Chugwater Formation (N, NE), or Chugwater Group or Formation (S)	19,032	1.3
^Pg	Goose Egg Formation	12,423	0.8
P*c	Casper Formation	23,832	1.6
Pzr	Madison Limestone, Darby Formation, Bighorn Dolomite, Gallatin Limestone, Gros Ventre Formation, and Flathead Sandstone (N); Madison Limestone and Cambrian rocks (S); Minnekahta Limestone, Opeche Shale, Minnelusa Formation, Pahasapa and Englewood Limestones, Whitewood Dolomite, and Winnipeg and Deadwood Formations-various combinations (NE)	13,842	0.9
Wgn	Granite gneiss	11,697	0.8
Wg	Granitic rocks of 2,600-Ma age group	24,376	1.6
Other	Individual geologic units that comprise less than 0.5 percent of the study area	47,481	3.2
		1,486,748	100.0

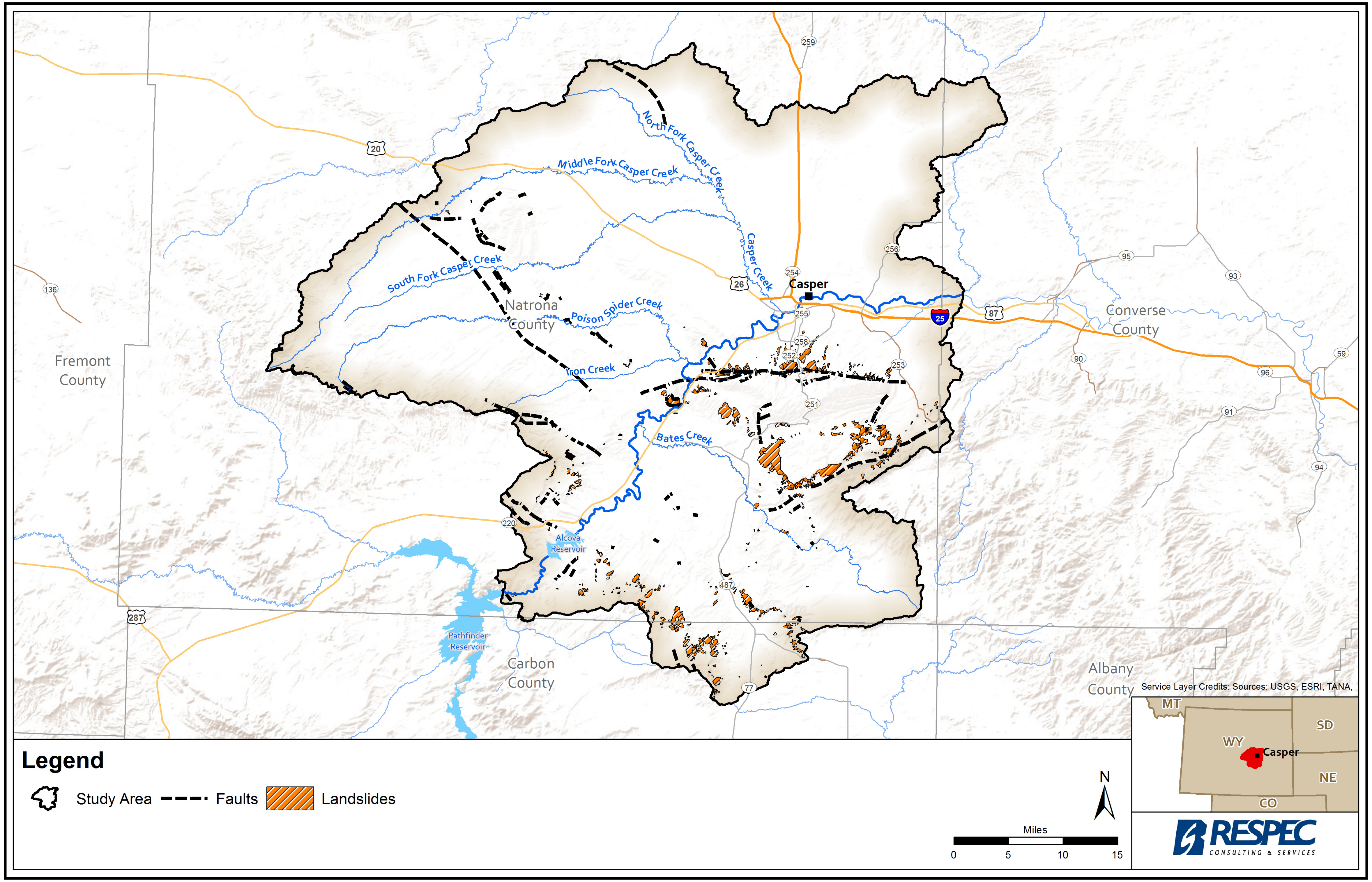

Figure 3.31. Hazardous Geologic Features Within the Study Area.

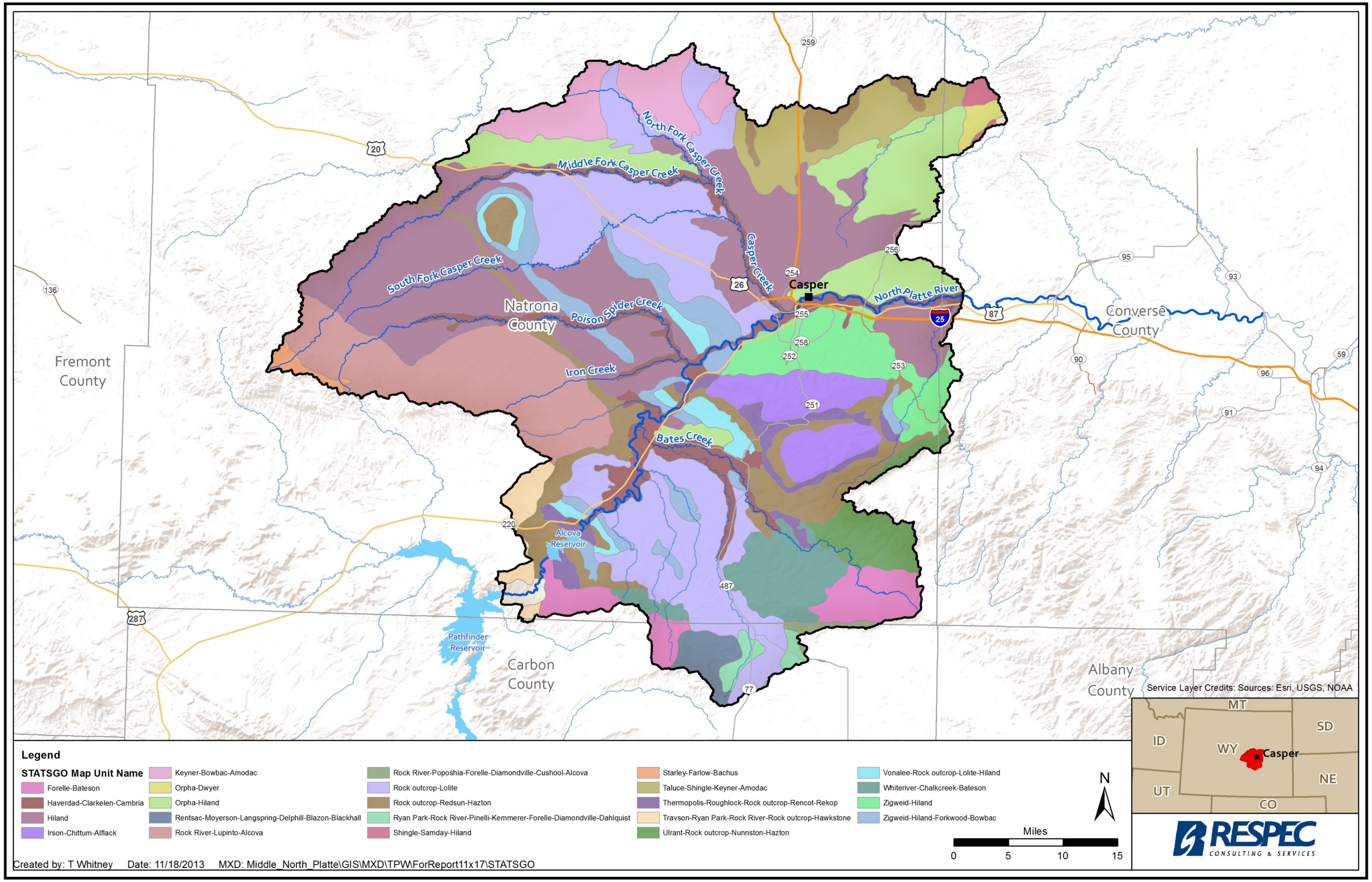

Figure 3.32. 1:250,000 Scale Soils Map of the Study Area.

Table 3.24. Summary of Hydric Soil Map Units Within the Study Area (Page 1 of 2)

Map Unit Symbol	Map Unit Name	Area (acres)	Percent of Study Area
225	Nunnston loam, 2 to 15 percent slopes	20,700	1.39
195	Haverdad-Clarkelen complex, saline, 0 to 3 percent slopes	20,189	1.36
163	Cragosen-Chalkcreek association, 3 to 45 percent slopes	14,813	1.00
234	Petrie clay loam, dry, 0 to 3 percent slopes	13,738	0.92
129	Boettcher-Pinelli-Worfman loams, 3 to 15 percent slopes	11,428	0.77
303	Whiteriver loam, 0 to 6 percent slopes	11,022	0.74
194	Haverdad-Clarkelen complex, 0 to 3 percent slopes	9,412	0.63
125	Blackdraw-Lolite-Gullied land complex, 3 to 20 percent slopes	6,709	0.45
130	Bosler-Alcova complex, 2 to 10 percent slopes	6,610	0.44
277	Silhouette clay loam, 0 to 6 percent slopes	5,947	0.40
206	Irson-Sebud complex, 40 to 65 percent slopes	5,658	0.38
154	Chittum-Sneffels loams, 5 to 40 percent slopes	4,832	0.33
106	Alflack-Irson-Foxton variant complex, 3 to 20 percent slopes	3,978	0.27
126	Blazon-Worfman loams, 6 to 30 percent slopes	4,079	0.27
235	Petrie-Zigweid complex, wet, 0 to 3 percent slopes	3,606	0.24
160	Crago gravelly loam, 3 to 15 percent slopes	3,081	0.21
111	Aquic Ustifluvents, saline-Orpha complex, undulating	2,644	0.18
205	Irson-Kezar-Rock outcrop complex, 6 to 40 percent slopes	2,706	0.18
110	Aquic Ustifluvents, saline, 0 to 3 percent slopes	2,588	0.17
122	Bessemer gravelly clay loam, 1 to 8 percent slopes	2,550	0.17
203	Inchau-Farlow complex, 15 to 40 percent slopes	2,495	0.17
288	Fluvaquentic Endoaquolls, 0 to 4 percent slopes	2,265	0.15
298	Urban land-Silhouette complex, 0 to 4 percent slopes	2,280	0.15
251	Anvil sandy loam, 0 to 6 percent slopes	2,103	0.14
271	Salt flats	1,896	0.13
191	Griffy-Emblem fine sandy loams, 0 to 6 percent slopes	1,818	0.12
165	Curecanti very stony loam, 3 to 12 percent slopes	1,491	0.10
180	Farlow, moist-Starley-Rock outcrop complex, 40 to 65 percent slopes	1,397	0.09
192	Grimstone-Grimstone variant loams, 4 to 35 percent slopes	1,409	0.09
193	Haverdad loam, 0 to 4 percent slopes	1,156	0.08
102	Adel-Pagosa association, rolling	1,034	0.07
166	Curecanti variant very cobbly loam, 8 to 35 percent slopes	1,107	0.07
285	Tisworth sandy loam, 0 to 5 percent slopes	1,078	0.07
122	Hiland-Bowbac complex, 6 to 15 percent slopes	786	0.05
129	Samday-Shingle-Worf complex, 3 to 15 percent slopes	698	0.05

Table 3.23. Summary of Hydric Soil Map Units Within the Study Area (Page 2 of 2)

Map Unit Symbol	Map Unit Name	Area (acres)	Percent of Study Area
252	Rivra-Urban land complex, 0 to 6 percent slopes	729	0.05
123	Bessemer-Urban land complex, 2 to 8 percent slopes	629	0.04
147	Cavegulch-Brokenhorn complex, 2 to 10 percent slopes	586	0.04
212	Lander loam, 0 to 3 percent slopes	584	0.04
118	Badwater-Rubble land association, moderately steep	323	0.02
287	Typic Fluvaquents-Aquic Ustifluvents, saline, complex, 0 to 3 percent slopes	338	0.02
115	Forkwood-Cambria-Cushman complex, 6 to 15 percent slopes	182	0.01
147	Vonalee-Terro complex, 6 to 15 percent slopes	159	0.01
158	Connerton loam, 0 to 3 percent slopes	94	0.01
204	Orpha-Tullock-Badland complex, 6 to 45 percent slopes	137	0.01

were mapped to identify areas where soils were formed under saturated, flooded, or ponded conditions during the growing season creating anaerobic conditions in the soil profile. The categories for the watershed's hydric soil are below:

- 2B3 – Aquic, Albolls, Historthels, Histoturbels, Pachic, or Cumulic that are poorly drained or very poorly drained and have a water table at a depth of 1-foot or less during the growing season if permeability is less than 6 inches per hour in any layer within a depth of 20 inches.
- 2B3,3 – Aquic, Albolls, Historthels, Histoturbels, Pachic, or Cumulic that are poorly drained or very poorly drained and have a water table at a depth of 1-foot or less during the growing season if permeability is less than 6 inches per hour in any layer at a depth of 20 inches and are frequently ponded for long or very long durations during the growing season.
- 4 – Soils that are frequently flooded for long or very long durations during the growing season.

3.6 HYDROLOGY

3.6.1 Groundwater

Groundwater availability within the watershed is variable because of the diverse aquifer characteristics and hydrogeologic properties in the study area. Depending on the specific area of the watershed, groundwater can be found at varying depths; areas near streams and along alluvial valleys have shallower groundwater with depths of 25 feet or less. Other locations within the watershed have deep groundwater aquifers with depths of more than 2,000 feet

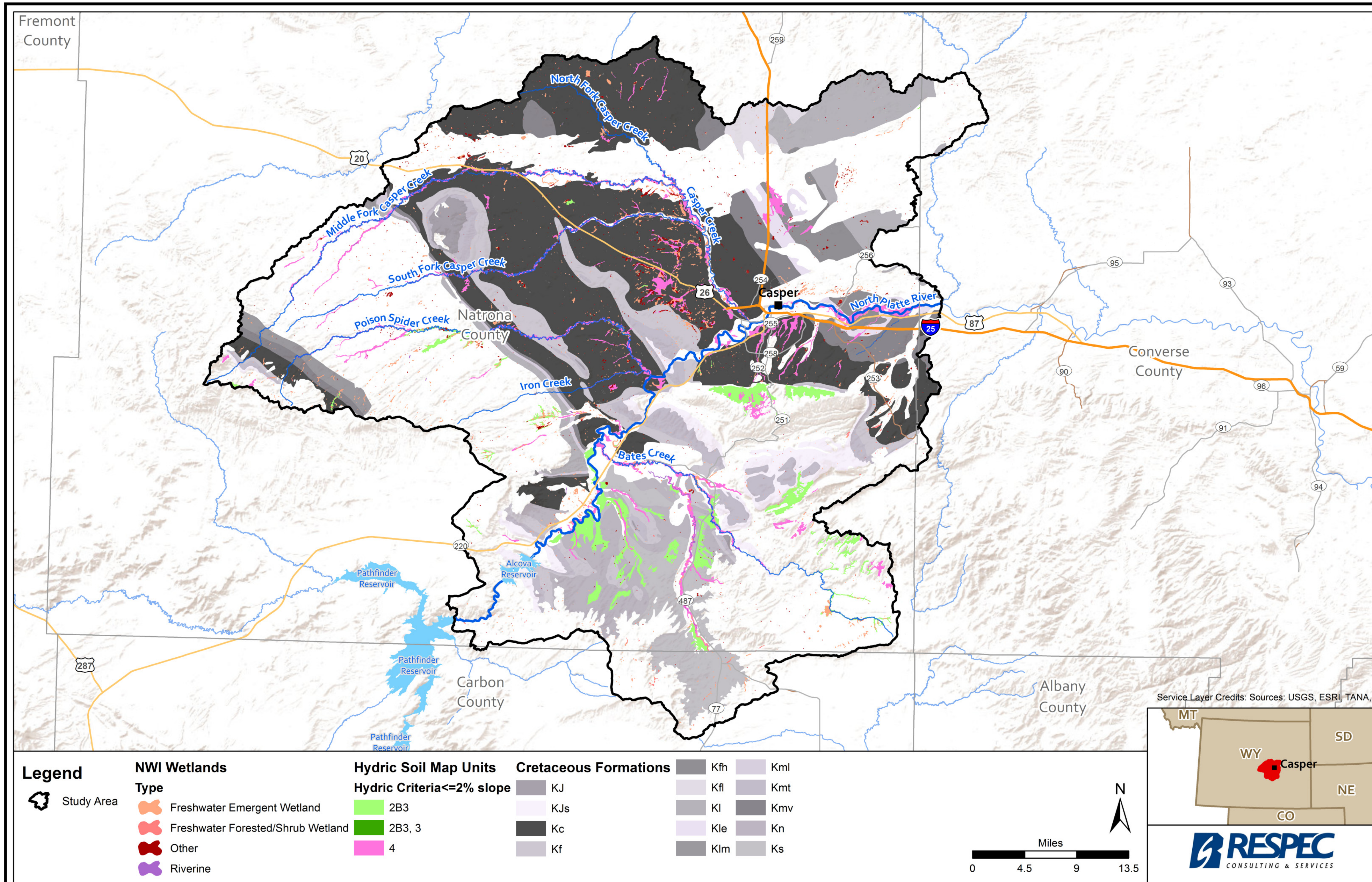

Figure 3.33. Hydric Soils Map Units Within the Study Area.

below the ground surface. Most of the private wells in the area are within these shallow sands and gravel alluvial aquifers, which cap the Cody Shale. Additionally, these alluvial aquifers are limited in extent and tend to have very low water yields.

Deeper aquifers that serve as a groundwater supply include the Tertiary Formations, Cloverly Group (including the Dakota and Lakota sandstone), and the Casper-Tensleep Formation. More than 28 geologic formations, from Precambrian to Holocene age, yield water to wells and springs in Natrona County. However, their water-bearing properties and chemical qualities differ greatly causing low-yield aquifers to be considered locally important for water sources [Crist and Lowry, 1972]. Approximately 40 percent of Natrona County contains groundwater that has more than 1,000 milligrams per liter (mg/L) of dissolved solids but most of the county has groundwater that is suitable for livestock to drink which can be developed at depths of less than 1,000 feet [Crist and Lowry, 1972].

Groundwater is locally important for livestock/wildlife water, private domestic wells, and municipal water for the CWRWS, which serves Casper and surrounding communities. The CWRWS relies on surface water and groundwater both to supply water to CWRWS members, such as the city of Casper, Pioneer Water and Sewer District, Salt Creek Joint Powers Board, Wardwell Water and Sewer District, Poison Spider Improvement and Service District, Sandy Lake Estates, 33 Mile Service and Improvement District, and Lakeview Service and Improvement District [Trihydro, 2006].

Groundwater information and water well databases were obtained from the Wyoming SEO. Permitted water well information including locations, yields, and depths was collected and compiled in the study's GIS. Figure 3.34 shows the locations of the SEO permitted water wells within the study area.

Many small springs and seeps exist within the study area. Large springs occur in the study area in the area surrounding Casper Mountain and include the largest spring in the watershed, Goose Egg Spring. Goose Egg Spring flows at approximately 17 cubic feet per second (cfs), or approximately 7,630 gpm [Crist and Lowry, 1972]. Figure 3.35 displays the location of springs mapped by the USGS and the BLM. Springs and seeps occur when the groundwater intersects the ground surface.

3.6.2 Surface Water

The study area begins on the North Platte River from Pathfinder Dam and Reservoir downstream to approximately 15 miles east of Casper, Wyoming, where Cole Creek enters the North Platte River as shown in Figure 1.1. The watershed covers approximately 2,323 square miles or 1,486,748 acres in central Wyoming. The study area is in the upper portion of the Pathfinder Dam to Guernsey Subbasin. The North Platte River flows from Pathfinder Dam northeasterly for 63 miles to Casper and then flows east for 19 miles before exiting the study area. Approximately 4,797 stream miles are located within the watershed. Approximately 566 stream miles are classified as perennial.

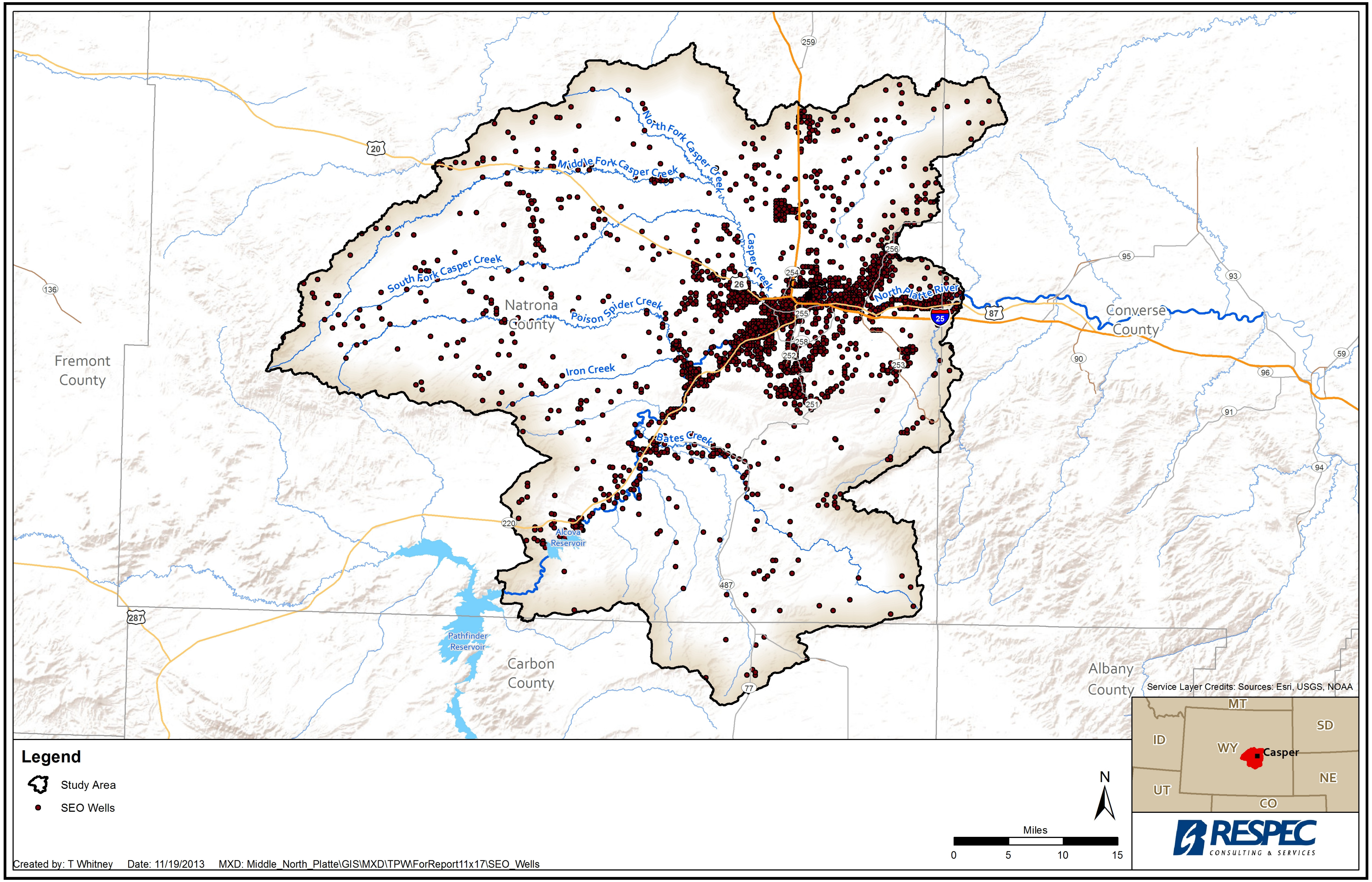

Figure 3.34. Permitted Water Wells Located Within the Study Area.

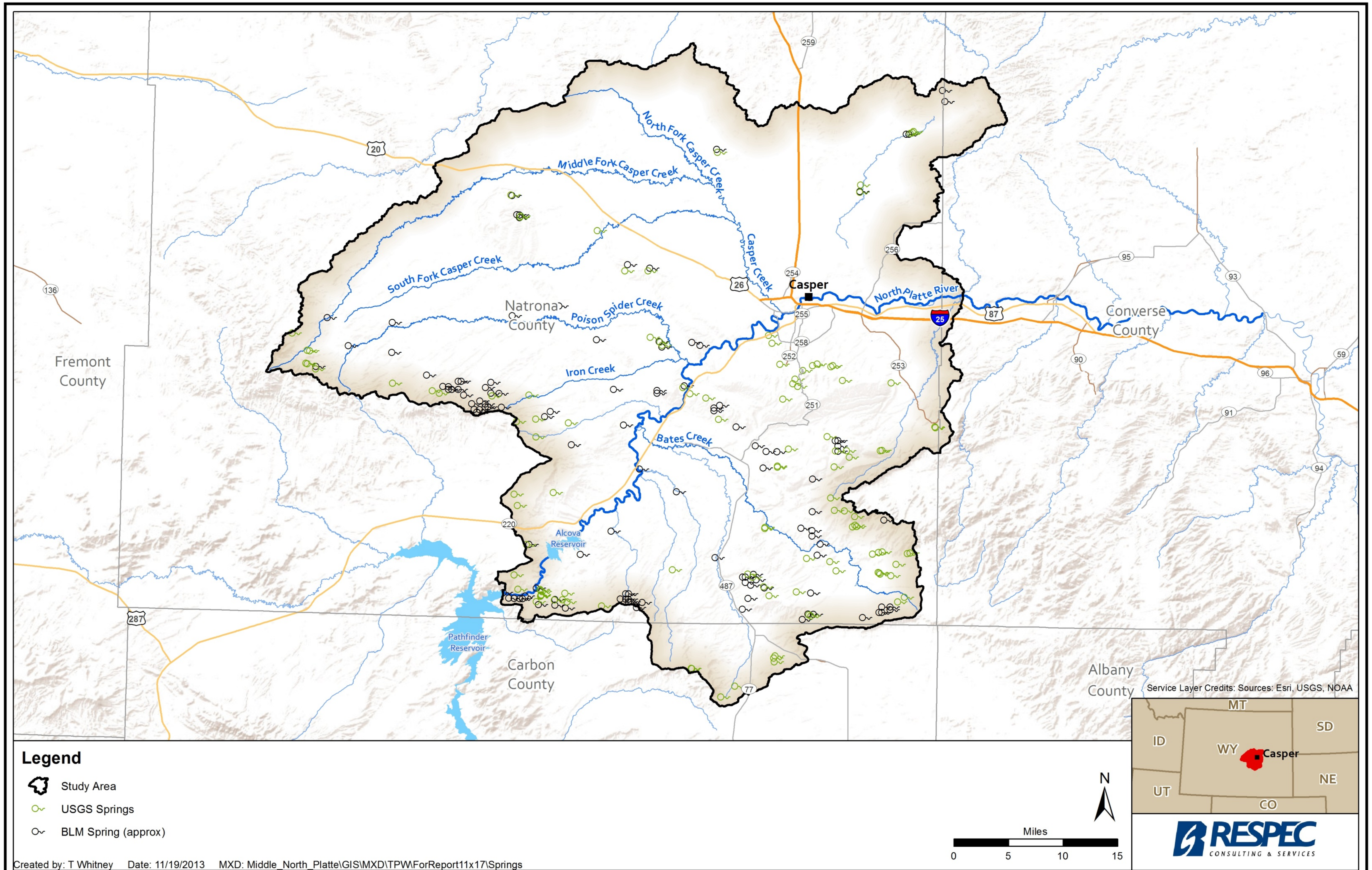

Figure 3.35. Springs Located Within the Study Area.

The North Platte River and its major tributaries, Bates Creek, Bolton Creek, Casper Creek, Muddy Creek, Poison Spider Creek, Poison Spring Creek, occur in the watershed. Other small tributaries include Blue Gulch, Hogback Draw, Ledge Creek, Schrader Gulch, Lone Tree Gulch, Bear Creek, Coal Creek, Cottonwood Creek, MacNales Creek, Oregon Trail Drain, Wolf Creek, Garden Creek, Sage Creek, Elkhorn Creek, and Claude Creek.

The USGS has delineated watersheds through a hydrologic classification which divides and subdivides the nation into continually smaller watersheds. These organized levels watersheds are called “hydrologic units” and assigned a Hydrologic Unit Code (HUC). The HUC identifies the level based on the size and locale of the unit. There are currently six levels of classification with the first level dividing the nation into 21 regions, which is referred to as a HUC-2 because a two-digit code identifies each region. Each of these regions is further split into second, third, fourth, fifth, and sixth levels representing HUC-4, HUC-6, HUC-8, HUC-10, and HUC-12, respectively. As expected, a HUC-12 is represented by 12 digits assigning it to all above levels. Table 3.25 provides an example of the HUC system as it refers to Iron Creek, one of the North Platte River tributaries. Figure 3.36 displays the HUCs in the study area.

Table 3.25. Representation of Hydrologic Unit Levels Within the Study Area

Region	10	Missouri Region	Second order HUC
Subregion	1018	North Platte	Fourth order HUC
Accounting Unit	101800	North Platte	Sixth order HUC
Cataloging Unit	10180007	Middle North Platte-Casper	Eighth order HUC
Eight Subbasins	1018000704	Poison Spider Creek	Tenth order HUC
52 Subbasins	101800070406	Iron Creek	Twelfth order HUC

The Middle North Platte River watershed study area was defined by the portion of the eighth order HUC 10180007 that drains to the Middle North Platte River upstream of the Natrona County/Converse County line including eight subbasins: 1018000701 – North Platte River-Bolton Creek, 1018000702 – Bates Creek, 1018000703 – North Platte River – Muddy Creek, 1018000704 – Poison Spider Creek, 1018000705 – Casper Creek, 1018000706 – Middle Fork Casper Creek, 1018000707 – South Fork Casper Creek, and 1018000708 – Sand Spring Creek. Table 3.26 summarizes the HUC system as it pertains to the North Platte River and its tributaries within the study area.

3.6.2.1 U.S. Geological Survey Gaging Stations

The USGS has operated multiple stream gaging stations within the study area; however, there are no active USGS gaging stations operated within the study area currently. Historically, a total of 15 USGS gaging stations were in operation within the study area. The most recently operated station, USGS 06642000, North Platte River at Alcova, WY, was discontinued in September of 1998. The remainder of the gaging stations historically operated within the study area range in dates of discontinuance. Figure 3.37 displays the period of record for all gages. Up to eight gages were operated simultaneously and are illustrated in Figure 3.38.

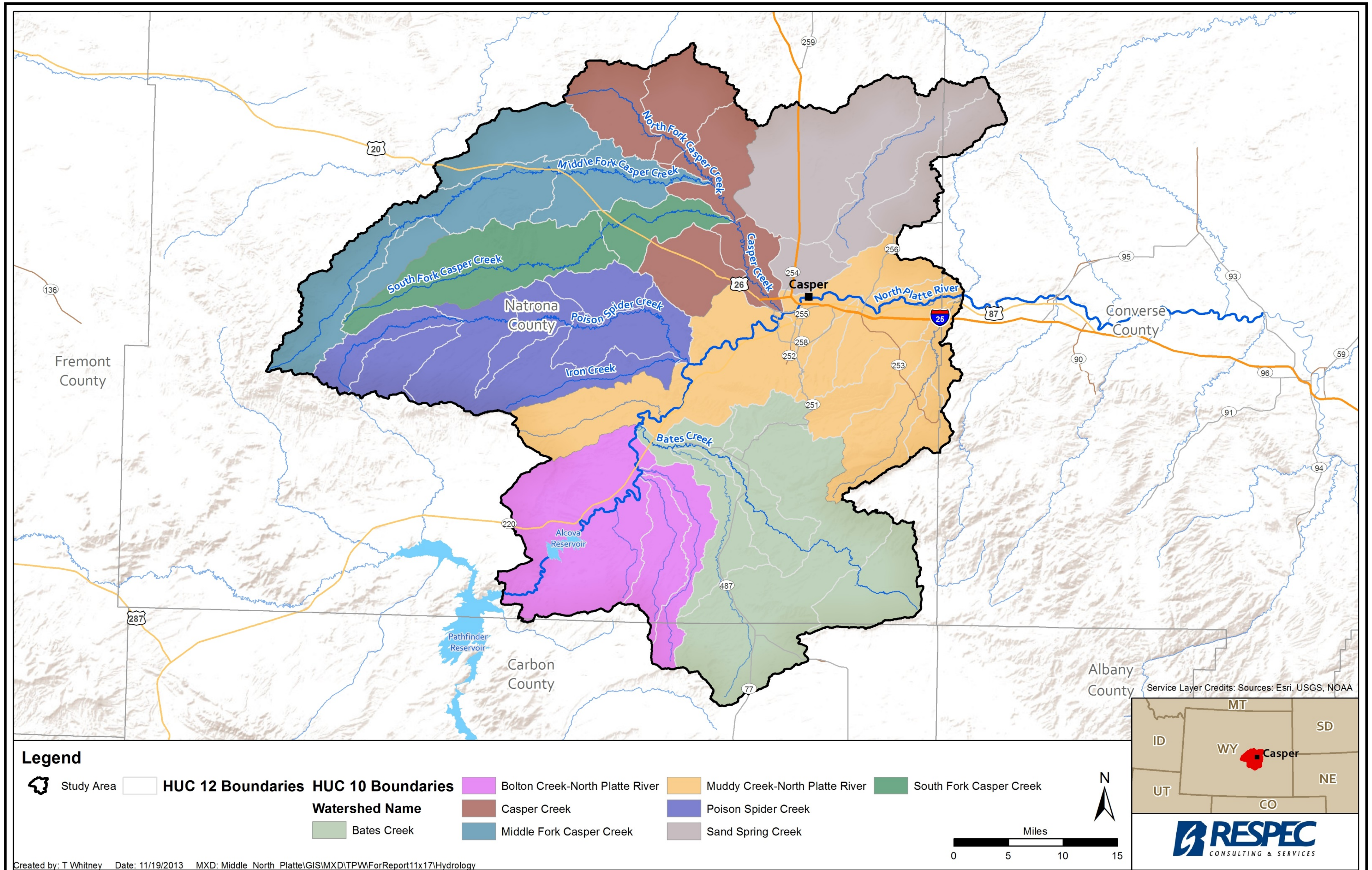

Figure 3.36. Hydrologic Units Within the Study Area.

Table 3.26. Hydrologic Unit Codes Within the Middle North Platte Watershed (Page 1 of 2)

HUC 2	HUC 4	HUC 6	HUC 8	HUC 10 Number	HUC 10 Name	HUC 12 Number	HUC 12 Name	Area (sq. mi.)
Region 10: Missouri	Subregion 1018: North Platte	Accounting Unit 101800: North Platte	Cataloging Unit 10180007: Middle North Platte-Casper	1018000701	North Platte River-Bolton Creek	101800070101	Alcova Reservoir	64.7
						101800070102	North Platte River-Eagle Creek	64.8
						101800070103	North Platte River-Lone Tree Gulch	49.9
						101800070104	Bear Creek-North Platte River	44.2
						101800070105	Bolton Creek	42.6
				1018000702	Bates Creek	101800070201	Bates Creek-East Fork Bates Creek	57.1
						101800070202	Bates Creek-Spruce Creek	50.0
						101800070203	Bates Creek-Garret Ranch	36.6
						101800070204	Corral Creek-Bates Creek	57.6
						101800070205	Bates Creek-Schnoor Reservoir	24.9
						101800070206	Little Red Creek	21.1
						101800070207	Upper Stinking Creek	52.2
						101800070208	Middle Stinking Creek	51.8
						101800070209	Lower Stinking Creek	45.2
				1018000703	North Platte River- Muddy Creek	101800070301	North Platte River-Coal Creek	46.2
						101800070302	Willow Creek-North Platte River	56.8
						101800070303	North Platte River-Garden Creek	67.5
						101800070304	North Platte River-Sage Creek	55.1
						101800070305	Elkhorn Creek	20.0
						101800070306	North Platte River-Dry Muddy Creek	54.0
						101800070307	Upper Muddy Creek-North Platte River	43.9
						101800070308	Negro Creek	15.9
						101800070309	Lower Muddy Creek-North Platte River	25.1
						101800070310	Clear Fork Muddy Creek	40.6
						101800070310	Clear Fork Muddy Creek	40.6

Table 3.26. Hydrologic Unit Codes Within the Middle North Platte Watershed (Page 2 of 2)

HUC 2	HUC 4	HUC 6	HUC 8	HUC 10 Number	HUC 10 Name	HUC 12 Number	HUC 12 Name	Area (sq. mi.)
Region 10: Missouri	Subregion 1018: North Platte	Accounting Unit 101800: North Platte	Cataloging Unit 10180007: Middle North Platte-Casper	1018000704	Poison Spider Creek	101800070401	Poison Spider Creek-Peach Creek	33.7
						101800070402	Soap Creek	33.4
						101800070403	Poison Spider Creek-Austin Creek	54.8
						101800070404	Poison Spider Creek-Poison Spider Oil Field	32.5
						101800070405	Meadow Creek-Poison Spider Creek	27.9
						101800070406	Poison Spider Creek-Clevidence Draw	53.2
						101800070407	Hot Springs	32.1
						101800070408	Iron Creek	33.3
				1018000705	Casper Creek	101800070501	Casper Creek-Gowin Kesecker Lake	49.8
						101800070502	Casper Creek-Statzer Draw	53.6
						101800070503	Casper Creek-Twentymile Draw	50.9
						101800070504	Casper Creek-Natrona County International Airport	32.8
						101800070505	Sixmile Draw	46.9
				1018000706	Middle Fork Casper Creek	101800070601	Upper Middle Fork Casper Creek	62.0
						101800070602	Middle Middle Fork Casper Creek	61.3
						101800070603	Coyote Creek-Middle Fork Casper Creek	22.4
						101800070604	Lower Middle Fork Casper Creek	59.3
						101800070605	Town of Powder River	60.1
				1018000707	South Fork Casper Creek	101800070701	Upper South Fork Casper Creek	64.8
						101800070702	Middle South Fork Casper Creek	52.5
						101800070703	Lower South Fork Casper Creek	40.8
				1018000708	Sand Spring Creek	101800070801	Sand Spring Creek	69.2
						101800070802	McKenzie Draw	35.8
						101800070803	Jim Hill Draw	19.8
						101800070804	Pratts Soda Lakes	24.7
						101800070805	Soda Lake	23.3
						101800070806	McPherson Draw	105.4

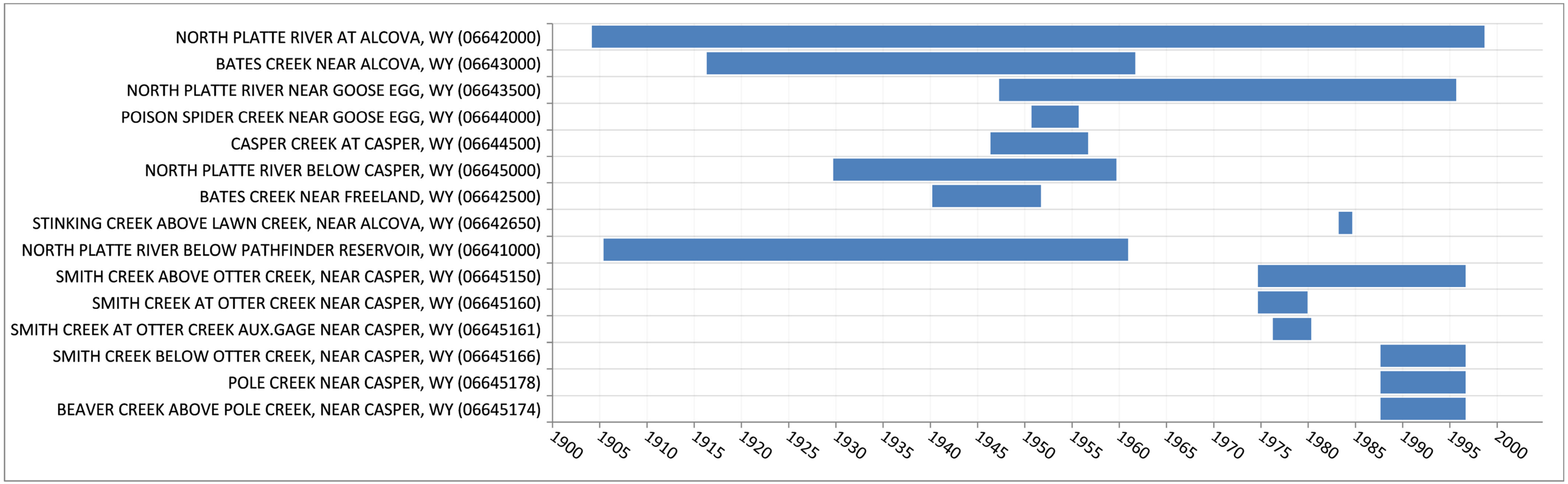

Figure 3.37. Period of Record for U.S. Geological Survey Streamflow Gages Within the Study Area.

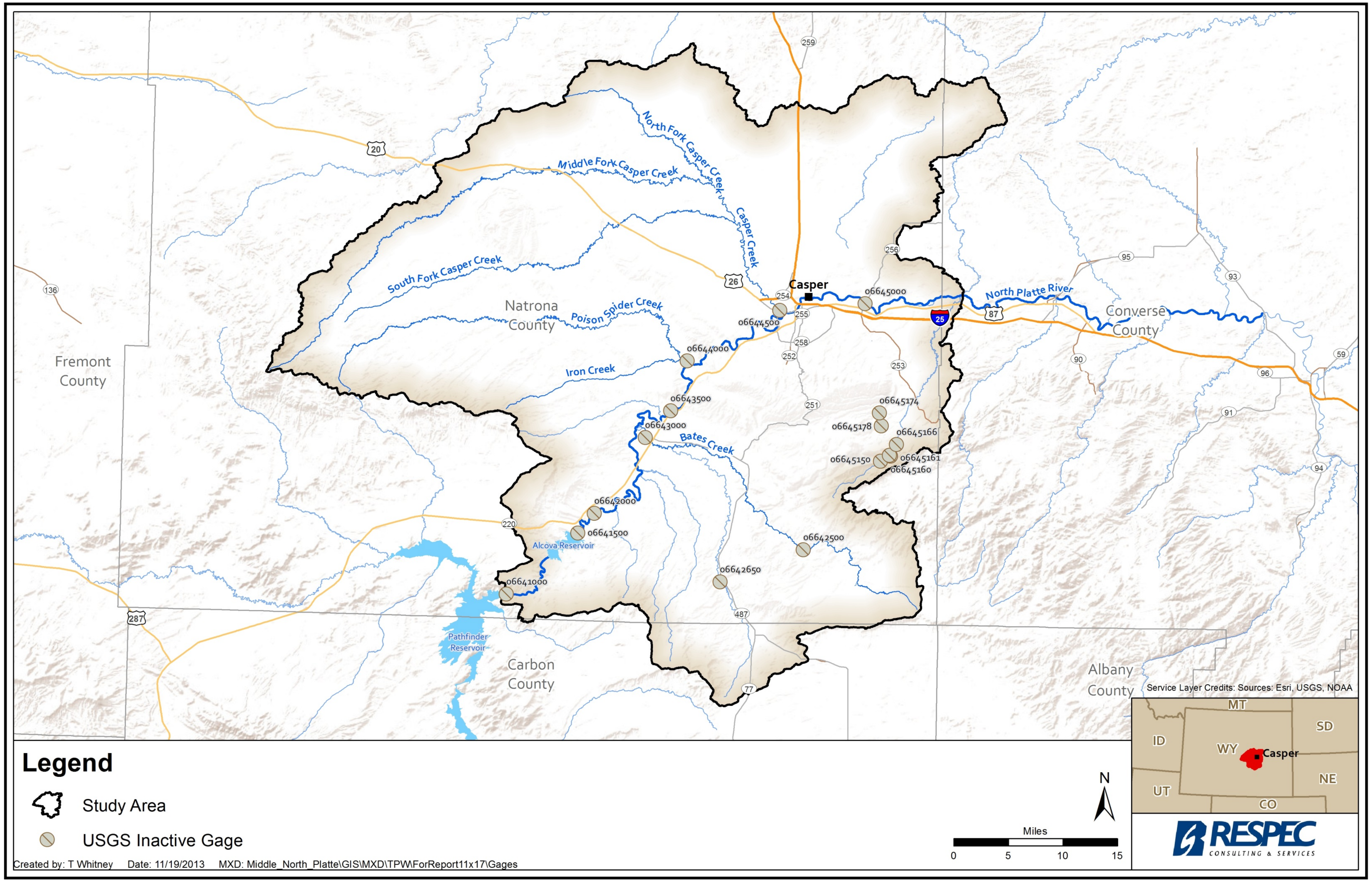

Figure 3.38. U.S. Geological Survey Gages Within the Study Area.

In an effort to obtain a relationship regarding seasonality in collected historical USGS discharge data, historical monthly mean discharge rates were computed for all available gaging stations within the study area. As can be seen in Table 3.27, monthly mean discharge rates reflect typical seasonal runoff patterns.

Gaging locations on the North Platte River report highest discharge rates in middle summer (July to August). The latter part of the summer and fall season exhibit declining discharge rates. Increases in observed discharge rates throughout the spring and early summer months at North Platte River gaging stations can be attributed to snowmelt and precipitation runoff. Decreases in streamflow in the latter part of the summer and fall months indicate the transition to typical winter baseflow stream conditions throughout the study area.

Gaging stations located on tributaries to the North Platte River have earlier and much smaller peak mean discharge rates than that of North Platte River gages. Peak monthly mean discharge rates typically occur in the months of March and May and are significantly smaller in magnitude than those observed on the North Platte River.

In an effort to obtain a relationship regarding seasonality in collected historical USGS discharge data, historical monthly mean discharge rates were computed for all available gaging stations within the study area. As can be seen from Table 3.28, monthly mean discharge rates reflect typical seasonal runoff patterns. To visually display this seasonal relationship, historical monthly mean hydrographs of gaging stations on the North Platte River within the study area were plotted in Figure 3.39. Figure 3.40 displays historical monthly mean hydrographs for all gages within the study area who are located on tributaries to the North Platte River. Figure 3.41 shows the mean flow for tributaries.

3.6.2.2 Bureau of Reclamation Gaging Stations

The USBR operates and maintains multiple automated hydrologic monitoring stations, deemed HYDROMET stations, within the study area [Bureau of Reclamation, 2013]. These stations remotely log field data for various hydrologic and meteorological parameters. Streamflow gaging data were obtained from five HYDROMET monitoring stations. Table 3.29 displays the five USBR HYDROMET stations and associated monthly mean discharge for the respective periods of record. Figure 3.42 visually displays historical monthly mean discharge rates for these five stations.

3.6.2.3 Wyoming Water Development Commission Temporary Gaging Stations

Given the incomplete nature of available stream gaging data within the study area, five gaging stations were installed in an effort to obtain additional streamflow data. The five temporary gaging stations and information pertinent to their location are given in Table 3.30 and shown in Figure 3.43.

Table 3.27. Summary of Discontinued U.S. Geological Survey Gaging Stations Within the Middle North Platte Watershed

USGS Station Number	Station Name	Period of Record	Drainage Area (sq. mi.)	Latitude	Longitude	Gage Elevation (ft, NGVD29)
06641000	North Platte River below Pathfinder Reservoir, WY	06/01/1905–12/31/1960	14,661	42°27'54"	106°50'47"	5,670
06642000	North Platte River at Alcova, WY	03/01/1904–09/30/1998	10,812	42°34'27"	106°41'31"	5,299
06642500	Bates Creek near Freeland, WY	04/01/1940–09/30/1951	118	42°32'00"	106°19'00"	6,510
06642650	Stinking Creek above Lawn Creek, near Alcova, WY	04/25/1983–09/30/1984	92	42°29'11"	106°27'49"	6,070
06643000	Bates Creek near Alcova, WY	05/01/1916–09/30/1961	393	42°40'34"	106°36'09"	5,290
06643500	North Platte River bear Goose Egg, WY	05/01/1947–09/30/1995	11,423	42°42'43"	106°33'29"	5,215
06644000	Poison Spider Creek near Goose Egg, WY	10/01/1950–09/30/1955	301	42°46'44"	106°31'46"	5,199
06644500	Casper Creek at Casper, WY	06/01/1946–09/30/1956	668	42°50'52"	106°21'52"	5,110
06645000	North Platte River below Casper, WY	10/01/1929–09/30/1959	12,574	42°51'32"	106°12'41"	5,070
06645150	Smith Creek above Otter Creek, near Casper, WY	10/01/1974–09/30/1996	10	42°38'59"	106°10'46"	6,550
06645160	Smith Creek at Otter Creek near Casper, WY	10/01/1974–12/31/1979	11	42°39'24"	106°09'40"	6,360
06645161	Smith Creek at Otter Creek near Casper, WY	04/29/1976–05/22/1980	11	42°39'24"	106°09'40"	6,360
06645166	Smith Creek below Otter Creek, near Casper, WY	10/01/1987–09/30/1996	19	42°40'20"	106°09'03"	5,980
06645174	Beaver Creek above Pole Creek, near Casper, WY	10/01/1987–09/30/1996	5	42°42'50"	106°10'56"	5,800
06645178	Pole Creek near Casper, WY	10/01/1987–09/30/1996	3	42°41'48"	106°10'42"	5,880

Table 3.28. Historical Monthly Mean Discharge Rates for U.S. Geological Survey Gaging Stations Within the Study Area

USGS Station No.	Period of Record	Historical Monthly Mean Discharge (cfs)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
06642000	03/01/1904–09/30/1998	478	475	599	908	1,660	2,360	3,000	2,850	1,460	640	560	495
06641000	06/01/1905–12/31/1960	31	132	239	756	2150	4340	4550	3760	1930	489	170	136
06642500	04/01/1940–09/30/1951	2.5	2.7	12	52	71	20	6.1	2.3	1.9	2.7	3.1	3.0
06642650	04/25/1983–09/30/1984	3.0	5.2	18	27	21	7.6	4.1	3.9	1.3	2.2	2.3	1.7
06643000	05/01/1916 -09/30/1961	9.2	11	21	85	74	7.4	5.2	1.8	18	6.1	9.3	11
06643500	05/01/1947–09/30/1995	398	371	478	937	1,590	2,230	3,310	3,090	1,520	526	456	399
06644000	10/01/1950–09/30/1955	3.4	3.2	5.1	5.5	5.3	4.4	3.4	3.4	4.0	3.4	3.3	3.4
06644500	06/01/1946–09/30/1956	0.7	0.9	6.2	2.4	4.2	4.9	1.5	1.3	1.3	0.9	0.9	0.7
06645000	10/01/1929–09/30/1959	92	96	112	366	1,500	2,730	4,320	4,140	1,890	270	119	98
06645150	10/01/1974–09/30/1996	1.5	1.5	1.6	3.2	7.9	5.0	2.9	2.3	2.0	1.9	1.8	1.6
06645160	10/01/1974–12/31/1979	1.4	1.3	1.3	3.4	8.8	4.7	2.5	1.7	1.4	1.6	1.4	1.4
06645161	04/29/1976–05/22/1980	1.4	*	*	*	8.1	4.4	1.9	3.3	1.5	1.4	*	1.6
06645166	10/01/1987–09/30/1996	1.9	1.8	2.3	5.5	15	12	5.1	3.3	2.6	2.5	2.5	2.1
06645174	10/01/1987–09/30/1996	3.6	3.7	3.9	4.2	6.9	6.3	4.5	3.9	3.8	3.9	3.9	3.7
06645178	10/01/1987–09/30/1996	0.5	0.5	0.7	1.6	4.0	2.5	1.1	0.7	0.7	0.6	0.6	0.5

* = no data available

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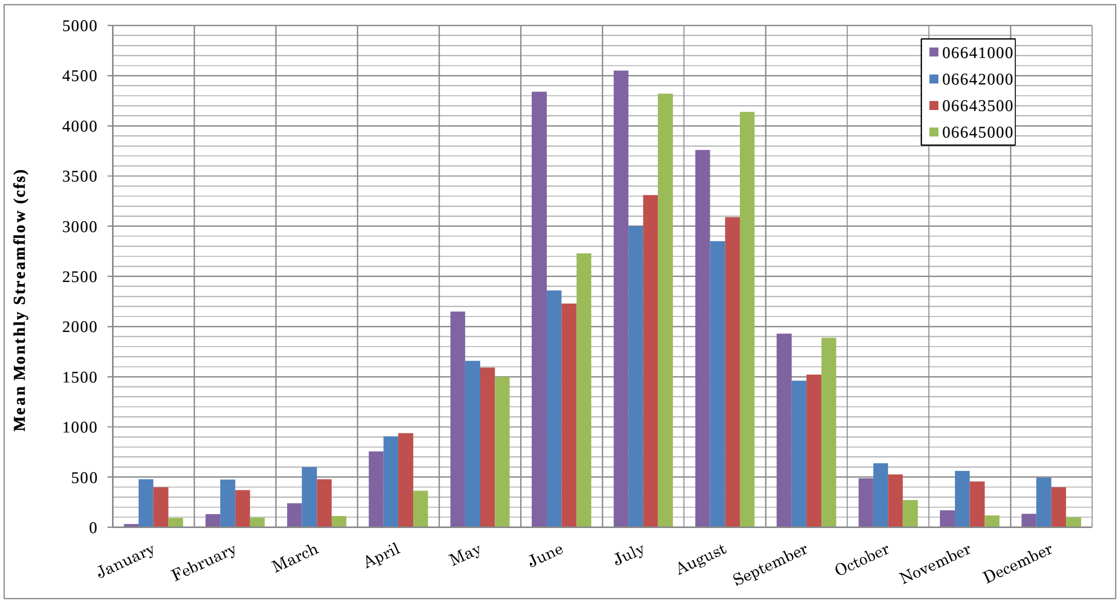

Figure 3.39. Mean Monthly Streamflow for U.S. Geological Survey Gaging Stations on the North Platte River Within the Study Area.

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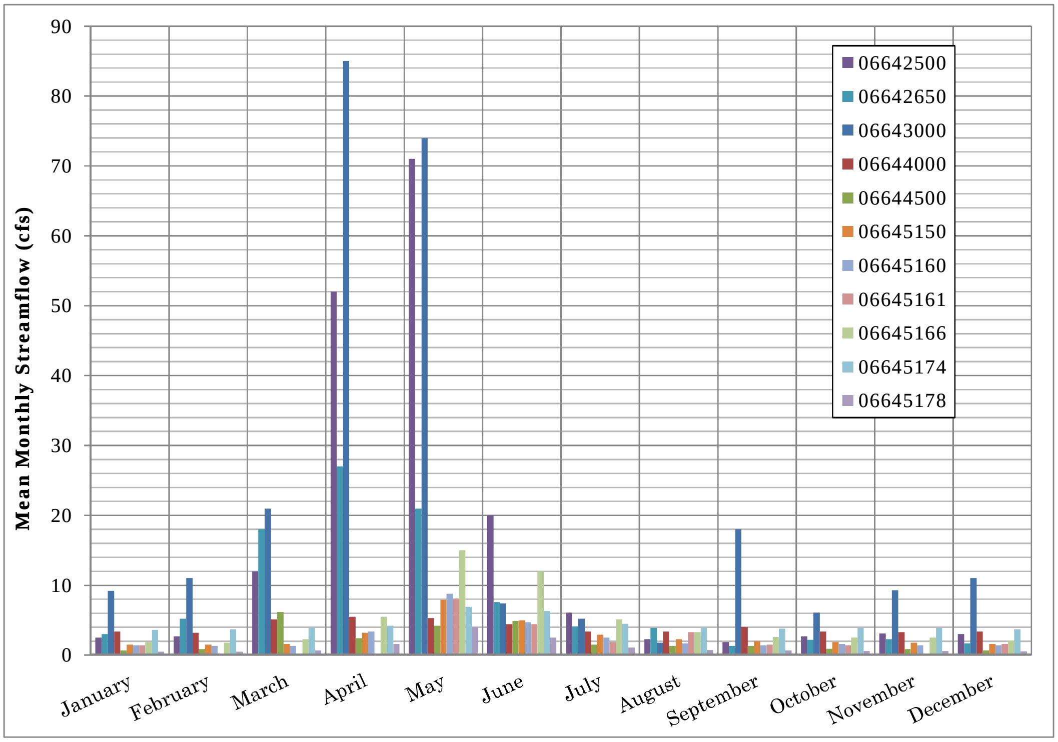

Figure 3.40. Historical Mean Monthly Streamflow for U.S. Geological Survey Gaging Stations on the North Platte River Within the Study Area.

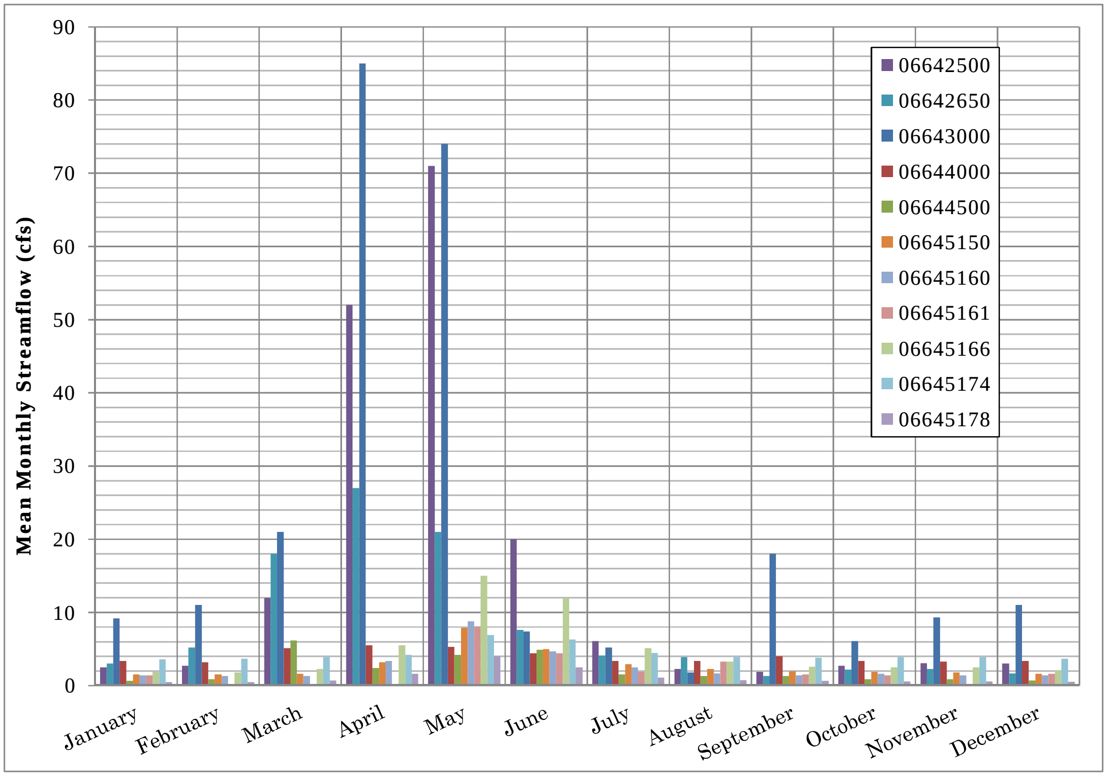

Figure 3.41. Historical Mean Monthly Streamflow for U.S. Geological Survey Gaging Stations on Tributaries to the North Platte River Within the Study Area.

The gages consist of pressure transducers with built in data loggers protected by PVC housings. The transducer setup and staff gage for East Fork Bates Creek can be seen in Figure 3.44. Transducers were programmed to collect depth of water at 15-minute intervals throughout the study period. Water depth was related to a staff gage allowing stage/discharge relationships to be made to translate the 15-minute water-depth data to streamflow.

All five gages were installed by RESPEC in June 2012. Transducers were retrieved in October 2012 and reinstalled in the spring of 2013. Data were collected throughout the summer and fall of 2013 before the gages were removed in November 2013. The data collected at these sites provide insight to the hydrologic processes in portions of the North Platte River watershed lacking any historic gages. This information will reduce uncertainty associated with the existing hydrologic regime.

Rating curves were developed for each of the five gages to convert continuous water depth (stage) recordings to streamflow. Flow measurements and stage were recorded several times each year. Using a least-squares regression, a stage/discharge equation was fit to the manual measurements by maximizing the coefficient of determination. Site surveys were also completed which included a gage cross-section, channel slope, and observations of bed and overbank

Table 3.29. Monthly Mean Discharge for Bureau of Reclamation Gaging Stations

Bureau of Reclamation Gaging Station	Historical Monthly Mean Discharge (cfs)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pathfinder Reservoir, WY	590	599	803	1,448	1,781	2,550	3,099	2,797	1,399	420	634	587
North Platte River below Pathfinder, Dam, WY	20	18	75	231	385	942	880	581	132	22	43	20
North Platte River below Gray Reef, Reservoir, WY	687	700	905	1,232	1,650	2,289	2,447	2,162	1,302	881	779	713
Alcova Reservoir, WY	576	583	742	1,109	1,611	2,290	2,790	2,552	1,374	737	653	586
North Platte River at Casper, WY	1,009	886	1,001	2,012	2,594	3,591	3,422	2,632	1,228	546	555	944

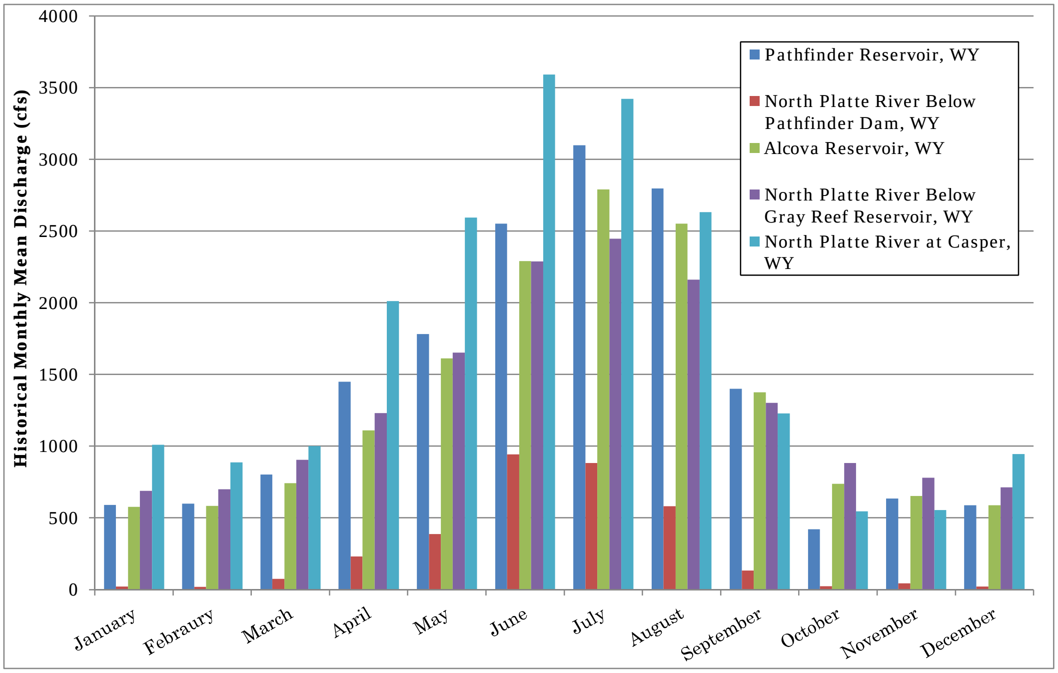

Figure 3.42. Monthly Mean Discharge for HYDROMET Stations in the Study Area.

Table 3.30. Wyoming Water Development Commission Temporary Stream Gages Within the Study Area

Gage Name and Identifier	General Location	Drainage Area (acres)	Latitude/ Longitude	Elevation (ft)
Poison Spider Creek (PSC3)	Located on the left hand side of County Road 201, approximately 3.60 miles after the fork in County Road 201 and the start of County Road 210.	88,500	42.830675 106.79995	5,689
Bates Creek Downstream (BACR1)	Located on the left hand side of Highway 220 approximately 0.50 miles southwest from the confluence of Highway 487 and Highway 220. Site is 50 yards downstream from the Highway 220 bridge.	252,400	42.669311 106.592639	5,323
Bates Creek Upstream (BACR10)	Located approximately 3.90 miles off of County Road 402 at Miles Land and Livestock below the stream crossing and walk-in area.	36,600	42.507586 106.213275	7,302
East Fork Bates Creek (BACR_NF)	Located approximately 750 yards upstream from the Diversion Dam.	10,300	42.501803 106.176056	7,379
Oregon Trail Drain (OTD)	Located upstream of South Robertson Road, approximately 1.40 miles from the confluence of South Robertson Road and Highway 220.	8,400	42.827761 106.415761	5,143

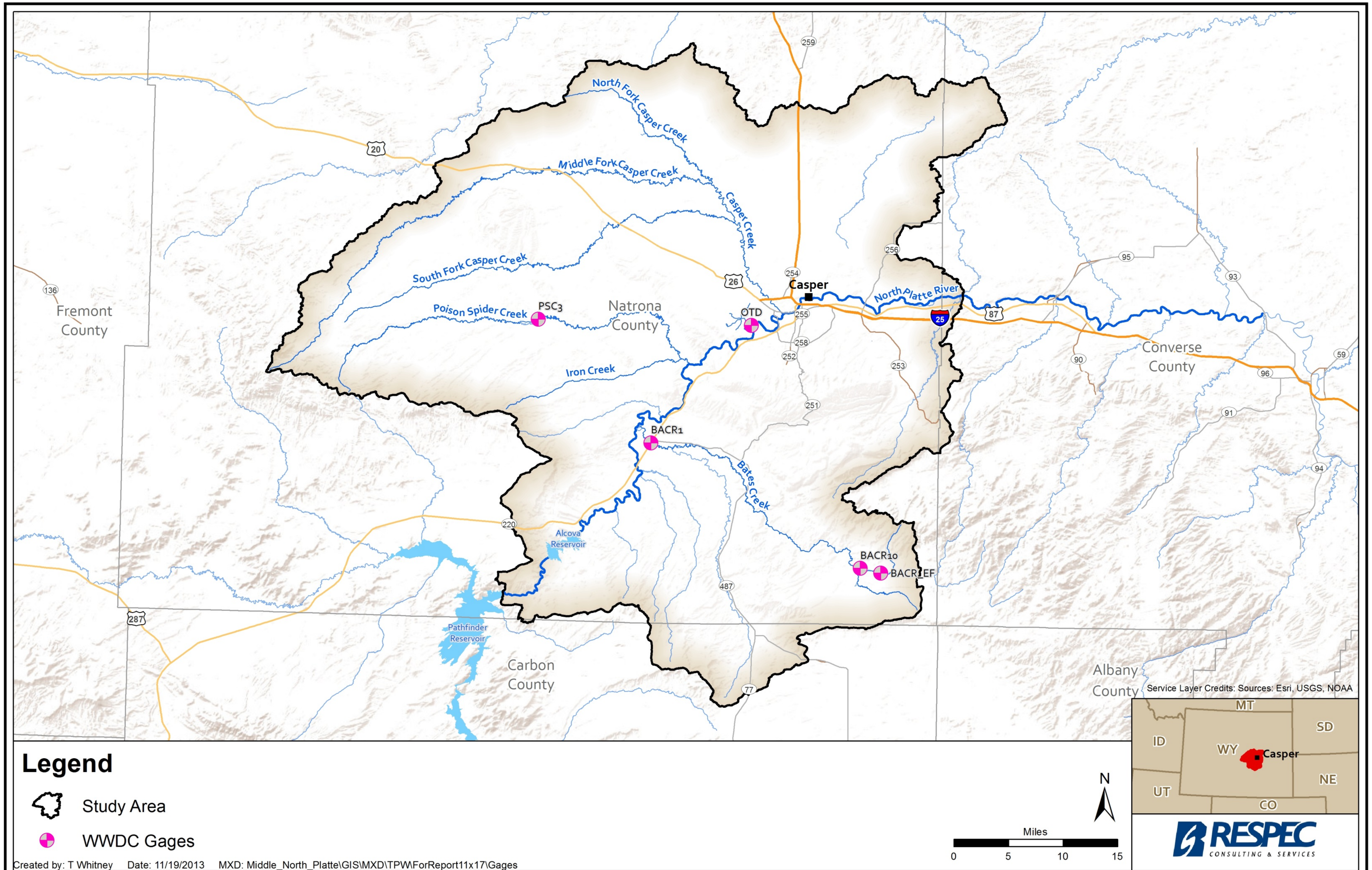

Figure 3.43. Locations of Temporary Stream Gages Within the Study Area.

conditions. This allowed for the use of other flow calculation equations, such as Manning's formula, as a means to validate or modify the rating curve. Continuous stage data collected by the transducers was then converted to flow using the rating curve at each site. Table 3.31 summarizes the results of the temporary stream gaging effort and the discharge statistics and yield estimates for each of the five WWDC gaging stations.

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Figure 3.44. Temporary Stream Gage Installed on East Fork Bates Creek.

Poison Spider Creek (PSC3)

For the entire 2012 stream monitoring period, flow in Poison Spider Creek did not exceed 0.10 cfs. However, this gaging station was installed on June 19, after spring snowmelt and precipitation runoff had occurred. Approximately 21 percent of flows were less than 0.03 cfs. These are estimated and may be considered zero flow. Over the 2012 monitoring period, flows averaged 0.04 cfs. The greatest flow during the period (0.10 cfs) was measured on October 24, the day the transducer was removed for the winter. Increases in flow during October may have been caused by a snow storm and corresponding melt.

The transducer was returned to the stream on March 21, 2013. During 2013, Poison Spider Creek experienced high flow events in April and May from snowmelt and precipitation, then flow reduction through June into July and August, as it did in 2012. Flow increased slowly through September then increased to a peak of approximately 14 cfs from snowmelt after winter storm Atlas. Flows over the 2013 monitoring period averaged 0.3 cfs, with approximately 13 percent of flows under 0.03 cfs. The pressure transducer was removed on November 8. Hydrographs from the 2012 and 2013 monitoring periods are displayed in Figure 3.45.

Table 3.31. Summary of Temporary Stream Gage Hydrology

Stream Gage	PSC3	BACR1	BACR10	BACR_NF	OTD
Drainage Area (mi^2)	138	394	57	16	13
2012					
Start Date	06/19/12	06/20/12	06/20/12	06/20/12	06/20/12
End Date	10/24/12	10/25/12	10/25/12	10/25/12	10/25/12
Average Flow (cfs)	0.04	1.3	2.0	1.1	8.5
Median Flow (cfs)	0.04	0.9	2.0	1.1	9.1
Total Yield (ac-ft)	11	331	500	283	2148
Mean Yield (ac-ft/ mi^2)	0.08	0.84	8.74	17.6	164
Peak Flow (cfs)	0.10	5.0	4.7	2.0	21
Date of Peak	10/24/12	10/20/12	10/25/12	10/25/12	07/15/12
Min. Flow (cfs)	0.0	0.20	1.2	0.77	0.33
Stage Max. (ft)	7.12	4.11	10.45	14.08	2.40
Stage Min. (ft)	6.72	3.41	10.25	13.75	1.22
2013					
Start Date	03/21/13	03/21/13	04/02/13	06/12/13	03/21/13
End Date	11/08/13	11/20/13	11/08/13	11/08/13	11/20/13
Average Flow (cfs)	0.30	2.8	5.0	1.1	7.2
Median Flow (cfs)	0.11	1.7	3.4	1.0	6.3
Total Yield (ac-ft)	138	1348	2180	319	3490
Mean Yield (ac-ft/ mi^2)	1.00	3.42	38.1	19.8	266
Peak Flow (cfs)	14	185	33	3.0	45
Date of Peak	10/09/13	10/11/13	05/20/13	11/02/13	10/06/13
Min. Flow (cfs)	0.0	0.38	1.1	0.71	0.0
Stage Max. (ft)	10.39	7.24	11.30	14.27	2.85
Stage Min. (ft)	6.74	3.49	10.24	13.73	0.97

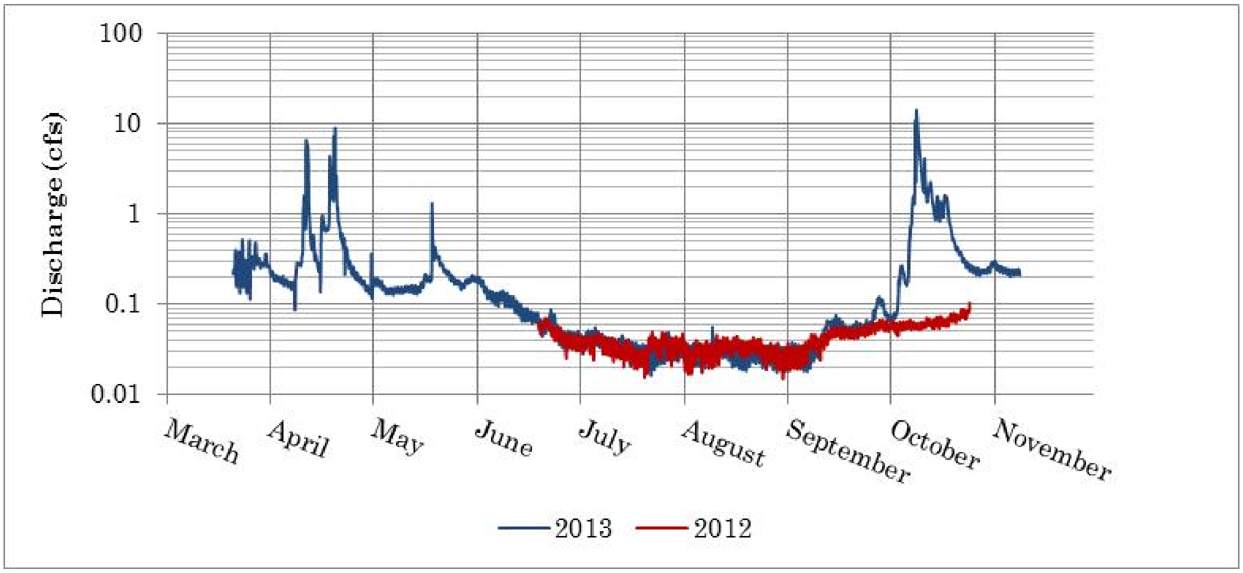

Figure 3.45. Hydrographs at Poison Spider Creek for the 2012 and 2013 Gaging Periods.

Bates Creek Downstream (BACR1)

The Bates Creek Downstream gaging site was installed on June 20, 2012, after spring snowmelt and precipitation runoff. Flows in Bates Creek at this site were generally consistent over the 2012 gaging period and averaged 1.3 cfs. However, on October 7, flows increased from 1.0 cfs to 4.0 cfs when irrigation water diversions upstream from the site were discontinued. The highest flows in 2012 were near the end of October when the transducer was removed from the creek.

For the 2013 monitoring period, the pressure transducer was placed on March 21. High flow events from spring snowmelt and precipitation occurred in April and May. Irrigation water diversions likely caused the steep decrease in flow during April and the steep increase in September. On June 23, flow increased abruptly from 1.5 cfs to 4.0 cfs then decreased just as suddenly on July 8 from 3.5 cfs to 1.5 cfs, likely from changes in irrigation diversions upstream. Average flow over the 2013 period was 2.8 cfs, and peak flow of 185 cfs occurred on October 11 from snowmelt after winter storm Atlas. The transducer was removed on November 20. Hydrographs from the 2012 and 2013 monitoring periods are displayed in Figure 3.46.

Bates Creek Upstream (BACR10)

The Bates Creek Upstream gaging station was installed on June 20, 2012, after spring snowmelt and precipitation runoff had occurred. Greater than 90 percent of flow at this site ranged between 1.5 cfs and 2.5 cfs over the 2012 monitoring period. Average flow for the period was 2.0 cfs, and peak flow at the site was observed on October 25 at a rate of approximately 4.7 cfs.

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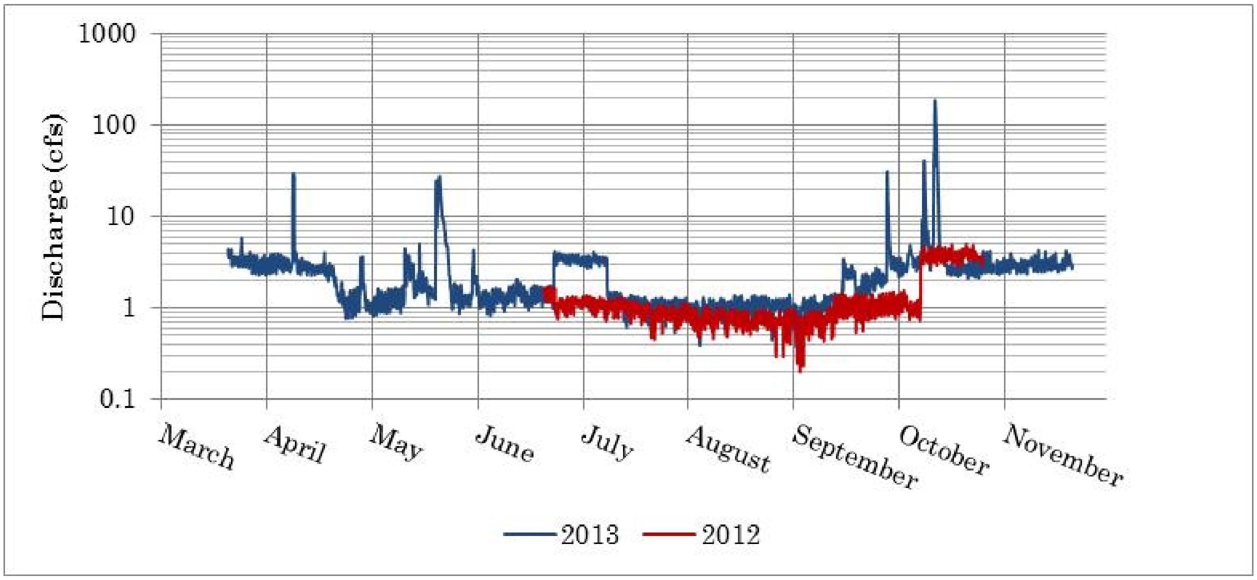

Figure 3.46. Hydrographs at Bates Creek Downstream for 2012 and 2013 Gaging Periods.

For the 2013 monitoring period, the pressure transducer was placed on April 2. The 2013 hydrograph reflects spring snowmelt and precipitation runoff through April and May. Peak flow for the 2013 monitoring period occurred on May 20 at a rate of 33 cfs. Flow decreased during June, then ranged between 1.5 cfs and 3.0 cfs for most of July and August. Flow increased steadily through September, then experienced fluctuations through October and November from snowmelt after winter storm Atlas. Flow over the 2013 monitoring period averaged 5.0 cfs. Hydrographs from the 2012 and 2013 monitoring periods are displayed in Figure 3.47.

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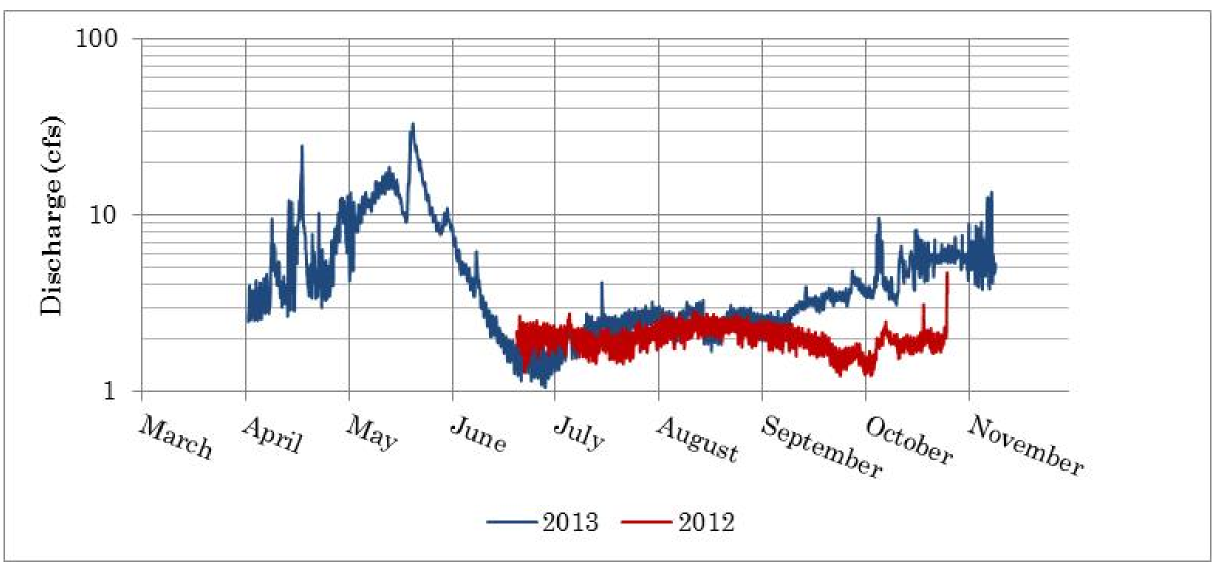

Figure 3.47. Hydrographs at Bates Creek Upstream for the 2012 and 2013 Gaging Periods.

East Fork Bates Creek (BACR_NF)

The East Fork Bates Creek previously referred to as North Fork Bates Creek gaging station was installed on June 20, 2012, after the majority of spring snowmelt and precipitation runoff had occurred. Flows in the East Fork Bates Creek consistently ranged between 0.8 cfs and 1.4 cfs, with an average of 1.1 cfs over the 2012 monitoring period.

For the 2013 monitoring period, the pressure transducer was not placed until June 12, after the majority of spring snowmelt and precipitation runoff. Flows through July, August, and September were similar to those for the same period of 2012. Flows increased and fluctuated through October and November from snowmelt. As in 2012, average flow over the 2013 monitoring period was 1.1 cfs. Hydrographs from the 2012 and 2013 monitoring periods are displayed in Figure 3.48.

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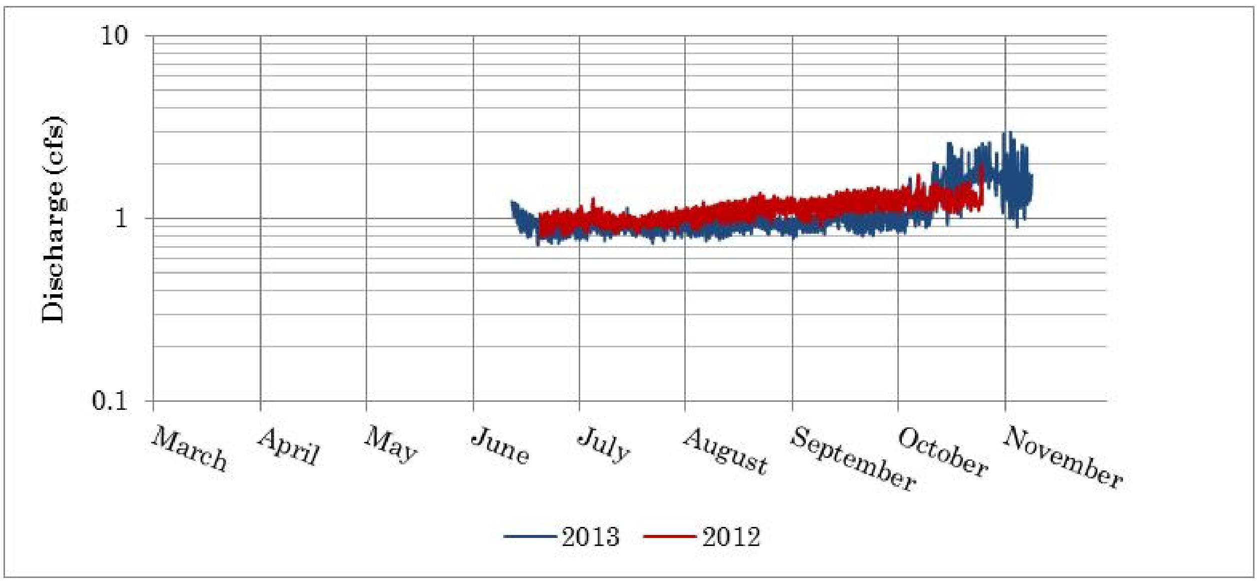

Figure 3.48. Hydrographs at North Fork of Bates Creek for the 2012 and 2013 Monitoring Periods.

Oregon Trail Drain (OTD)

The Oregon Trail Drain gaging station was installed on June 20, 2012. Returns from irrigated cropland caused frequent fluctuations in flow from June through September of 2012, generally ranging from 1.5 cfs to 20 cfs. Peak flow occurred on July 15 at a rate of 21 cfs. With the end of irrigation season, flow decreased in October to less than 1.0 cfs. Average flow for the 2012 monitoring period was 8.5 cfs.

The pressure transducer was placed on March 21 for the 2013 monitoring period. Flow from March through May was impacted by spring snowmelt and precipitation runoff. Flow during

May was potentially impacted by irrigation, as were flows from June through September. Over that period, fluctuations were similar to those in 2012. Flow peaked after winter storm Atlas on October 6 at a rate of 45 cfs then decreased through October to approximately 1.0 cfs. Flows for the 2013 monitoring period averaged 7.2 cfs. Hydrographs from the 2012 and 2013 monitoring periods are displayed in Figure 3.49.

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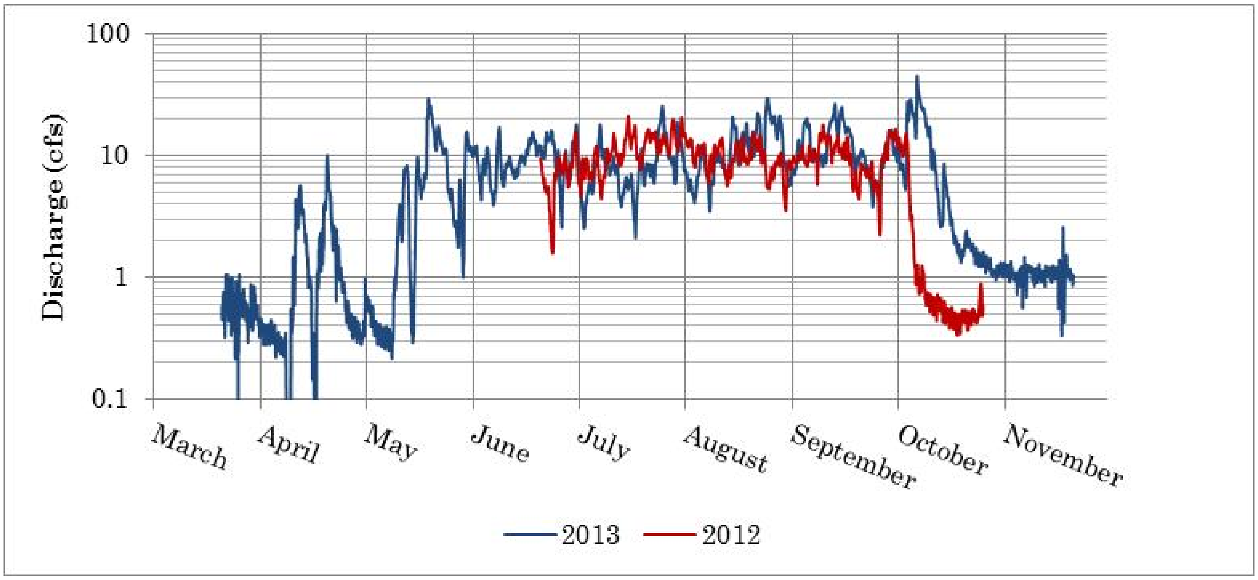

Figure 3.49. Hydrographs at Oregon Trail Drain for the 2012 and 2013 Monitoring Periods.

Wyoming Water Development Commission Temporary Stream Gage Hydrology Summary

At each of the temporary stream gaging stations, streamflow was used to characterize hydrology of the respective drainage areas for both monitoring periods. In addition to those characteristics previously mentioned, this includes median flow, total yield, mean yield, minimum flow, and maximum and minimum stream stage. The results are shown in Table 3.31. The Oregon Trail Drain gaging station has the smallest drainage area, but had the greatest yields during both monitoring periods with 2,148 acre-feet (ac-ft) in 2012 and 3,490 ac-ft in 2013. This resulted in respective mean yields of 164 ac-ft per square mile (mi^2) and 266 ac-ft/mi^2. These high "yields" can be attributed almost entirely to irrigation return flows, and may be used to indicate efficiency of irrigation application.

The Bates Creek Upstream gaging station showed the second-highest yield for both monitoring periods with 500 ac-ft in 2012 and 2180 ac-ft in 2013. This resulted in respective mean yields of 8.74 ac-ft/mi^2 and 38.1 ac-ft/mi^2. Yield and peak flow at this site are both impacted by the Bates Creek Reservoir system. Also, the Bates Creek Upstream drainage area includes the Bates Creek North Fork drainage area. Therefore, these yields include those recorded for the Bates Creek North Fork gaging station, minus any volume diverted to and stored within Bates Creek Reservoir.

Yields at the Bates Creek Downstream gaging station were third-highest for both monitoring periods with 331 ac-ft in 2012 and 1348 ac-ft in 2013. These yields are reduced by irrigation water diversions upstream, so the resulting mean yields are low at 0.84 ac-ft/mi^2 and 3.42 ac-ft/mi^2, respectively. Poison Spider Creek had the lowest yields, with 11 ac-ft in 2012 and 138 ac-ft in 2013. It was also the least productive drainage area with mean yields at 0.08 ac-ft/mi^2 and 1.0 ac-ft/mi^2, respectively.

3.7 STREAM GEOMORPHOLOGY

3.7.1 General

The field of fluvial geomorphology is the study of how land is formed under processes associated with running water. The balance between processes such as erosion, deposition, and sediment transport determines the character and condition of a stream. The objective of the geomorphic evaluation of the study area is to determine the nature of this balance, and where the balance has been upset.

The condition of a stream can be assessed with respect to its basic form (width, depth, and slope), as well as its state of equilibrium, or geomorphic stability [Thorne et al., 1996; Johnson et al., 1999]. Stable, or equilibrium, channels are defined as those that have achieved a balance between flow energy and sediment delivery, such that sediment is transported at the rate at which it is delivered, and the form and pattern of the channel is maintained [Thorne et al., 1996]. Dynamically stable channels are adjustable in nature, and "stability" does not preclude lateral migration and associated dynamics such as bank erosion and sediment deposition.

In geomorphically stable conditions, minor changes in either sediment supply or transport energy result in gradual adjustment of channel form to accommodate those changes [Lane, 1955]. Channels destabilize when changes in those factors are extreme enough to cause rapid and dramatic alterations in pattern or form. Common indicators of channel instability include active downcutting and accelerated bank erosion, major changes in channel width/depth ratios, and increased flooding from sediment deposition.

Geomorphic function is achieved when a channel is in equilibrium while undergoing processes such as lateral migration, sediment reworking, and occasional overbank flooding that create and sustain quality habitat elements, such as bars, pool/riffles, step/pools, and healthy, regenerating riparian corridors. Impairments to geomorphic function reflect a significant loss of the functional potential of the green channel segment. These impairments are typically described in general, qualitative terms, and any rehabilitation of impaired channels requires a more thorough, site-specific assessment of impacts, impairments, and feasible remedies.

3.7.2 Rosgen Classification System

The literature includes numerous systems for classifying and evaluating stream systems. Of these, perhaps the most widely used today is the Rosgen classification system [Rosgen, 1996]. This system, based upon the stream's existing channel morphology, was used in this study. Parameters such as the sinuosity, slope, width/depth ratio, and size of channel materials were evaluated and used to classify the stream into one of the various types included in the system.

The Rosgen system has four levels of classification, and each level is more detailed than the previous level. Figure 3.50 displays the hierarchy of the assessment levels and the general nature of effort associated with each. Much of the Level I geomorphic characterization is qualitative and uses aerial photography and topographic maps. Streams are divided into eight broad types on the basis of their channel and floodplain geometry. In the Rosgen classification system, stream types can be thought of in their relative location within the watershed, from their headwaters through lowlands. The major stream types reflect their location in the watershed. For example, A-type streams are located in headwaters and C and E stream types are located in meandering lowlands.

The Level II effort provides a more detailed description of the stream using measurements at selected locations. Stream types are further subdivided into 94 subtypes based upon degree of entrenchment, width-to-depth ratio, water surface slope, streambed materials, and sinuosity as shown in Figure 3.51. Consequently, the Level II characterization is more quantitative than the Level I effort. Levels III and IV require more extensive data collection and quantification of stream characteristics. The Middle North Platte Study included Level I classification of the mainstem streams and their principal tributaries.

3.7.2.1 Level I Methods

The purpose of the Level I geomorphic classification is to provide an inventory of the watershed's overall stream morphology, character, and condition. It is intended to serve as an initial assessment for use in more detailed assessments and to determine the location and approximate percentage of stream types within the study area. The results of the Level I classification can be integrated directly into the study's GIS providing a graphical "snapshot" of the basin. Based upon this initial effort, potential stream reference reaches can be identified for further study in Level II classification efforts. The end product of the Level I classification is the determination of the major stream types, A through G. Figure 3.52 shows the major stream types within the Rosgen Classification System and with their relative locations within a typical watershed. Brief descriptions of the various stream types encountered in the watershed are presented in the following paragraphs.

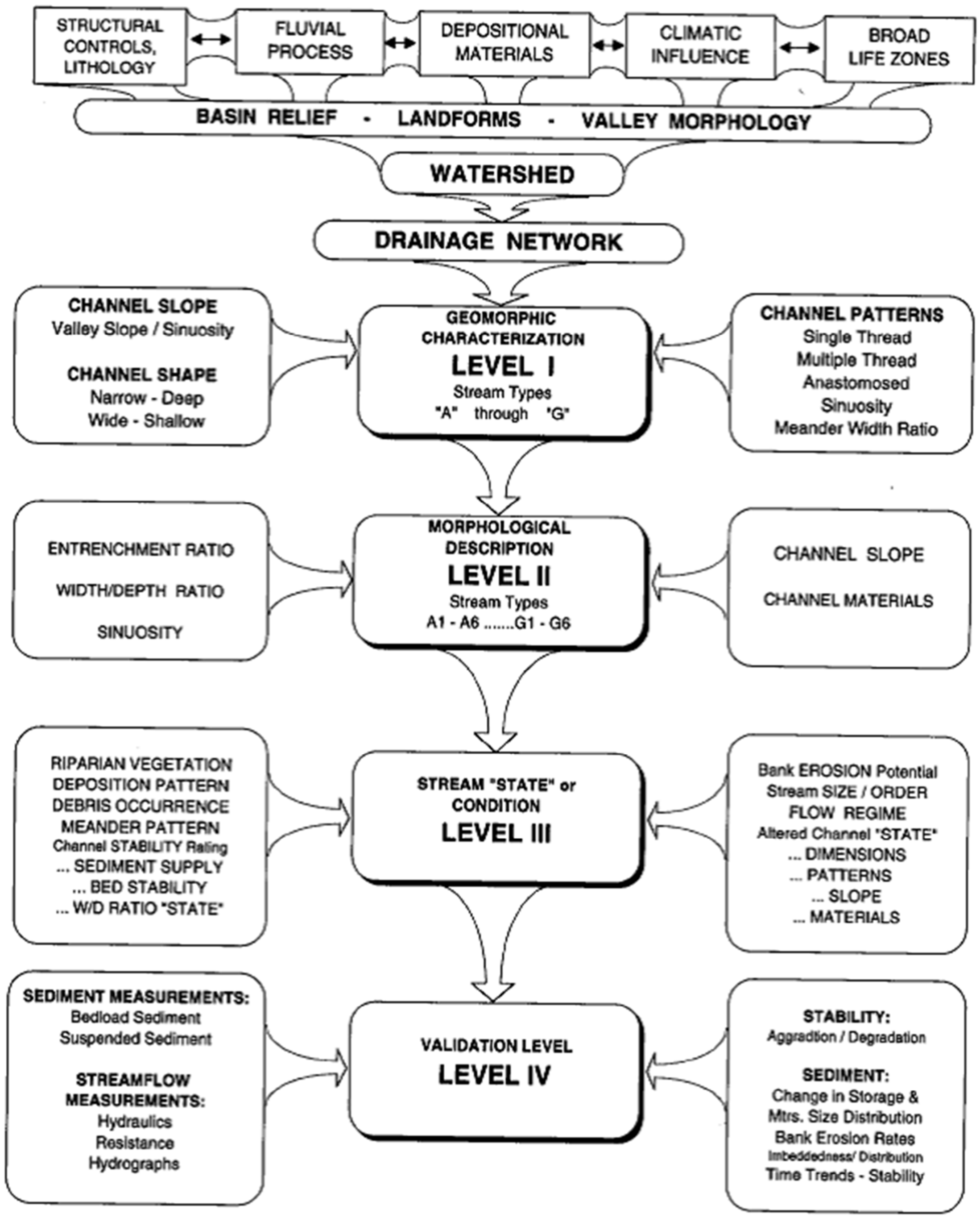

Figure 3.50. Hierarchy of the Rosgen Stream Classification System.

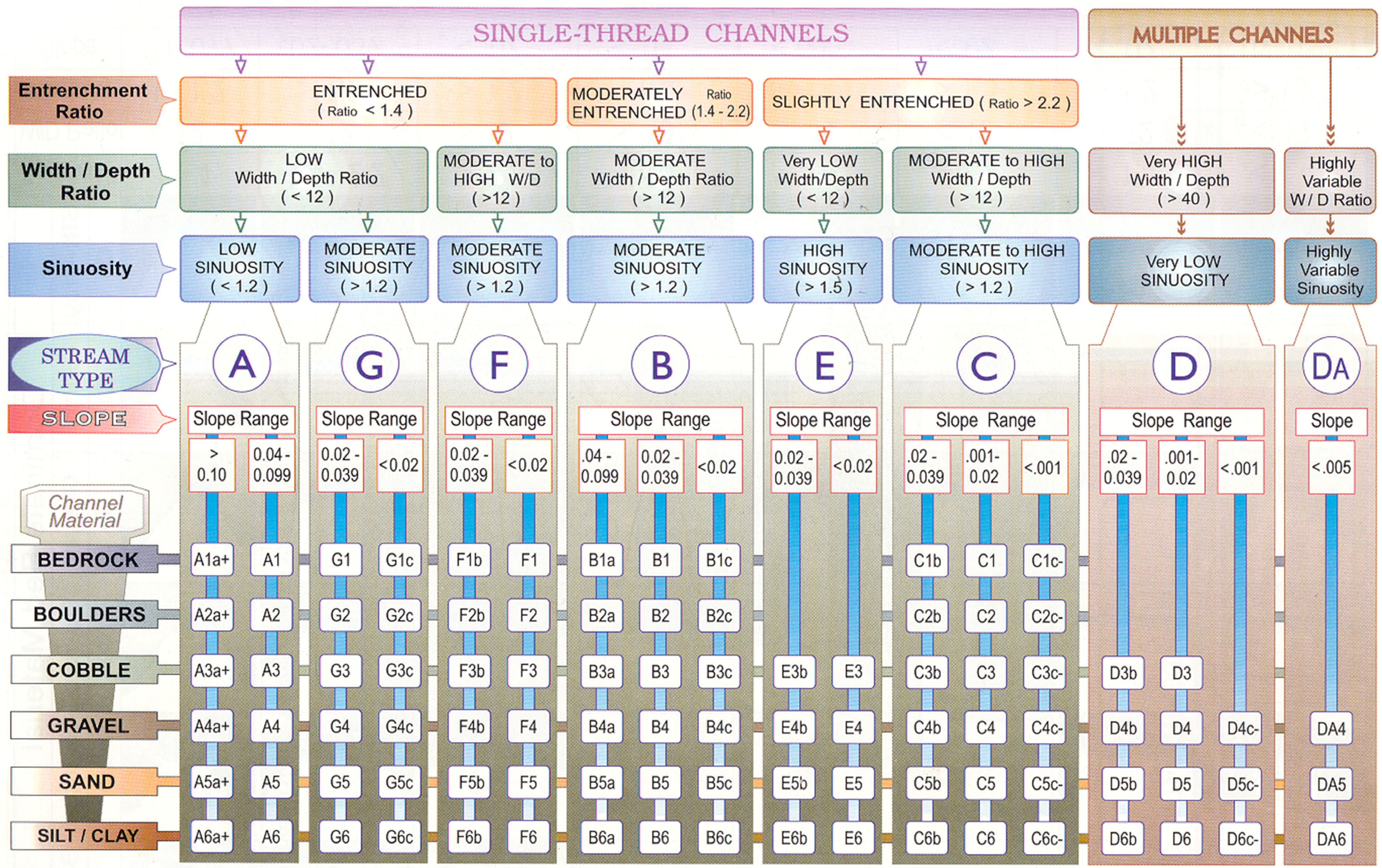

Figure 3.51. Rosgen Classification Matrix [Rosgen, 1996].

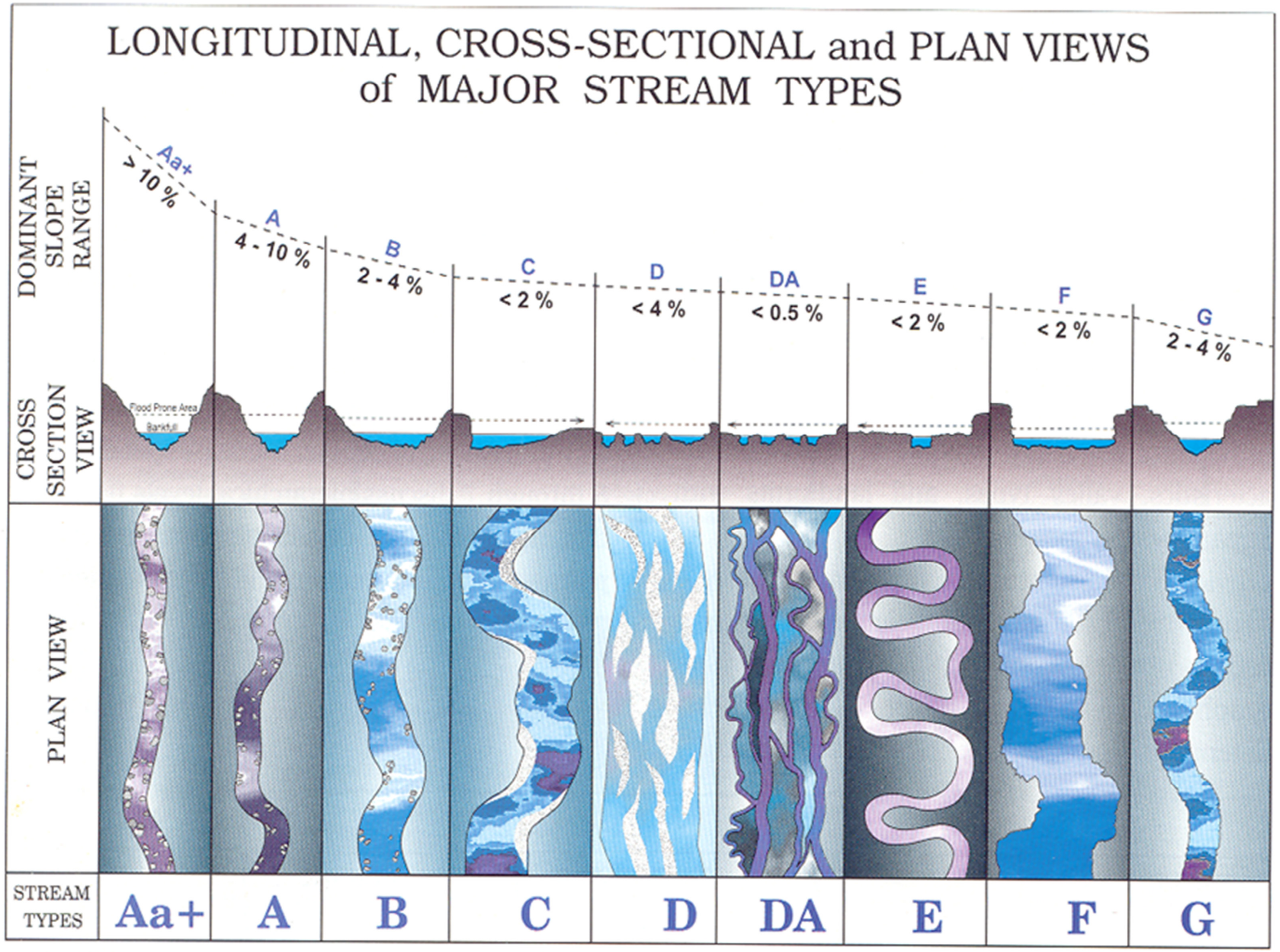

Figure 3.52. Major Stream Types Within the Rosgen Classification System.

A-Type Channels are relatively steep channels that form in headwater areas as well as within bedrock canyons. These channels are entrenched and confined by steep valley margins such that little to no floodplain area borders them. Because the boundaries of A-type channels are typically highly resistant to erosion, these stream types are generally quite resilient with respect to human impacts. The most common cause of geomorphic change within A-type channels is large-scale sediment transport events, (landslides, debris flows, debris jam failure) that may result in blockage or deflection of channel flow.

B-Type Channels tend to form downstream of headwater channels, in areas of moderate slope where the watershed transitions from headwater environments to valley bottoms shown in Figure 3.53. B-type channels are characterized by moderate slopes, moderate entrenchment, and stable channel boundaries. Because of the relatively steep channel slopes and stable channel boundaries, B-channels are moderately resistant to human impacts, although their reduced slopes relative to headwater areas can make them prone to sediment deposition and subsequent adjustment following a large sediment transport event such as an upstream landslide, debris flow, or flood.

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Figure 3.53. Example Type B Channel: Poison Creek – Reach 3.

C-Type Channels are typically characterized by relatively low slopes, meandering planforms (i.e., the shape one would see if viewing from above, as on a map or aerial photograph), and pool/riffle sequences as shown in Figure 3.54. The channels tend to occur in broad alluvial valleys, and they are typically associated with broad floodplain areas; they are not entrenched and still have 'access' to their floodplains. C-channels tend to be relatively sinuous, as they follow a meandering course within a single channel thread. In stream systems in which the boundaries of C-type channels are composed of alluvial sediments, channels tend to be dynamic in nature, and susceptible to rapid adjustment in response to disturbance.

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Figure 3.54. Example Type C Channel: North Platte River.

E-Type Channels are somewhat similar to C channels, as they form as single threads with defined, accessible floodplain areas. However, E channels are different in that they tend to have fine-grained channel margins, which provide cohesion and support dense bankline vegetation. The fine-grained, vegetation-reinforced banklines allow for the development of steep banks, very sinuous planforms, and relatively deep, U-shaped channel cross-sections. E-type channels commonly form in low gradient areas with fine-grained source areas, mountain meadows, and in beaver-dominated environments. E-channels tend to have very stable planforms, and efficient sediment transport capacities from low width/depth ratios.

F-Type Channels typically have relatively low slopes (<2%), similar to C and E channel types. The primary difference between C/E channels and F channels is with respect to entrenchment. F-type channels are entrenched, which means that the floodplain is quite narrow relative to the channel width. The entrenchment of alluvial F-type channels typically is an indicator of an historic downcutting event. F-type channels may form in resistant boundary materials (e.g., U-shaped bedrock canyons), and relatively erodible alluvial materials (e.g., arroyos). When the boundary materials are erodible, as shown in Figure 3.55, the steep valley walls are prone to instability, and channel widening commonly occurs within the entrenched channel cross-section.

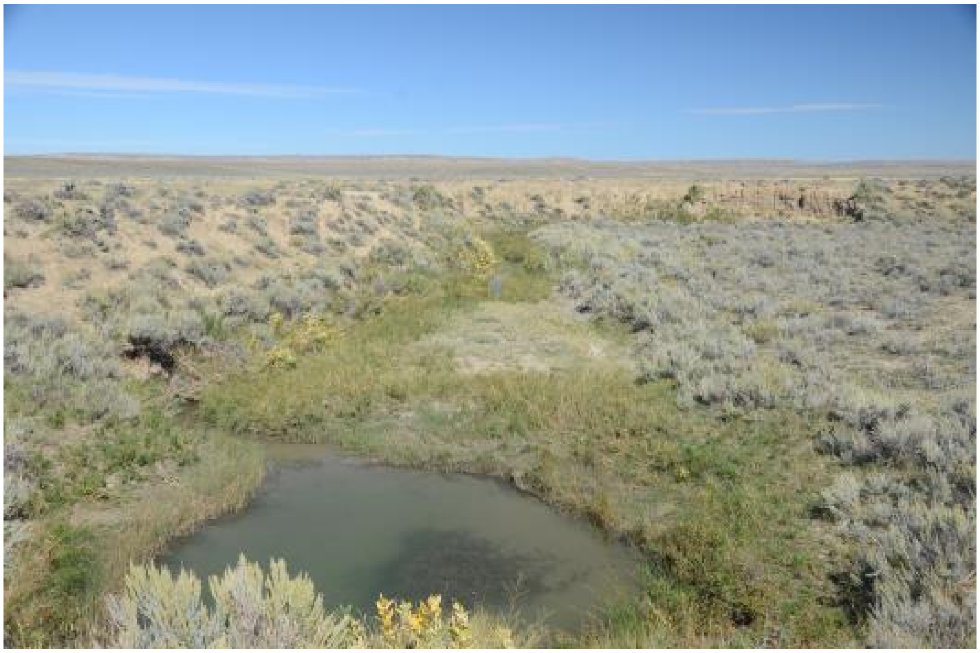

Figure 3.55. Example Type F Channel: Poison Spider Creek – Reach 2.

G-Type Channels are narrow, steep entrenched gullies. G-type channels typically have high bank erosion rates and a high sediment supply. Channel degradation and sideslope rejuvenation processes are typical (Figure 3.56).

The Level I classification effort was conducted primarily using existing information incorporated into the project GIS. Several analytical tools were developed and integrated into the GIS which allowed the evaluation of various geomorphic parameters (sinuosity, slope, stream station determination). The data collated and incorporated in the project GIS include digital aerial photography, USGS topographic maps, Landsat color infrared imagery, a digital elevation model (DEM), and digitized hydrography information. The most current data available were used in the geomorphic evaluation. Because the DEM was limited to a 10-meter grid, elevations and subsequent slope calculations are approximate. Stream alignments were digitized using 2012 aerial photography and represent the best available estimate of current channel alignment.

The streams evaluated were divided into reaches based upon definable geographic factors (e.g., confluences with tributaries and major road crossings) or where their geomorphic character displayed changes. Each reach was evaluated in light of the characteristics required at the Level I classification. These parameters were channel slope, channel shape, channel patterns, and valley morphology. Note that in the Level I classification, these parameters are not typically quantified and the relative magnitude (i.e., "moderate" or "slightly") is used to classify the stream.

Figure 3.56. Example Type G Channel: McClanahan Draw (Tributary to Middle Fork Casper Creek).

3.7.2.2 Level I Classification Results

Results of the Level I classification effort are presented in Table 3.32 and graphically in Figure 3.57. This figure displays a map of the study area depicting the various stream types as well as the reach designations used in the classification. In the mountainous areas (i.e., Casper Mountain), the channels are steeper and typically bounded by very coarse, resistant materials that include hillslope colluvium and bedrock.

As a result, the channels are laterally stable, and geomorphically resilient with respect to human impacts. Channel change in these upper subreaches typically result from punctuated hillslope processes rather than gradual channel migration. The channels are A-type or B-type, which reflects their steep slope and stable boundaries. As the stream channels descend into the lower watershed, the lateral confinement is reduced, the slope lessens, and the boundary materials become less coarse. As a result of these downstream changes in boundary conditions, the lower subreaches display meandering channel dynamics; that is, pool/riffle development and increased lateral channel migration. The channels transition from B-type channels, which are located in transition zones at the foot of the mountains, to C-type channels, which are gravel bed meandering streams that dominate the lower basin.

Table 3.32. Summary of Rosgen Level I Classification Results in the Study Area

Name	Reach Number	Length (miles)	Slope (feet/foot)	Sinuosity	Rosgen Type
Bates Creek	1	18.4	0.00367	1.8251	F
	2	16.5	0.00775	1.8007	E
	3	15.5	0.01308	1.3645	B
Casper Creek	1	16.6	0.00163	1.5062	C
	2	24.0	0.00126	1.9439	E
Corral Creek	1	7.1	0.00739	1.9173	E/F
	2	4.4	0.01401	1.4557	B
Middle Fork Casper Creek	1	16.2	0.00145	1.7510	F
	2	19.8	0.00168	2.0096	E/F
	3	19.1	0.00178	1.9800	C/F
Muddy Creek	1	15.3	0.00183	2.6718	E/F
	2	18.5	0.00282	2.9178	E/F
North Platte River	1	21.0	0.00094	1.1705	C
	2	28.5	0.00072	1.5933	C
	3	20.2	0.00106	1.6143	C
Poison Spider Creek	1	15.1	0.00344	1.6227	F
	2	18.8	0.00265	2.1058	F
	3	13.9	0.00233	2.0787	B
Sand Spring Creek	1	32.3	0.00340	1.3829	B
South Fork Casper Creek	1	12.0	0.00176	1.9096	E/F
	2	22.9	0.00212	1.7584	F
	3	16.0	0.00299	1.6556	B
Stinking Creek	1	18.1	0.00534	1.5556	C
	2	16.4	0.00492	1.7648	C

As shown in Table 3.32, many of the channels were classified as either type F or G stream channels in at least portions of their extent. Type F and G stream classifications both denote channels which have “disconnected” from their floodplains. These channels are typically erosive, actively downcutting, or widening. Based upon the GIS classification effort followed by field verification, it was concluded that the majority of the tributaries to the North Platte within the study area are entrenched to some degree. Entrenchment occurs for a variety of reasons, including presence of erosive soils coupled with land use practices such as road construction, energy development, and grazing. Observations of channel conditions within the study area revealed entrenchment ranging from slight to severe. Figure 3.58 displays an entrenched reach of Poison Spider Creek.

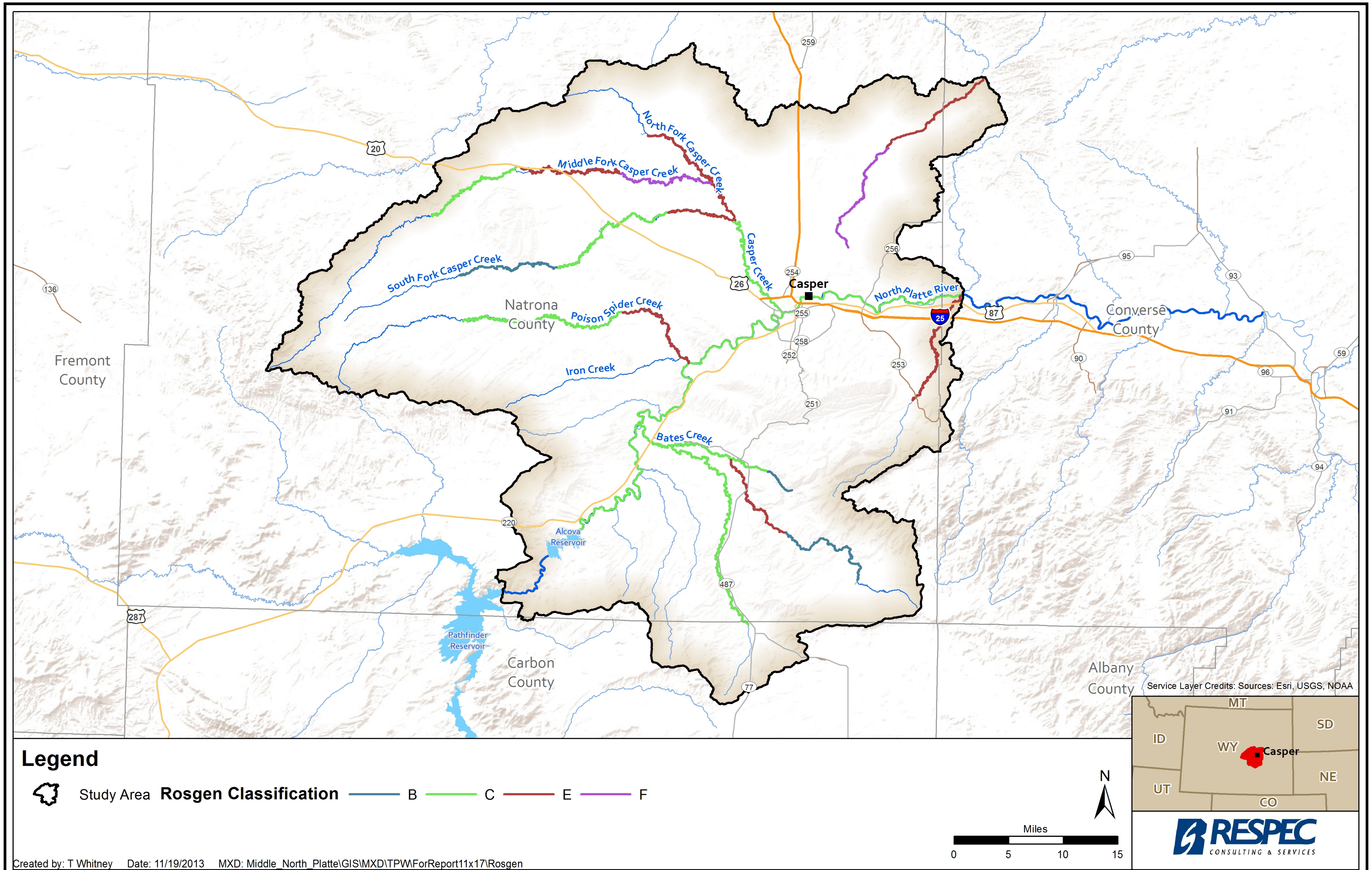

Figure 3.57. Major Stream Types Within the Rosgen Classification System [Rosgen, 1996].

Figure 3.58. Moderately Entrenched Reach of Poison Spider Creek.

Many of the first-order tributaries in the lower portions of the study area can be classified as G-type channels, or gullies. These channels are highly erosive, generate high sediment, and can result in the loss of productive lands and destabilize upland conditions. Observation of many of these channels indicates that while the major stream channels appear to have achieved a level of stability, the upper reaches of the watershed are still suffering a level of destabilization. These channels could be forming in response to one or more of numerous stimuli including, but not necessarily limited to, channel realignment (straightening), road and culvert construction, range management practices, or base-level lowering associated with main channel incision.

The North Platte River within the boundaries of the study area was classified as a Level I C-type channel. Throughout most of its extent, the river appears to have access to its floodplain on at least one of its banks. As part of the field work conducted for the city of Casper's North Platte River Master Plan, the entire 13.5-mile reach of the North Platte River was evaluated for bank conditions, fish habitat, channel pattern, manmade structures, sediment conveyance, stream cross-sections, and potential restoration opportunities [Stantec, 2012]. Additionally, field work for the master plan included a geomorphic field survey that collected cross-sectional and longitudinal profile data on two reaches of the North Platte River in the planning area. The first river reach was near Morad Park and had an average slope of 0.08 percent and a type F3 Level II Rosgen channel classification. The second reach was downstream of near Crossroad

Park and had an average slope of 0.1 percent and a type F3 Level II Rosgen channel classification.

3.7.3 Proper Functioning Condition Assessment

Proper Functioning Condition (PFC) assessment data within the study area was obtained from the BLM Casper Field Office. There were over 60 miles of assessment completed on federal lands from 1989 through 2011 as shown in Figure 3.59. PFC is the assessment tool that the BLM uses to assess the function of riparian-wetland areas and to evaluate Standard No. 2, Wetland/Riparian Health, of the Rangeland Standards Assessment Process [Bureau of Land Management, 2007]. The PFC assessment is explained in *Riparian Area Management: A User Guide to Assessing Proper Functioning Condition and the Supporting Science for Lotic Areas* [Pritchard, 1998]. The user guide defines PFC as follows:

> *A qualitative method for assessing the condition of riparian-wetland areas. The term PFC is used to describe both the assessment process, and a defined, on the-ground condition of a riparian-wetland area. The PFC assessment refers to a consistent approach for considering hydrology, vegetation, and erosion/deposition (soils) attributes and processes to assess the condition of riparian-wetland areas. A checklist is used for the PFC assessment, which synthesizes information that is foundational to determining the overall health of a riparian-wetland system (BLM, 1998).*

The PFC assessment's checklist is used to determine one of three function categories for a given riparian-wetland area as described below.

> ***Proper Functioning Condition***
> *A riparian-wetland area is considered to be in proper functioning condition when adequate vegetation, landform, or large woody debris is present to:*
>
> - *dissipate energies associated with wind action, wave action, and overland flow from adjacent sites, thereby reducing erosion and improving water quality;*
> - *filter sediment and aid floodplain development;*
> - *improve flood water retention and groundwater recharge;*
> - *develop root masses that stabilize islands and shoreline features against cutting action;*
> - *restrict water percolation;*
> - *develop diverse ponding characteristics to provide the habitat and water depth, duration, and temperature necessary for fish production, water bird breeding, and other uses; and*
> - *support greater biodiversity.*

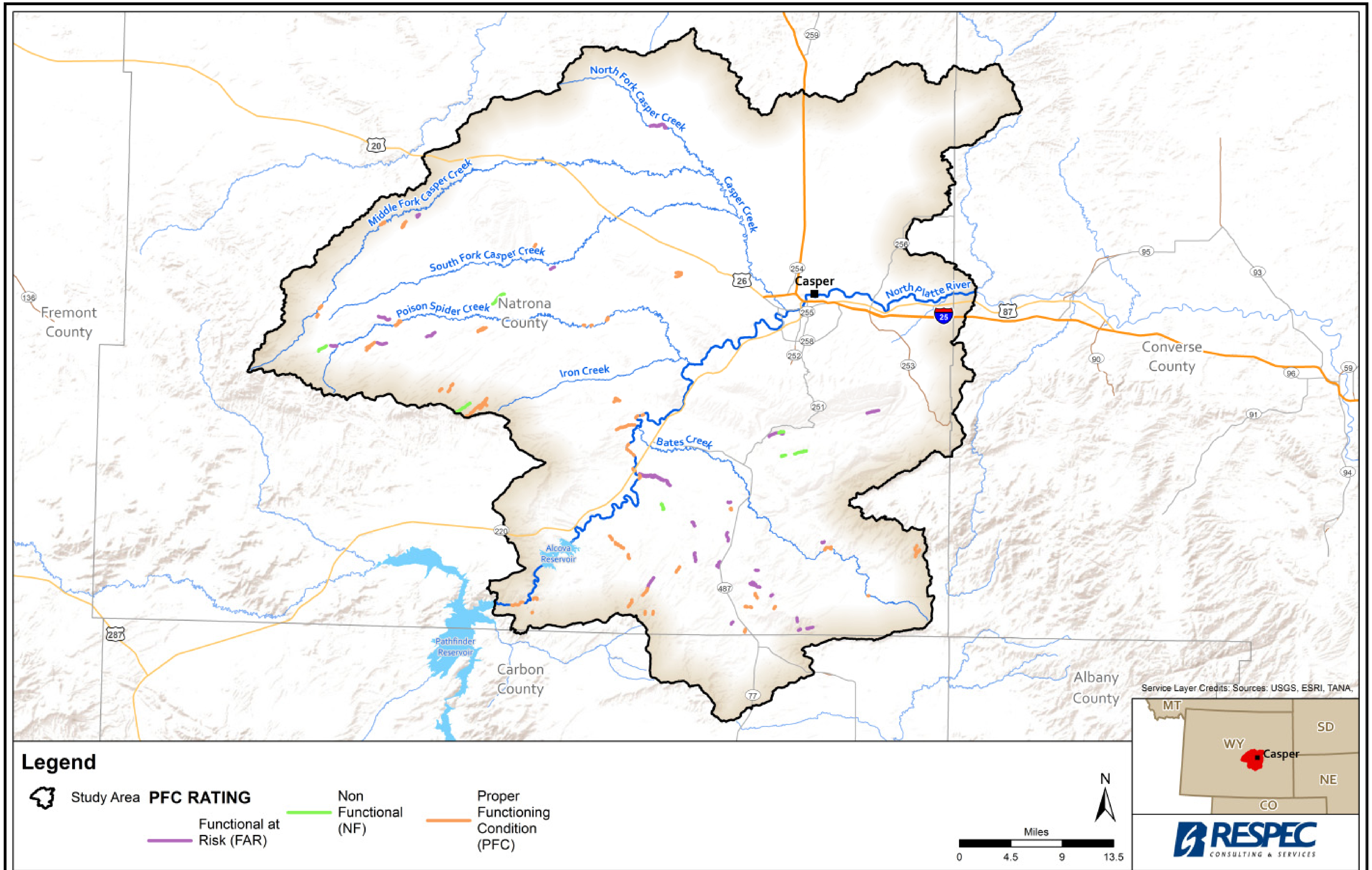

Figure 3.59. Proper Functioning Condition Assessment Data Within the Study Area.

Functional At Risk
Riparian/wetland areas are classified as functioning-at-risk when they are in functioning condition but an existing soil, water, or vegetation attribute makes them susceptible to degradation. These areas are further distinguished based on whether or not they demonstrate an upward, not apparent, or downward trend.

Nonfunctioning
Riparian/wetland areas are classified as nonfunctioning when they clearly are not providing adequate riparian vegetation, physical structure, or large woody debris to dissipate stream energy associated with high flows.

3.7.4 North Platte River Master Plan

As part of the watershed study effort, information was obtained from the City of Casper's draft report titled, *North Platte River Environmental Restoration Master Plan – Phase 1*, which was prepared by Stantec Consulting Services Inc. and SWCA Environmental Consultants [Stantec, 2012]. This draft master plan presented an assessment of existing conditions and proposed restoration strategies for the 13.5-mile stretch of the North Platte River that flows through the city of Casper in Natrona County, Wyoming, as shown in Figure 3.60.

The master plan effort analyzed the health and status of the vegetation, scenic view corridors, fish habitat, stream stabilization, and cultural resources within the planning area. Field work conducted for the master plan included surveys and evaluations of bank conditions, fish habitat, channel pattern, manmade structures, sediment conveyance, stream cross-sections, and potential restoration opportunities on the 13.5-mile reach of the North Platte River. Field crews found well-established Russian olive stands, which averaged approximately 20 percent of the riparian vegetation. Fish habitat was analyzed by floating the river. The analysis found long sections of the river lacked riffle-pool complexes, which reduces the amount of effective fish habitat. The river was surveyed and reaches were classified using Rosgen Classification, Channel Evolution Model, and a geomorphic field survey that collected channel cross-sectional and longitudinal data on two reaches of the North Platte River. Three channel evolution scenarios were found to be applicable to the river within the master plan project area and are shown in Figure 3.61.

In general, the river is over-widened and even divided or completely braided in areas [Stantec, 2012]. Widening of a stream lowers velocities, which increases sediment deposition. Stream bank stability and erosion estimation was based on a stream bank survey conducted along the entire project reach. It was estimated that 5,900 tons of sediment is lost each year from the stream banks within the project area. Potential management and rehabilitation alternatives from the master plan are summarized in Chapter 4.0.

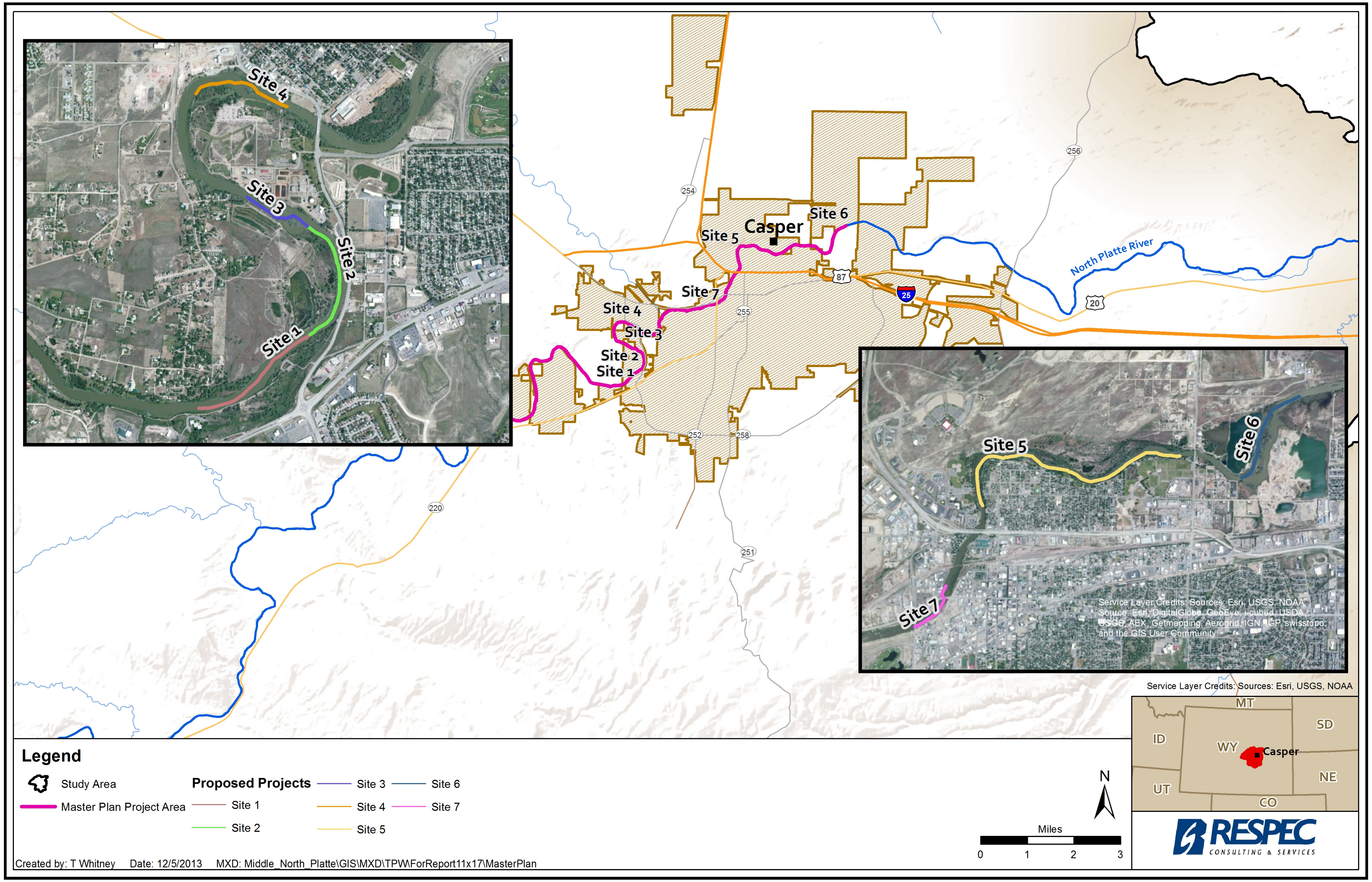

Figure 3.60. Project Area Map for North Platte River Master Plan.

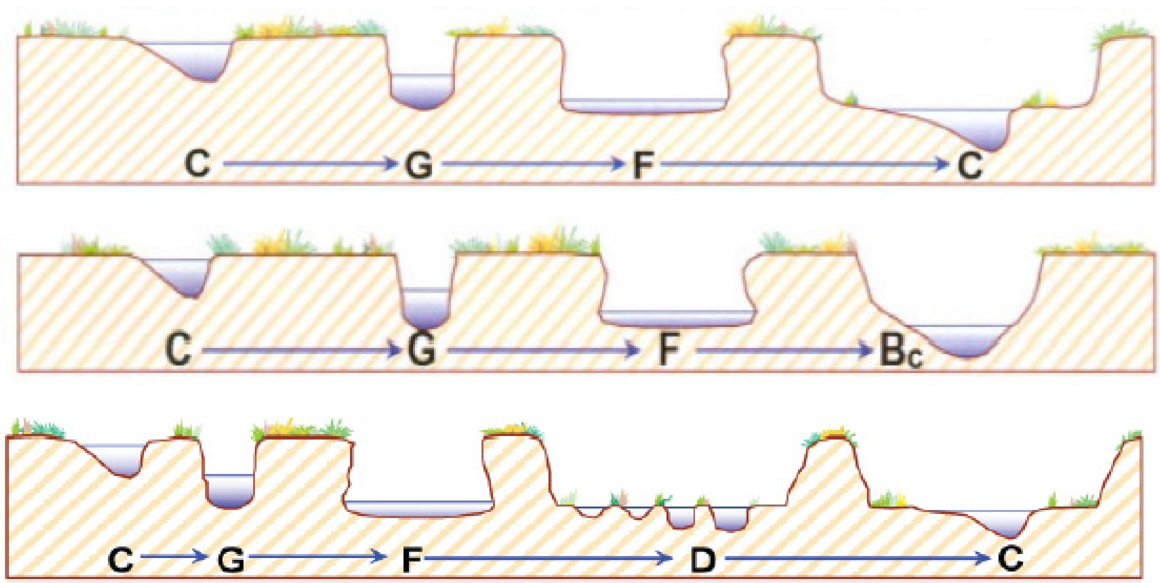

Figure 3.61. Three Channel Evolution Scenarios for the North Platte River Near Casper, Wyoming [Rosgen, 2006; Stantec, 2012].

3.7.5 Stream Channel Impairments

Reaches of perennial tributaries to the North Platte River within the study area commonly displayed indications of riparian degradation as evidenced by bank erosion, loss of riparian habitat, channel widening, and stream degradation. Impairments to stream channels within the study area appear to fall into three broad and interrelated categories:

- Channel Degradation: Active headcutting and channel incision
- Riparian Degradation: Generally bank erosion and physical disturbance of stream banks
- Riparian Vegetation Degradation: Impaired riparian condition and habitat

Channels classified as F-type channels are common in the lower portions of the study area, as evident on Muddy Creek and shown in Figure 3.62.

Reaches on the streams are entrenched and consequently have lost connection with their floodplains. Some streams are heavily incised and restoration could be problematic. This is evident on Oregon Trail Drain and shown in Figure 3.63.

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Figure 3.62. Incised Channel on Muddy Creek.

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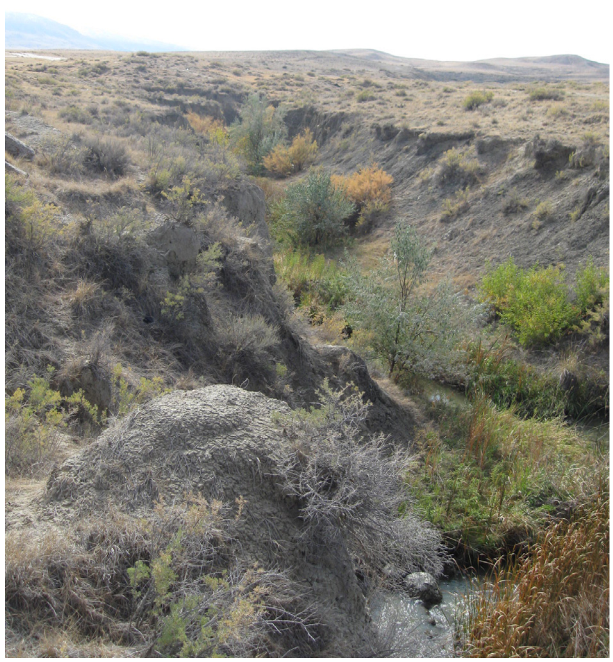

Figure 3.63. Incised channel on Oregon Trail Drain.

Multiple approaches to restoration can be applied to incised river channels [Rotar and Boyd, 1999]. Common objectives in such restoration efforts are to promote channel stability and to connect the channel to its historic floodplain. The reconnection of the channel to its historic floodplain requires raising the channel bed, which can be achieved through grade controls and channel infilling, or even reconstruction of a new channel. These approaches can have difficult and costly challenges, such as tying in the project end points to the incised channel grade, or preventing post-project channel relocation or avulsion.

Another approach to incised channel stabilization is to completely armor the channel banks and add grade control structures. This process reduces sediment inputs, but does not provide a dynamic, functional channel. Perhaps the most geomorphically beneficial approach to incised channel restoration is to promote the natural process of channel widening and incised floodplain development. This can be achieved by encouraging the development of a new floodplain adjacent to the channel to provide an area for flood energy dissipation and new riparian area establishment. Any work in incised channel restoration requires an assessment of the status of the current channel stability, so that the potential for further downcutting is known and accommodated for in the restoration design.

3.8 WATER QUALITY

3.8.1 Stream Classifications

The Water Quality Division of the WDEQ has classified waterbodies in the state into two parts, primary (Table A) and secondary (Table B). Table A classifications are those either named on the USGS 1:500,000 scale hydrologic map or those specifically classified by the WDEQ. Table B classifications are taken from the WGFD's "Streams and Lakes Inventory" and are based on the presence or absence of fish species. Where there are differences in classification, then Table A takes precedence. Table 3.33 shows the use designation associated with each classification.

Table 3.34 shows the surface water classifications within the study area. The North Platte River from Natrona County Road 309 Bridge, or "Goose Egg Bridge," upstream to Alcova Dam is designated as the only Class 1, Outstanding Water in the watershed as defined in the WDEQ's Water Quality Rules and Regulations, Chapter 1 [Wyoming Department of Environmental Quality, 2013].

3.8.2 Wyoming Pollutant Discharge Elimination System Permitted Discharges

There are 25 Wyoming Pollution Discharge Elimination System (WYPDES) point source discharge permits in the watershed, shown in Figure 3.64. A list of WYPDES permits is in Table 3.35. Also, three permitted Municipal Separate Storm Sewer Systems (MS4s) are in the study area; including the city of Casper (WYR040005), Wyoming Department of Transportation's Casper Urbanized Area (WYR040006), and Casper College (WYR040007).

Table 3.33. Surface Water Classification and Use Designations

Designated Use	Surface Water Classification										
	1	2AB	2A	2B	2C	3A	3B	3C	4A	4B	4C
Drinking Water	X	X	X								
Game Fish	X	X		X							
Nongame Fish	X	X		X	X						
Fish Consumption	X	X		X	X						
Other Aquatic Life	X	X	X	X	X	X	X	X			
Recreation	X	X	X	X	X	X	X	X	X	X	X
Wildlife	X	X	X	X	X	X	X	X	X	X	X
Agriculture	X	X	X	X	X	X	X	X	X	X	X
Industry	X	X	X	X	X	X	X	X	X	X	X
Scenic Value	X	X	X	X	X	X	X	X	X	X	X

3.8.3 Waters Requiring Total Maximum Daily Loads

The Middle North Platte Watershed has several waterbodies listed as impaired for selenium in the state of Wyoming 2012 Integrated Report [Wyoming Department of Environmental Quality, 2012]. Selenium loadings have resulted in exceedances of the chronic aquatic life other than fish criterion in several waters, including the North Platte River, Casper Creek, and lower Poison Spider Creek and impairments to wildlife uses in some waters near Kendrick. Oregon Trail Drain, Poison Spring Creek, Goose Lake, Rasmus Lee Lake, Thirty Three Mile Reservoir, and Illco Pond were added to the 303(d) list since 2000 [Wyoming Department of Environmental Quality, 2012] as shown in Figure 3.65.

Because of concerns for potential effects on fish, wildlife, and human health related to selenium, water-quality assessments were conducted by several different agencies, including the USGS, USFWS, USBR, University of Wyoming (UW), and WDEQ. The source of selenium in the watershed is the Cretaceous Tertiary shale formations. These studies indicated that irrigation return flows from the Kendrick Project contained high levels of selenium, which resulted in selenium loading to the North Platte River and several streams, wetlands, and reservoirs. These studies also indicated that naturally occurring selenium dissolves from the soil during irrigation and is returned to the streams through excessive drainage water. However, the North Platte River and its tributaries also receive surface runoff water moving through Cretaceous Tertiary shale-derived soils with naturally high concentrations of selenium.

Table 3.34. State of Wyoming Surface Water Classifications Within the Study Area

Waterbody	Class	Waterbody	Class
Alcova Reservoir	2AB	Morton Creek	3B
Austin Creek	3B	Muddy Creek	2AB
Bates Creek	2AB	North Fork Casper Creek	3B
Bates Creek Reservoir	2AB	North Platte River (Natrona County Road 309 Bridge (Goose Egg Bridge) upstream to Alcova Dam)	1
Bear Creek	2C		
Bear Spring Creek	3B		
Beaver Creek	3B	North Platte River (remainder)	2AB
Bolton Creek	3B	Negro Creek	2AB
Casper Canal	4A	Nine Mile Lake	3B
Casper Creek	2AB	Oregon Trail Drain	3B
Clarks Gulch	3B	Peak Gulch	3B
Claude Creek	3B	Poison Spider Creek (from Class 2AB Section upstream for 5 miles)	2C
Clear Fork Muddy Creek	3B		
Corral Creek	2AB	Poison Spider Creek (Remainder)	3B
Coyote Creek	3B	Poison Spider Creek(Lower Most Mile)	2AB
Drainy Muddy Creek	2C	Poison Spring Creek	3B
East Fork Bear Creek	3B	Red Creek	3B
Eagle Creek	3B	Rhobaugh Drain	3B
Eight Mile Lake	3B	South Fork Bear Creek	3B
Elkhorn Creek	2AB	South Fork Casper Creek	3B
Elkhorn Creek	2AB	Sand Spring Creek	3B
Garden Creek	2AB	Sandy Drain	3B
Goose Creek	3B	Six Mile Drain	3B
Gray Reef Reservoir	2AB	Sixmile Drain	3B
Hemingway Drain	3B	Soap Creek	3B
Iron Creek	3B	Spruce Creek	2AB
Jack Allen Drain	3B	Squaw Creek	2C
Johnson Reservoir #2	3B	Stinking Creek	2C
Ledge Creek	3B	Suicide Soda Lake	3B
M Fork Casper Creek	3B	West Fork Bear Creek	3B
Matheson Creek	3B	West Fork Garden Creek	2AB
McKenzie Drain	3B	Webb Drain	3B
McNales Creek	3B	Willow Creek	3B
Meadow Creek	3B	Wolf Creek	2AB

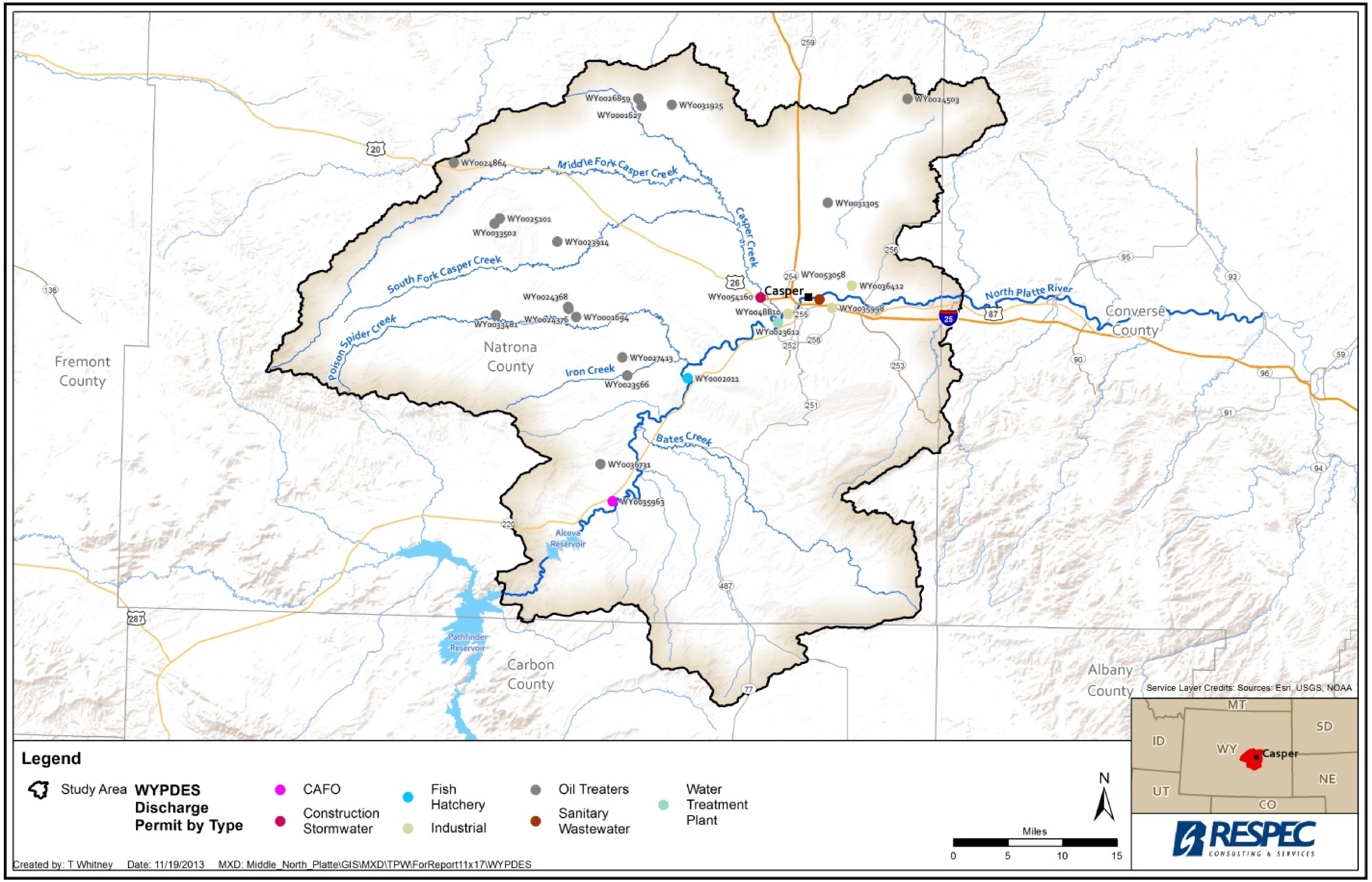

Figure 3.64. Wyoming Pollutant Discharge Elimination System Permitted Locations Within the Middle North Platte Watershed.

Table 3.35. Wyoming Pollution Discharge Elimination System Permitted Discharges Within the Watershed

WYPDES Permit No.	Permittee	Facility Name	Permit Type	Receiving Water
WY0001627	Corkill Drilling Corporation	North Casper Oil Field	Oil Treaters	N Fork Casper Creek
WY0001694	Rock Well Petroleum (U.S.) Inc.	Poison Spider Field	Oil Treaters	Poison Spider Creek
WY0002011	Wyoming Game and Fish Department	Speas Rearing Station	Fish Hatchery	North Platte River
WY0021920	Casper, City of	Casper WWTF	Sanitary Wastewater	North Platte River
WY0023566	Iron Creek Properties, Inc.	Iron Creek Oil Field	Oil Treaters	Iron Creek
WY0023612	Central Wyoming Regional Water System	Casper Water Treatment Plant	Water Treatment Plant	North Platte River
WY0023914	Citation Oil and Gas Corp.	South Casper Creek Field	Oil Treaters	Poison Spider Creek
WY0024368	Arnell Oil Company	Poison Spider Fld#1 Battery	Oil Treaters	Poison Spider Creek
WY0024376	Arnell Oil Company	Poison Spider Fld#2 Battery	Oil Treaters	Poison Spider Creek
WY0024503	Black Bear Oil Corporation	Sage Spring Creek Unit A Battery	Oil Treaters	Sage Creek
WY0024864	Black Bear Oil Corporation	Clark Ranch Field	Oil Treaters	
WY0025101	Scarlett Energy Enterprises	Pine Mountain Tank Battery #1	Oil Treaters	Jack Allen Draw
WY0026859	Corkill Drilling Corporation	North Casper Creek Field Gowin #1 Battery	Oil Treaters	North Fork Casper Creek
WY0027413	Summit Resources	Speas Lease #1-A	Oil Treaters	Poison Spider Creek
WY0031305	Black Bear Oil Corporation	Lease C-048864-A	Oil Treaters	Nine Mile Lake
WY0031925	Capitan Operating, LLC	Horse Ranch Federal Tank Battery #1	Oil Treaters	North Fork Casper Creek
WY0033481	Quicksilver Resources, Inc.	West Poison Spider Unit	Oil Treaters	Poison Spider Creek
WY0033502	Scarlett Energy Enterprises, LLC	Lease W-41244, Weaver Oil Inc-Gov't 35-1, South Pi	Oil Treaters	South Fork Casper Creek
WY0035963	Grey Reef Ranch, LLC	Miles Land and Livestock Cattle Feedlot	CAFO	North Platte River
WY0035998	Flying J Oil and Gas, Inc.	Flying J Travel Plaza, Casper	Industrial	North Platte River
WY0036412	Chevron Environmental Services	Texaco Casper Plant	Industrial	
WY0036731	Resolute Wyoming, Inc.	Gov't Trigg #1, Gov't Bridge Field	Oil Treaters	Lone Tree Gulch
WY0048810	BP Products North America	BP Former Refinery	Industrial	Soda Lake
WY0053058	BP Products North America	Soda Lake Inlet Basin	Terminate	Soda Lake
WY0054160	McMurry Ready Mix Company	Wash Plant Discharge	Construction Stormwater	Casper Creek

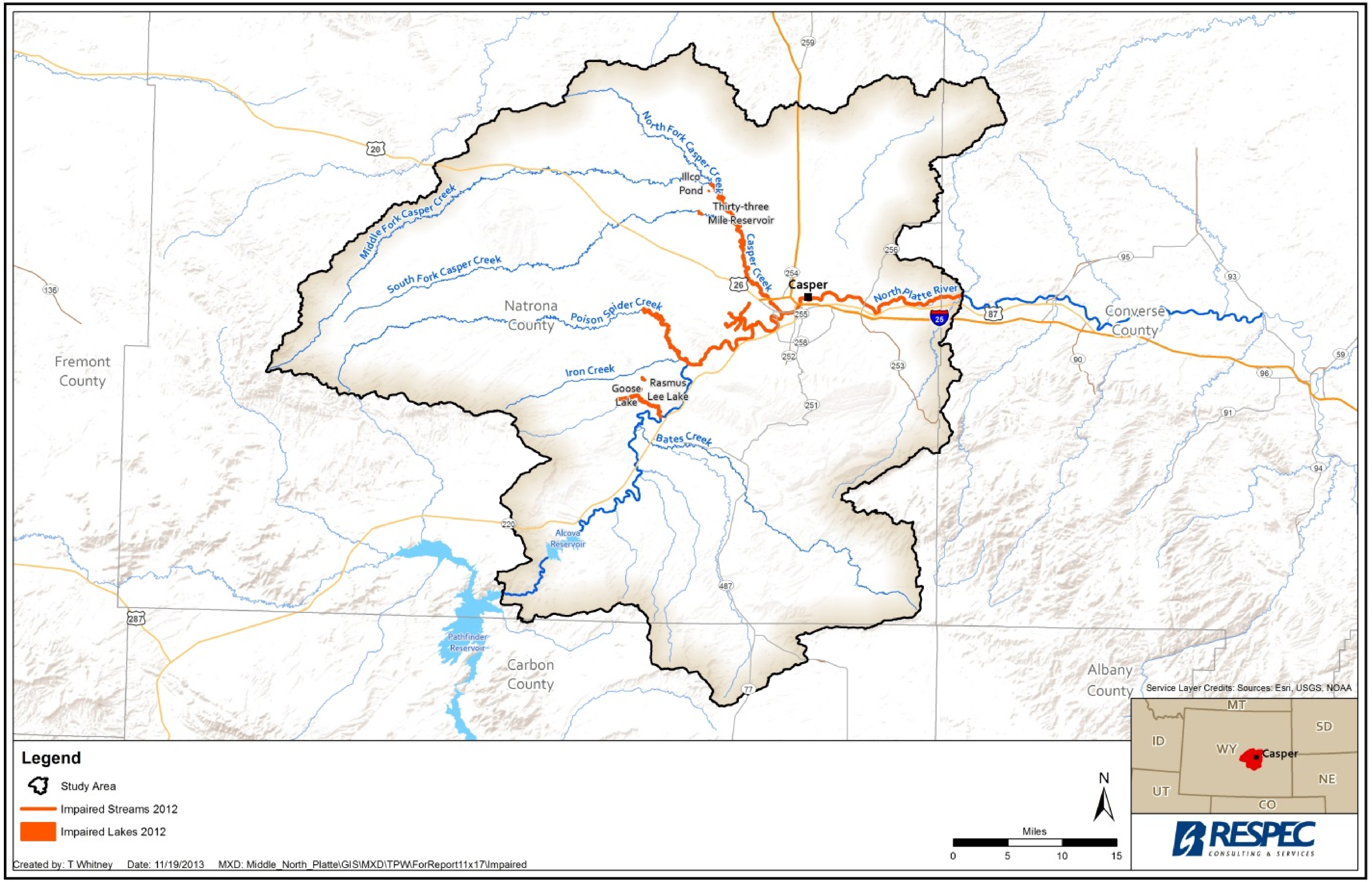

Figure 3.65. Impaired Streams Within the Middle North Platte Watershed.

The North Platte River selenium TMDL was the most recent of these assessments. In 2009, the WDEQ initiated a TMDL assessment for selenium on the North Platte River and four of its major tributaries. Selenium sources, load allocations, and estimated reductions necessary for the river to meet water-quality criteria and attain designated uses were included in the TMDL. Many of the past assessments focused mainly on the Kendrick Project; however, the TMDL assessment examined more of the contributing watersheds above the impaired segments of the North Platte River and its tributaries. Irrigated and nonirrigated areas underlain by the Cody and other Cretaceous formations are the sources of selenium being delivered downstream to the North Platte River and its tributaries during the irrigation season and precipitation runoff events. This makes the identification of selenium loading from natural background, point, and nonpoint sources difficult and complicated the TMDL development.

In 2012, the NCCD) obtained a grant through the WDEQ Nonpoint Source Program and a grant from the Wyoming Department of Agriculture (WDA) Wyoming State Water Quality Funding to initiate the North Platte River Watershed TMDL Implementation Project – Segment I. The NCCD's 3-year project is the first of three planned segments that address 11 TMDLs, and focuses technical and financial resources on critical selenium areas within the Kendrick Project. The Segment I project includes promoting, implementing, and monitoring recommended BMPs and their effects in critical selenium areas on irrigated and nonirrigated lands.

3.9 WATER STORAGE

The investigation of water storage focused on existing stock ponds and potential upland water storage facilities less than 20 ac-ft. Large storage reservoirs within the watershed were not identified as a priority for this Level I study. The reasoning for this statement reflects the yield associated with the surface water sources within the North Platte River Basin, which are fully appropriated, meaning there is typically not sufficient water on an average year to support the adjudicated water rights. Furthermore, institutional constraints related to the North Platte Decree or the Platte River Recovery and Implementation Program limit the opportunity to create new reservoir projects or increase existing storage reservoirs through enlargement. Nevertheless, a cursory evaluation of the existing reservoirs was conducted and resulted in the major reservoirs within the watershed that are listed in Table 3.36.

Although it is understood that additional large water storage reservoirs or enlargements to the existing storage reservoirs may be limited by the institutional constraints identified above, improvements to fully realize and sustain the capacity of the existing reservoirs are not limited by these constraints. During the completion of this study, the water users identified problems with Bates Creek Reservoir that severely limited the potential to store water in this facility. Consequently, an investigation of Bates Creek Reservoir was conducted and is summarized in the Chapter 4.0.

Table 3.36. Major Reservoirs Within the Study Area

Reservoir Name	Permit Number	Capacity (ac-ft)	Total Capacity (ac-ft)
Johnson No. 1 Reservoir	P1708R	11,865.0	11,865.0
Soda Lake Reservoir	P6279R	8,815.0	8,815.0
Bates Creek Reservoir	P549R	3,112.0	3,112.0
Bates Creek Reservoir, Enlargement	P5144R	1,605.0	4,717.0
J. and J. Reservoir	P5199R	1423.1	1423.1
Reynolds No. 2 Reservoir	P1067R	1008.0	1008.0

3.9.1 Urban Drainage Basins

Casper is the second largest city in Wyoming and the largest city within the study area. According to the 2010 U.S. Census, Casper has more than 55,000 residents within the 27 square miles of city limits. Casper is a regulated Phase II MS4 that requires the implementation of a stormwater management program (SWMP). Until recently, the city of Casper has relied upon the original Stormwater Management Master Plan (SWMMP) written in 1983. In March 2013, a new and updated SWMMP was prepared by WLC Engineering and URS Corporation on behalf of the city of Casper's Department of Public Services [WLC Engineering, Surveying, and Planning, 2013]. The following quote is directly from the city of Casper's SWMMP [WLC Engineering, Surveying, and Planning, 2013]:

> *The overall goal for this Stormwater Management Master Plan for Casper is to minimize potential for flood damages, provide facilities that make periodic maintenance more efficient, and create opportunities for public amenities, open space, and enhancement of wildlife corridors and wetlands.*

The SWMMP included 13 major drainages, ranging in size from 0.5 to 20.6 square miles, shown in Figure 3.66. The EPA's **Storm Water Management Model** (**SWMM**) was used to evaluate existing conditions within the major drainages including the effectiveness of existing ponds and conveyance systems. **HEC-RAS** was also used in conjunction with **SWMM** to evaluate complex geometric conditions within the city. There were 57 ponds, including stock ponds, irrigation reservoirs, flood control detention ponds and inadvertent detention areas, identified from 2010 aerial photography within the SWMMP planning area. These small impoundments are permitted by the Wyoming SEO with existing storage capacities totaling approximately 575 ac-ft, summarized in Table 3.37.

3.9.2 Oregon Trail Drain and Emigrant Gap Draw

The Oregon Trail Drain/Emigrant Gap Draw drainage basin are located west of the city of Casper and the town of Mills. The Oregon Trail Drain is part of irrigation drainage

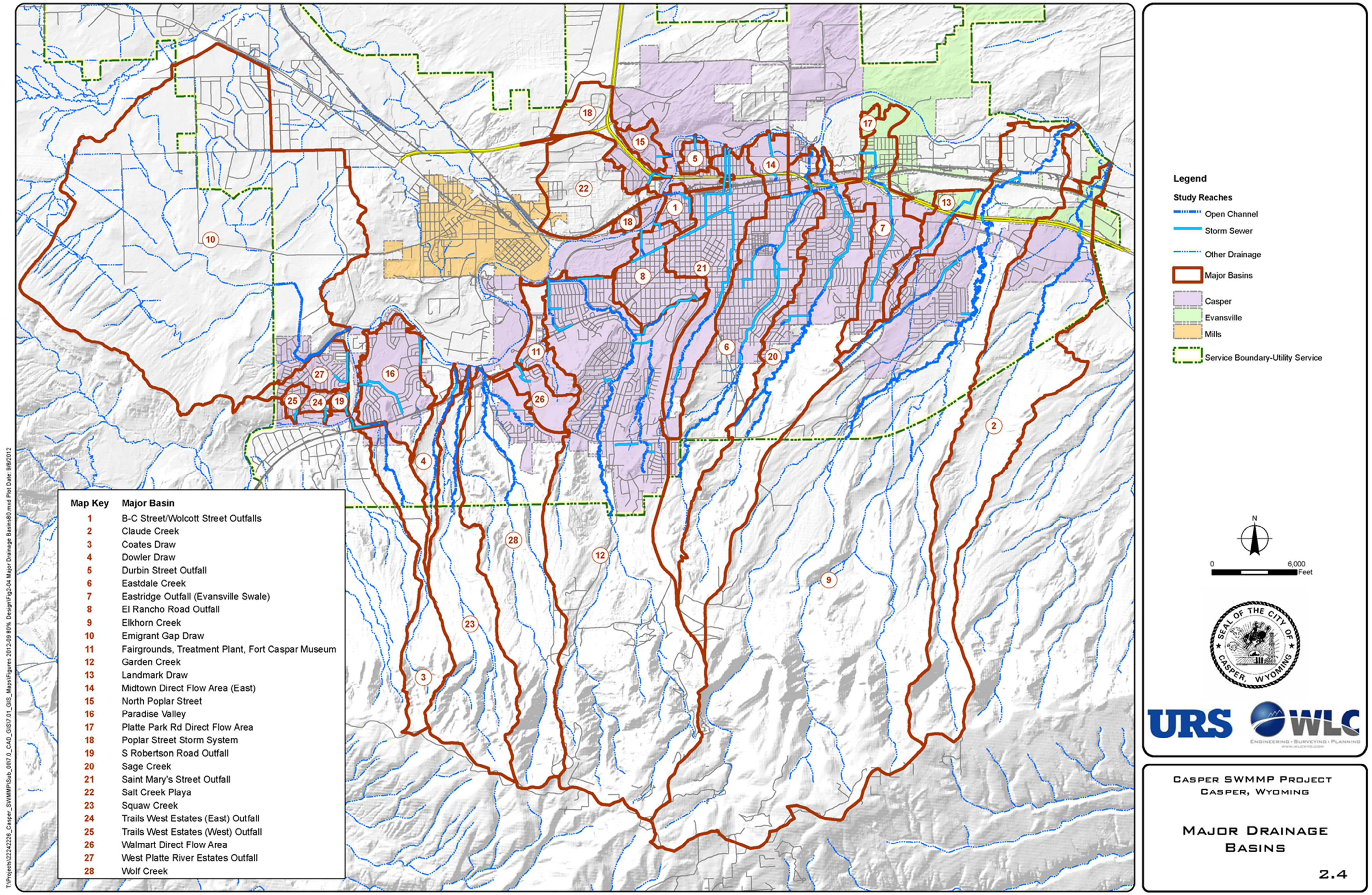

Figure 3.66. Major Drainage Basins as Presented in the City of Casper Stormwater Management Master Plan.

infrastructure for the USBR Kendrick Project, which is operated and maintained by the CAID. The drain collects surface water runoff, groundwater flows, and irrigation returns from over 9,000 acres or approximately 14.1 square miles within the Emigrant Gap Draw drainage basin, which was studied and described by the city of Casper's SWMMP [WLC Engineering, Surveying, and Planning, 2013].

Table 3.37. Summary of Small Reservoirs Within the Stormwater Management Master Plan Study Area [WLC Engineering, Surveying, and Planning, 2013]

SWMMP I.D.	Name	Permit Number	Owner-ship	Purpose	Capacity (acre/feet)
P-Q04	Baxter	6245R	Private	Irrigation	18
P-C04	Bentley	6518R	Private	Irrigation	45
P-E-NW11	Carroll No. 1	5556R	Private	Irrigation	28
P-EE01	Casper Parks No. 1	9214R	City of Casper	Irrigation	22
P-EE02	Casper Parks No.2	9881R	City of Casper	Irrigation	48
P-S02	Casper Sage Creek	5908R	Private	Irrigation	100
P-W14	East Fork Wolf Creek	7580R	Private	Irrigation	35
P-D24	Eastdale Creek Detention No.1	13124R	City of Casper	Flood Control	24
P-D04	Eastdale Creek Detention No.2	13125R	City of Casper	Flood Control	57
P-G02	Hogadon	9549R	City of Casper	Other	5
P-T01	Horsch Stockwater	5830R	Private	Stock	14
P-D02	Lower Spicer	5790R	Private	Stock	7
P-G29	Outer Drive Flood Detention	8134R	City of Casper	Flood Control	39
P-S06	Pratt Park	8053R	City of Casper	Flood Control	100
P-G31	Yesness	5524R	City of Casper	Fish and Wildlife	33

The Emigrant Gap Draw is shown as map key "10" in Figure 3.66 and is the only major drainage basin studied in the SWMMP that was a left bank tributary to the North Platte River [WLC Engineering, Surveying, and Planning, 2013]. The Oregon Trail Drain along with the existing land uses and drainage features area are shown in Figure 3.67. The Emigrant Gap Draw is the second largest drainage basin studied in the SWMMP with most of its drainage area upstream of Casper's city limit [WLC Engineering, Surveying, and Planning, 2013]. The Oregon Trail Drain has been listed on Wyoming's 303(d) List since 2000 because of selenium water-quality criteria exceedances. Also, new highway construction project for the Casper West Belt Loop, Robertson and Poison Spider roads cross the lower part of the drainage.

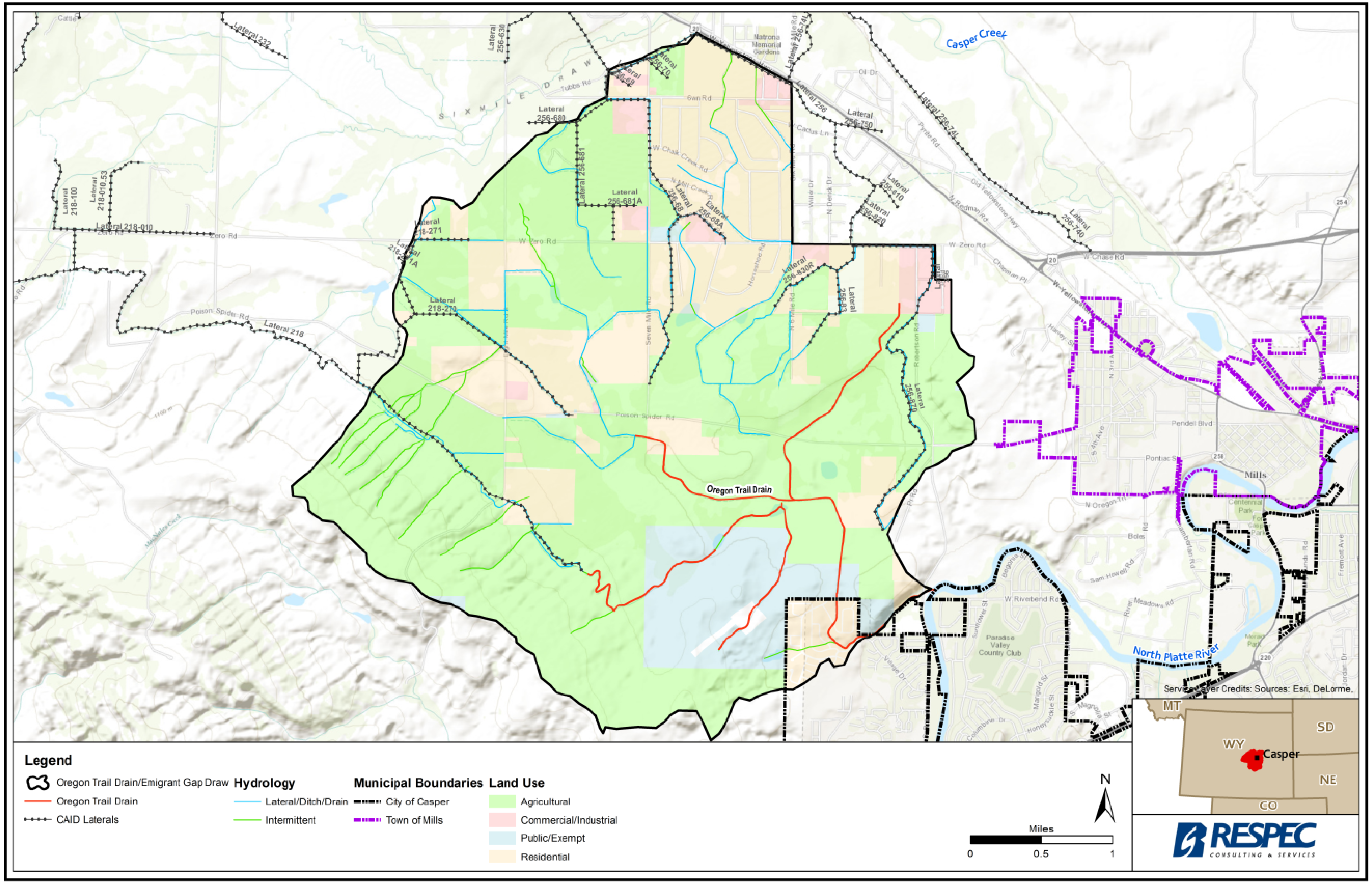

Figure 3.67. Oregon Trail Drain and Emigrant Gap Draw Location Within the Study Area.

The drainage basin is mostly undeveloped with agricultural land comprising approximately 60 percent of the drainage basin; residential, commercial, and industrial uses are on approximately 27 percent of the area. Drainage deficiencies identified in the drainage basin included an existing culvert under South Robertson Road and the channel upstream of Robertson Road [WLC Engineering, Surveying, and Planning, 2013]. A major stormwater detention site that is currently a natural depression downstream of the new West Belt Loop Road was identified in the drainage basin; however, the site was not considered in the SWMMP since the proposed facility would be difficult to permit because of high selenium concentrations and the project would meet resistance from landowners, USBR, and CAID [WLC Engineering, Surveying, and Planning, 2013]. As part of the SWMMP and in regards to the Emigrant Gap Draw, WLC Engineering, Surveying, and Planning [2013] recommended the following items:

- Coordinate projects that have beneficial effects with the NCCD to leverage water quality related grants and funding sources.
- Initiate a new detailed study of Emigrant Gap Draw from its confluence to the limit of the current planning area boundary.
- Improve the channel upstream of Robertson Road, rebuild the existing berm on the south side of the channel, and remove a concrete flume downstream of Robertson Road.
- Design and construct a channel to cover exposed Cody Shale and stabilize the channel invert and banks to reduce potential selenium discharges to the North Platte River.

4.0 MIDDLE NORTH PLATTE WATERSHED MANAGEMENT AND REHABILITATION PLAN

4.1 OVERVIEW

The objective of this Level I study is to generate a watershed management and rehabilitation plan that is technically sound, practical in nature, and economically feasible. In conjunction with the development of the study's GIS, the inventory focused on assessment of the watershed and the identification and evaluation of improvements to address those issues described in Chapter 3.0. Potential improvements were developed and categorized into the following:

- **Irrigation System Conservation and Rehabilitation.** The inventory and evaluation of the existing infrastructure was completed and improvements identified for the rehabilitation of existing structures and the potential conservation of existing irrigation diversions.
- **Livestock/Wildlife Upland Watering Opportunities.** Based upon an evaluation of existing water sources and the condition of upland grazing resources, potential upland water source development projects were identified.
- **Grazing Management Opportunities.** Based upon a review of the pertinent ESDs and the ambient vegetation and soil conditions, grazing management strategies are presented.
- **Surface Water Storage Opportunities.** Results of previous investigations pertaining to development of water storage opportunities within the watershed are incorporated.
- **Stream Channel Condition and Stability**. Stream channels within the watershed were characterized with respect to their condition and stability. Impaired channels were identified for further evaluation and alternative improvements developed.
- **Wetlands Enhancement Opportunities.** Opportunities to establish new wetlands or enhance existing wetlands exist within the watershed.
- **Other Watershed Management Opportunities.** For each of the categories described above, a series of recommended projects are prescribed in the following portions of this chapter. These plans have been prepared to provide an overview of potential improvements that can partially or fully address the key issue identified within the watershed.

In the remainder of this chapter, the conceptual plans developed within each watershed component are described and evaluated with respect to providing benefits to improving the existing water supply through conservation. For the purposes of tracking individual components of the watershed management plan, each component was designated a unique project or "improvement" number. The prefixes used for each improvement describe the category of the watershed management plan it falls under. The prefixes are as follows:

- Project Components “I”: Irrigation system rehabilitation components (Section 4.3)
- Project Components “L/W”: Livestock/wildlife upland watering opportunities (Section 4.4)
- Project Components “G“: Grazing management opportunities (Section 4.5)
- Project Components “S”: Surface water storage opportunities (Section 4.6)
- Project Components “C”: Stream channel stability components (Section 4.7)
- Project Components “W”: Wetlands enhancement opportunities (Section 4.8)
- Project Components “O”: Other watershed management opportunities (Section 4.9).

4.2 POTENTIAL EFFECTS AND BENEFITS OF WATERSHED MANAGEMENT PLAN COMPONENTS

The Wyoming Water Development Commission’s (WWDC) Level I Watershed Study is a fundamental landscape analysis confined to a hydrologically connected drainage area or watershed and is focused on two primary components. The first is an identification of the physical attributes of that analysis area. This is accomplished by conducting a comprehensive inventory of the natural resources and subsequently using that inventory to articulate a description of the current natural resource conditions. The second is a long range plan outlining management and/or rehabilitation opportunities and activities that address ecological enhancement and watershed function.

Such activities, in the conservation community, are commonly referred to as best management practices (BMPs) or conservation practices. These BMPs and conservation practices are eligible for grant funding assistance through the WWDC’s Small Water Project Program (SWPP). The WWDC’s SWPP funds are mainly used for installing BMPs and conservation practices such as stock ponds, water wells, buried water delivery pipelines, stock tanks, spring developments, solar platforms and pumps, wetland enhancement and restoration, windmills, and irrigation diversion and conveyance improvements.

There can be one or more benefits resulting from the implementation of BMPs and conservation practices. Such benefits can be either quantitative or qualitative or both. Benefits can be local or global and specific or surrogate, depending on multiple factors unique and specific to the BMP or conservation practice, ecological site, watershed, or major land resource area. BMPs and conservation practices also provide opportunities to relieve grazing pressure on riparian areas and create the potential to induce improvements to soil health, plant community diversity, and improved forage production. They allow for grazing deferment in the event that rest is required due to invasive species control efforts, which can also stimulate water release.

Benefits to ecosystem functionality and landscape health can be and is a response to soil health, water infiltration/percolation and a functioning water cycle. Expected project benefits can be related to watershed function including collection and storage of water along with ecological enhancements such as plant and animal habitat and stream corridor or riverine stability as well as societal values including economic stability and open space maintenance. Multiple benefits can result from improvement opportunities for water resources, which are critical to meet the daily water demands of the resident population of man and beast, develop, increase or extend irrigation water availability, and improve fishery habitat and potential recreational benefits.

4.2.1 Natural Resources Conservation Service Conservation Effects Assessment Program

In 2003, in the interest of government accountability, Congress and the Office of Management and Budget requested information from the U.S. Department of Agriculture (USDA) about the effectiveness of its conservation programs. In response, the Conservation Effects Assessment Project (CEAP) was initiated by NRCS to provide quantitative information about the environmental impacts of its conservation practices on agricultural lands within the contiguous 48 United States. The CEAP is a joint effort of the NRCS, Agricultural Research Service (ARS), National Institute for Food and Agriculture, other federal agencies, and university scientists to quantify the environmental effects of NRCS conservation practices and programs and develop the science base for managing the agricultural landscape for environmental quality. Initially focused on croplands, the CEAP effort has been expanded to include wildlife, wetlands, pastures, and rangelands.

Project findings have been used to guide USDA conservation policy and program development that will assist conservationists, farmers, and ranchers with informed conservation decisions" [Spaeth et al., 2013]. The end product of the CEAP is a literature review and concise collation of information from hundreds of published scientific papers, journals, and additional references. Consequently, the CEAP documents provides a valuable source of information pertaining to various BMPs incorporated in this plan and is referenced throughout the remainder of this section.

4.2.2 Watershed Function

Identifying improvement opportunities for hydrologic and watershed function, including water quantity, yield and use, is an essential element of the Level I Watershed Study. Hydrologically, there are three fundamental watershed functions: (1) collection of the water from rainfall, snowmelt, and storage that becomes runoff, (2) storage of various amounts and durations, and (3) discharge of water as runoff [Black, 1997]. Watershed characteristics such as geologic structure, soils, landform, topography, vegetation, and climate influence the capture or collection of precipitation, infiltration and storage of surface and ground water, and the runoff or discharge of water.

4.2.2.1 Water Quantity

Implementation of BMPs and conservation practices can affect water resource quantity through improvement of plant communities, vegetative diversity, and ecological site health achieved from water development and the creation of reliable water sources in areas devoid of such allows for the establishment of grazing systems and changes in grazing distribution.

Hydrological responses to grazing are strongly contingent on the vegetative community composition, with communities that provide greater cover and obstruction to overland flow, such as midgrass-dominated communities having greater hydrological function, including infiltration rate, than shortgrass-dominated communities [Wood and Blackburn 1981b; Thurow 1991; Natural Resources Conservation Service, 2011]. Poor water distribution has been the primary cause of poor livestock distribution [Holecheck, 1997]. Livestock distribution and grazing behavior can be modified by adjusting the location of supplemental feed and water, implementation of patch burns, and herding in addition to the traditional practice of fencing [Williams 1954; Ganskopp 2001; Fuhlendorf and Engle 2004; Bailey 2005]. Natural Resources Conservation Service [2011] reviewed many studies and found that water distribution, steep slopes, and high elevations unequivocally influenced livestock distribution. Also sufficient evidence existed to recommend that NRCS increase the role of herding and supplement placement along with water development and fences for managing livestock distribution [Natural Resources Conservation Service, 2011].

Soil vegetative cover is widely recognized as a critical factor in maintaining soil surface hydrologic condition and reducing soil erosion [Gifford, 1985; Natural Resources Conservation Service, 2011]. Stocking rates, regardless of grazing system, that reduce soil surface vegetative cover below a site-specific threshold increases detachment and mobilization of soil particles due to raindrop impact, decreases soil organic matter and soil aggregate stability, increases soil surface crusting and reduces soil surface porosity, and thus decreasing infiltration and increasing soil erosion and sediment transport [Blackburn, 1984]. Sufficient vegetative cover, critical soil cover, or residual biomass must remain during and following grazing to protect soil surface condition (e.g., porosity, aggregate stability, and organic matter) and hydrologic properties (e.g., infiltration), however, these site-specific vegetation cover requirements vary depending on cover type (e.g., vegetation, litter, or rock), soil type, rainfall intensities, and water quality goals [Gifford 1985]. The erosive energy of water and the long-term reduction of organic matter additions to soil detrimentally affect numerous soil properties, including the increase of bulk density, disruption of biotic crusts, reduced aggregate stability, and organic matter content, which collectively reduce infiltration rate and increase sediment yield and runoff [Natural Resources Conservation Service, 2011].

These efforts can increase water infiltration/percolation, stimulate spring flows and increase flow volume and duration. An example of restoring watershed function and water quantity was in a 74,000 acre watershed in West Texas near San Angelo where West Rocky Creek, a dry, intermittent stream for decades, started flowing again [Moseley, 1983; Wiedenfeld, 1986]. In the early part of the 20th century, West Rocky Creek was a yearlong flowing stream until the late 1910s, when it became an intermittent stream and by 1935, the springs feeding the creek had been dried up by mesquite and other invading woody plants [Moseley, 1983; Wiedenfeld, 1986].

During the 1950s and 1960s, ranchers and landowners on five ranches, covering about half the watershed, began conservation work including root-plowing, reseeding, tree-dozing, aerial spraying, and chaining of mainly mesquite and juniper brush, which limited water availability for native grasses such as sideoats grama, buffalograss, curly mesquite, and tobosa [Moseley, 1983]. About 30,000 acres or 70 percent of the mesquite was removed from the watershed, and the original prairie was restored [Moseley, 1983; Wiedenfeld, 1986]. In the mid to late 1960s, one of the 5 ranchers noticed that a spring, which was dry since 1935, had started flowing again and by replacing the water-hungry brush with a good grass cover, more rainfall soaked into the aquifer, recharging the dormant springs which began flowing on all 5 ranches by 1970 [Moseley, 1983]. Ongoing grazing management on each ranch enhanced the cover of grasses in the watershed with soils producing an estimated 2,000 to 2,500 pounds of forage per acre which helps retard brush succession; the ranchers periodically must do maintenance brush control to keep the desired vegetation balance [Moseley, 1983].

In southeast Arizona, long-term data on soils, vegetation, hydrology, and climate have been collected for over five decades on the Walnut Gulch Experimental Watershed, which is operated by the USDA's Agricultural Research Service (ARS). The Walnut Gulch Experimental Watershed is one of the most intensively instrumented semiarid experimental watersheds in the world, with a 10 to 100-year record of abiotic and biotic measurements and photographs [Moran et al, 2008]. Researchers studied the interaction between rainfall intensity and soils and vegetation by comparing the frequency of runoff producing summer events between a shrub-dominated watershed and a grass-dominated watershed and found that it takes higher rainfall intensities to produce runoff on the grassed watershed [U.S. Department of Agriculture, 2013]. Results also indicate that the grassland plant community is producing more plant material than the shrubland, with close to the same amount of precipitation input, making the grassland ecosystem more water use efficient [U.S. Department of Agriculture, 2013]. The researchers found that runoff quantities at the watershed scale are controlled more by infiltration of water into alluvial channels and spatial distribution of thunderstorm rainfall [U.S. Department of Agriculture, 2013].

4.2.3 Ecological Enhancement

An ecological enhancement is any activity that improves an ecosystem such as stabilizing erosive soils, increasing soil quality, planting or maintaining native grasses, shrubs, or trees, removing and controlling invasive species, and improving or maintaining riparian/wetland areas. Ecological sites are complex and varied within the study area as described in Section 3.4.5.5 and Figure 3.10. And so are the potential benefits achieved from project activities and implementations that influence the condition of those ecological sites and characteristics.

Conjunctive to soil function is plant community diversity, health and productivity and subsequent forage diversity, production and wildlife habitat. Benefits accrued to water quality are significant as improvements to the chemical, physical, and biological constituents of a water body produce both local site enhancements and those transferred downstream. Wetland enhancement and restoration provides benefits to ecological stabilization as well as contributions to water quality and quantity. Ecologically, watersheds function by providing diverse sites and pathways along which vital chemical reactions occur and furnishing habitat for the flora and fauna that constitute the biological elements of ecosystems [Black, 1997].

4.2.3.1 Plant and Animal Habitat

Locations of conservation practices and rangeland infrastructure can have a large, indirect impact on overall vegetation change with the spatial design of infrastructure including the locations of fences, watering points, and feeders that are used to modify patterns of animal movement and forage utilization, taking into account livestock behavior and the template of topography and plant communities to which livestock respond [Laca, 2009; Natural Resources Conservation Service, 2011]. The use of rangelands for sustainable livestock production has the potential to ensure the maintenance of wildlife habitat which will ensure that wildlife habitat will persist into the future [Natural Resources Conservation Service, 2011]. Livestock grazing can have negative or positive impacts on game bird habitat, depending on timing and intensity of grazing and the habitat being influenced [Beck and Mitchell, 2000]. Wildlife responses to conservation practices are usually species and even species-habitat specific, meaning not only that each species may respond differently to any specific practice but also that a single species may respond differently to the same practice in different vegetation associations or conditions [Natural Resources Conservation Service, 2011].

Free-stranding water has been considered to be a resource that limits distribution and abundance of many species of wildlife in arid regions of the United States, and water developments have been used since the 1940s to improve wildlife habitat [Simpson et al, 2011]. Simpson et al [2011] compiled and evaluated available literature for evidence of effects of water sources on wildlife populations. Positive effects of water developments on wildlife have been documented, and species thought previously not to use free-standing water developments do so when it is available [Simpson et al, 2011]. Additionally, researchers studied effects of wildlife water developments in southwestern Arizona and found that water developments were used by a diverse array of wildlife, including mule deer, game birds, a number of nongame species [Rosenstock et al, 2004].

4.2.3.2 Stream Corridors and Riparian/Wetland Areas

Reducing impact to riparian plant communities through the development of upland water resources can result in stream corridor benefits. Riparian plant community diversity and regeneration of desirable important woody species can help restore local water tables, trap sediments, increase wildlife habitat and migration corridors, and stabilize stream banks which can affect localized land loss. In addition, aquatic population benefits can accrue and recreation potential can be realized.

Livestock distribution practices such as water developments, supplement placement, and herding are effective means of managing the intensity and season of livestock grazing in riparian areas [Natural Resources Conservation Service, 2011]. Season of grazing also determines livestock grazing effects on riparian plant communities, particularly woody plants, and can be managed to conserve riparian habitats and their associated services [Natural Resources Conservation Service, 2011]. Sufficient evidence in peer-reviewed studies existed that Natural Resources Conservation Service [2011] suggested riparian grazing management that maintains or enhances key riparian vegetation attributes (i.e., species composition, root mass and root density, cover, and biomass) will enhance stream channel and riparian soil stability, which will in turn support ecosystem services, such as flood and pollutant attenuation and high-quality riparian habitat. Peer-reviewed literature generally supports the effectiveness of water developments, supplement placement and herding for reducing riparian vegetation utilization, or time spent in riparian areas [Natural Resources Conservation Service, 2011].

4.2.4 Societal Value

Natural resource stewardship not only has economic value in terms of forage, livestock, and wildlife production relationships, but also can have non-economic value placed on those conservation practices by society. Those values can even influence the perception of those implementing conservation practices and can be as much an influence in the decision process to implement conservation as is an economic value. Additionally, it is possible for a BMP or conservation practice that provides an ecological service to accrue more value to society in general than to a local landowner. Ecosystem services are defined as those things or experiences produced by natural systems on which humans place value [Natural Resources Conservation Service, 2011]. Ecosystem services benefit society in numerous and diverse ways while each of the conservation practices can potentially produce different kinds, qualities, and amounts of these goods and services, depending on location, natural potentials, current states, and other factors.

Non-economic values can and should be considered in determining watershed enhancement programs, particularly when considering public investment in conservation. Natural Resources Conservation Service [2011] found little to no research exists showing the direct noneconomic effects of BMPs and conservation practices on individuals, households, or social systems but acknowledged it was likely that producers do realize psychological benefits from conservation because stewardship typically ranks high among the management goals of livestock producers [Huntsinger and Fortmann, 1990; Sayre, 2004]. Moreover, livestock producers who believe strongly in a responsibility to society are more likely to engage in environmentally desirable management practices, such as invasive weed control and riparian protection [Kreuter et al, 2006].

In 2012, in cooperation with the Wyoming Stock Growers Association (WGSA), University of Wyoming, and University of California-Davis, research scientists with the USDA's ARS Rangeland Resources Research Unit in Cheyenne, Wyoming investigating effects of rangeland management decision-making asked WGSA producer members about their goals, ranching operations, and management practices via a mail survey and received a total of 307 rancher responses to the survey [Kacheris et al, 2013; Mealor, 2013]. Livestock production and forage production were the top management goals, with ecosystem characteristics that support these goals (e.g., soil health, water quality) tied for second [Kacheris et al, 2013; Mealor, 2013].

In addition to other social values and ecological enhancements, open spaces have long been held with high value to Wyoming and other western region states. From a ranching industry perspective, tourism interest, outdoor recreationist activity, or a real estate value, open space is significant. Preservation of our custom and culture has been and continues to be a focal point of consideration. Open spaces are critical for upland/riparian conductivity, wildlife migrations and habitat, and recreational opportunity. Open space is valued for preservation of cultural resources and for the reduction or prevention of land conversion to a condition that can be stewarded to an improved ecological condition.

4.3 IRRIGATION INVENTORY

Three investigations into the irrigation infrastructure and operations within the study area have been completed on behalf of the WWDC:

- *Final Report for Casper Alcova Irrigation District Computerized Irrigation Scheduling*, prepared by Anderson Consulting Engineers, Inc., May, 2003
- *Final Report for Casper Alcova Irrigation District Rehabilitation Needs Analysis*, prepared by Anderson Consulting Engineers, Inc., October, 2003
- *Final Report for Casper Alcova Irrigation District GIS Project Level II*, prepared by Anderson Consulting Engineers, Inc., January, 2008.

To avoid redundancy, the inventory efforts of this Level I study did not re-inventory the previously evaluated irrigation systems within CAID, however, the completed CAID rehabilitation projects were incorporated into the study's GIS. Specific irrigation structures, inventories, and evaluations were conducted at the request of irrigators and water users.More requests were received than could be accomplished during the study period, but the irrigators' concerns are included to provide guidance on future investigations or potential projects. In general, each landowner identified the structures to be evaluated during the site visit. Typically, the landowners accompanied field crews during the inventory. A summary of the irrigation structure inventory at these locations is included below. The landowners that requested an inventory of irrigation facilities included the following:

- Garrett Ranch

- Bates Creek Cattle Company
- Miles Land and Livestock
- Whisler Ranch
- Rafter Q Ranch
- 3 J Ranch
- The Ranch at Bates Creek
- 33 Ranch
- Goose Egg Ditch

Specific tasks completed during this effort included the following:

- Interviewing landowner/ditch representative
- Field inventory of irrigation structures
- Assessment of physical condition of structures
- Assessment of hydraulic efficiency of existing structure
- Photographic documentation of structures
- Location of structures using GPS technology
- Incorporation of data into the study's GIS.

Garrett Ranch

The headgate on Bates Creek is functional but in need of rehabilitation or replacement. The facilities at this location are unable to divert a double appropriation of water during spring runoff. Improvements to enlarge both the Bates Creek headgate and a siphon immediately downstream of the headgate are necessary to increase the diversion potential at this location. Figure 4.1 illustrates the headgate at this location on Bates Creek.

The diversion structure, headgate and wasteway located on Stinking Creek are in need of rehabilitation and replacement. The configuration for these structures should be improved to ensure the long-term integrity during high flows in Stinking Creek as well as the diversion from Stinking Creek to the irrigation ditch. The wasteway should be installed and configured to limit flows in the ditch to its maximum capacity plus freeboard. Flows diverted from Stinking Creek are conveyed to a Schnoor Reservoir that provides water to flood irrigated parcels. The storage reservoir is not fully functional as the dam outlet has limited capacity because of sediment accumulation. The reservoir outlet pipe should be replaced and a pipeline installed between the outlet and the flood irrigated parcels. Additionally, the flood acres are proposed to be converted to a center pivot.

RSI-2129-14-075

Figure 4.1. Garrett Ranch Headgate on Bates Creek.

Bates Creek Cattle Company

The sediment by-pass gate/structure located on the Bates Creek check structure should be improved or reconfigured to limit maintenance and ensure the functionality of the headgate, and measurement structure. The Whisler Ranch's headgate (18-inch gate on a 14-foot headwall) on the irrigation ditch diverting from Bates Creek is failing because of the location of an erosive headcut in the delivery ditch below the headgate. Rehabilitation of the headgate structure is required along with stabilization of the ditch bed to maintain the integrity of the structure. A siphon on Bates Creek has been exposed because of a headcut in the channel. Stabilization measures have been placed along the channel banks and bed to protect the siphon. Long-term improvements may be necessary to ensure the integrity of the siphon. The siphon that has been exposed because of channel erosion is presented in Figure 4.2.

RSI-2129-14-076

Figure 4.2. Siphon Exposed by Channel Degradation on Bates Creek.

A 36-inch headgate (Place/Krause Headgate) recently installed on Bates Creek is functional but unable to fully divert the water allotment during low to medium flows within the channel. The rock check structure associated with the headgate continues to lose rock during high flow events. Enlargement of the headgate or placement of more stable rock will be required to fully realize the diversion potential.

Miles Land and Livestock

An earthen ditch that conveys water to a center pivot is losing significant water because of seepage. A small storage pond in conjunction with a pipeline from the storage pond to the center pivot is proposed to bypass the section of a ditch that is losing water. The 60-inch headgate on Bates Creek, shown in Figure 4.3, is functional. The check structure incurred damage during high flows. Longevity of the check structure could be improved with some rehabilitation.

RSI-2129-14-077

Figure 4.3. Diversion Dam/Check Structure on Bates Creek.

Whisler Ranch

Two center pivots and a small storage pond for the center pivot were inventoried and found to be fully functional. No improvements were identified.

Rafter Q Ranch

Rehabilitation of a section of earthen ditch that has excessive seepage losses is recommended. The improvement would involve placement of a pipeline. To improve irrigation efficiency, a second pipeline is being proposed in conjunction with a center pivot.

3 J Land

Rehabilitation or replacement of the headgate structure on Corral Creek may be needed along with rehabilitation of an earthen ditch involving placement of a pipeline. An initial field visit was conducted for this irrigation delivery system but a more detailed inventory is required.

The Ranch at Bates Creek

The landowner has indicated that replacement of a headgate structure on Bates Creek is needed along with rehabilitation of an earthen ditch perhaps involving placement of a pipeline. An initial site visit was not conducted for this irrigation system, so a field inventory is required.

33 Ranch

The landowner has indicted that rehabilitation of the headgate structure may be needed along with rehabilitation of an earthen ditch involving placement of a pipeline. An initial visit was not conducted for this irrigation system, therefore a field inventory is required.

Goose Egg Ditch

A landowner has indicated that rehabilitation of Goose Egg Ditch Creek may be needed along with rehabilitation of control structures and placement of a pipeline. An initial field visit was conducted for this irrigation delivery system but a more detailed inventory is required.

4.4 IRRIGATION SYSTEM RECOMMENDATIONS

This plan and its alternatives provide the irrigators and landowners with an assessment of conditions associated with the irrigation delivery infrastructure and associated hydraulic structures. The landowner or manager could use the alternatives in this plan as a starting point from which they could select projects for further design and for potential funding assistance from the WWDC SWPP, the NRCS Environmental Quality Incentives Program (EQIP), or other participating conservation or watershed programs.

4.4.1 Summary of the Inventory of Irrigation System Projects

As presented in Chapter 3.0, the irrigation system inventory effort associated with this project consisted of evaluating structures and ditch conditions at the request of interested landowners and stakeholders. At the request of those individuals who requested to participate in the study, irrigation system components were inventoried. The recommendations included herein are not all-inclusive. There are additional irrigation structures located throughout the watershed in need of rehabilitation or replacement. By virtue of their location within the study area, those potential projects would still be considered eligible for application funding through the WWDC SWPP.

Based upon the results of the field inventory, conceptual rehabilitation plans were developed for each structure. In an effort to assist the irrigator or landowner, the CAID, and the NCCD in prioritizing potential improvements to each irrigation delivery system, relative priorities were defined as follows:

- **Priority 1:** Install, replace, or rehabilitate aging infrastructure critical to the diversion and delivery of water.

- **Priority 2:** Install, replace, or rehabilitate aging infrastructure critical to the operation, measurement, and management of the irrigation diversions.
- **Priority 3:** Install, replace, or rehabilitate aging infrastructure to provide improvements in efficiency and conservation on farms.

The information in this plan provides the landowners with an assessment of the conditions associated with the structures that were inventoried during the fieldwork. The following improvements were identified after the field investigation and assessment of the data collection efforts. In Sections 4.4.1.1 through 4.4.1.5, the individual structures inventoried and assessed are discussed.

Each irrigation system improvement was assigned a unique identifier within the watershed plan. The structures inventoried and their respective component identifiers in the watershed management plan are summarized in Table 4.1. This information has been incorporated in the study's GIS and geodatabase.

4.4.1.1 Irrigation Component I-01: Schnoor Reservoir Irrigation Pipeline Project

The Garrett Ranch identified a diversion dam and headgate on Stinking Creek in need of replacement and rehabilitation along with installation of a wasteway, and necessary improvements to Schnoor Reservoir, including replacement of the outlet pipe and installation of a pipeline to a center pivot. Based upon a limited field evaluation of the structures, the wasteway and headgate that controls flow from Stinking Creek to Schnoor Reservoir and the delivery ditch are in need of enlargement, renovation, or replacement. Additionally, improvements to the dam and outlet for Schnoor Reservoir are necessary to use as storage for a proposed center pivot. This project involves installing a new irrigation diversion to supply irrigation water with the following components:

- **Item No. I-01.1:** Replace a new large diversion/check structure on the Stinking Creek headgate structure to convey water into the adjacent irrigation ditch and wasteway structure to spill excess water back to Stinking Creek.
- **Item No. I-01.1:** Rehabilitate the delivery ditch and replace the outlet pipe for the Schnoor Reservoir that stores water conveyed to a center pivot.
- **Item No. I-01.1:** Install approximately 6,200 feet of buried 15-inch plastic irrigation pipe (PIP) low-pressure irrigation PVC pipeline from the diversion/check structure on Stinking Water Creek to a water control structure adjacent to Schnoor Reservoir.
- Incorporate all of the required valves, fittings, and appurtenances to facilitate management of flow, pressure, and delivery of irrigation water.
- Locate the proposed diversion, headgate, ditch, and pipeline mainly on state-owned lands managed by the Wyoming OSLI and involve a portion of the project on privately owned lands.

Table 4.1. Summary of Recommended Irrigation System Improvements

Rehabilitation Item Number	Description	Priority
I-01	Replacement of a large diversion/check structure	1
I-01	Rehabilitation of a delivery ditch and replacement of an outlet pipe	2
I-01	Installation of approximately 6,200 feet of buried 15-inch PIP low pressure irrigation PVC pipeline	1
I-02	Replacement of a headgate	1
I-02	Replacement and enlargement of siphon downstream of headgate	2
I-03	Rehabilitation of a diversion/check structure	1
I-03	Replacement of a headgate	2
I-03	Protection of a siphon with placement of rock	2
I-03	Rehabilitation of a headgate and diversion structure	2
I-04	Construction of a storage pond to regulate irrigation water supply	1
I-04	Installation of approximately 10,200 feet of buried 12-inch PIP low pressure irrigation PVC pipeline	1
I-04	Rehabilitation of a diversion dam structure	2
I-05	Installation of approximately 1,800 feet of buried 12-inch PIP low pressure irrigation PVC pipeline	1
I-05	Installation of approximately 2,300 feet of buried 12-inch PIP low pressure irrigation PVC pipeline	2

4.4.1.2 Irrigation Component I-02: Garrett Ranch

The Garrett Ranch identified a headgate and siphon in need of replacement and enlargement on Bates Creek. Based upon a limited field evaluation of the structures, the structure should be replaced. The upper headgate and siphon on Bates Creek could be enlarged to accommodate diversion of a double appropriation during spring runoff. This project involves installing a new irrigation diversion to supply irrigation water with the following components:

- **Item No. I-02.1:** Replace the headgate on Bates Creek. Enlarge the headgate to facilitate diversion of double appropriation of water during spring runoff.
- **Item No. I-02.2:** Replace and enlarge the siphon downstream of the headgate to increase capability to divert double appropriation.

4.4.1.3 Irrigation Component I-03: Bates Creek Cattle Company

The Bates Creek Cattle Company identified a headgate/check structure, siphon integrity due to erosion, and additional headgate rehabilitation within the study area. Based upon a limited field evaluation of the structures, the main Bates Creek headgate/check structure should be retro-fitted with an appropriate gate to bypass sediment and allow for better adjustment.

Headcuts are threatening the structures. One headcut is threatening a headgate and the ditch needs immediate rehabilitation and installation of a grade control or drop structure. The second headcut in Bates Creek exposed the siphon pipe, but steps have been taken to stabilize the area with bank protection and a rock check structure. A new headgate on the adjacent, upstream property has caused inadequate water delivery during moderate flows because the inlet structure is undersized. The rock check structure needs to be renovated and raised on the diversion to increase water delivery potential. This project involves installing a new irrigation diversion to supply irrigation water with the following components:

- **Item No. I-03.1:** Rehabilitate the diversion/check structure on Bates Creek to improve the sluicing of sediment through the structure. To achieve this objective, the sediment sluice gate needs to be replaced and reconfigured.
- **Item No. I-03.2:** Replace the Whisler Ranch headgate and stabilize the irrigation delivery ditch associated with the Stinking Creek main diversion ditch.
- **Item No. I-03.3:** Protect the siphon on Bates Creek is necessary. Long-term improvements for the channel bed and bank are recommended.
- **Item No. I-03.4:** Rehabilitate the Place/Krause headgate and diversion structure to increase the diversion from Bates Creek. Lowering the invert of the headgate and increasing the height of the diversion structure are recommended.

4.4.1.4 Irrigation Component I-04: Miles Land and Livestock

Miles Land and Livestock identified rehabilitation involving construction of a storage pond for delivering irrigation water to an existing center pivot. Based upon a limited field evaluation, the pivot is currently fed by a well and supplemented by water from an open ditch. The ditch has several leaks in this area. A pond with a pipe from the pond to the pivot are needed in order to bypass the leaking section of ditch. The pond would also help store more of irrigation water for use with the existing center pivot.

- **Item No. I-04.1:** Construct a storage pond to regulate irrigation supply water.
- **Item No. I-04.2:** Install approximately 10,200 feet of buried 12-inch PIP low-pressure irrigation PVC pipeline to convey water from the storage pond to a center pivot.
- **Item No. I-04.3:** Rehabilitate the diversion dam to improve the longevity of the structure.

4.4.1.5 Irrigation Component I-05: Rafter Q Ranch

The Rafter Q Ranch identified a leaking ditch to be replaced with a proposed pipeline and a second pipeline necessary for conveyance of irrigation water to an existing center pivot. Based upon a limited field evaluation, there are two, small, proposed ditch-to-pipeline projects. One project would be for an area of ditch with a lot of seepage and leakage and the second project would be for a pipeline to feed a proposed pivot.

- **Item No. I-05.1:** Install approximately 1,800 feet of buried 12-inch PIP low-pressure irrigation PVC pipeline to mitigate seepage losses from an open ditch.
- **Item No. I-05.2:** Install approximately 2,300 feet of buried 12-inch PIP low-pressure irrigation PVC pipeline to a center pivot to improve irrigation efficiency.

4.4.1.6 Irrigation Component I-06: Whisler Ranch

The Whisler Ranch requested an inventory of two existing pivots and a storage pond for the pivots. Based upon a field evaluation, no problems were noted or improvements proposed, however, the two pivots and a pivot pond on the property were cataloged.

4.4.2 Additional Ditch and Irrigation System Inventories

Irrigation structure inventories and evaluations were conducted at the request of irrigators and water users. There were more requests than could be completed during the study, but initial concerns are included here for future inventories.

4.4.2.1 Irrigation Component I-07: 3 J Land

Rehabilitation or replacement of the headgate structure on Corral Creek may be needed along with rehabilitation of an earthen ditch involving placement of a pipeline. An initial field visit was conducted for this irrigation delivery system, but a more detailed inventory is required.

4.4.2.2 Irrigation Component I-08: The Ranch at Bates Creek

The landowner has indicated that replacement of a headgate structure on Bates Creek is needed along with rehabilitation of an earthen ditch, perhaps involving placement of a pipeline. An initial site visit was not conducted for this irrigation system, therefore a field inventory is required.

4.4.2.3 Irrigation Component I-09: 33 Ranch

The landowner indicated that rehabilitation of irrigation facilities may be needed. An initial visit was not conducted for this irrigation system, therefore a field inventory is required.

4.4.2.4 Irrigation Component I-10: Goose Egg Ditch

A landowner indicated that rehabilitation of Goose Egg Ditch Creek may be needed along with rehabilitation of control structures and placement of a pipeline. An informal field visit was conducted for this irrigation delivery system, but a more detailed inventory is required.

4.5 LIVESTOCK AND WILDLIFE UPLAND WATERING SOURCES

4.5.1 Alternative Watering Opportunities

Water requirements for wildlife and livestock depend on the type, density, and seasonality of the grazing animals, along with the topography, water availability, and plant communities. Existing upland wildlife and livestock water sources that were evaluated in the study area were presented and discussed in Section 3.4.5.3 and shown in Figure 3.8. Buffers with a radius of 1-mile or 5,280 feet were delineated for existing water sources that can provide water to wildlife and livestock. The purpose of the buffers around the water sources is to display the recommended minimum spacing distances between available and viable water sources for livestock and wildlife within the study area. These buffers for evaluated and unevaluated water sources are shown in Figure 3.9. Buffers were not delineated for perennial and intermittent rivers or creeks.

The purpose of evaluating viable livestock/wildlife watering sources and facilities is to provide alternatives to unreliable surface water supplies, nonuniformly used rangelands, and nonfunctioning riparian areas. Most of the study area seems to have a suitable supply of livestock and wildlife water. However, there are some areas where surface and ground water sources are insufficient to meet the requirements for wildlife and livestock. Additionally, a large portion of these sources are reservoirs located on intermittent streams which have inconsistent and unreliable runoff patterns. Because of this uncertainty, some areas of the watershed could benefit from upland water source development. Furthermore, study participants identified places where existing water sources could be improved within the study area.

Many springs are located within the study area that could be developed as upland water sources for wildlife and livestock. However, before initiating any spring development project, a site-specific assessment should be performed to confirm that sufficient yield is present and to identify necessary conservation measures. Moreover, any final plan and design of an upland water project should consider the available water yield, topography of the site, component material and specifications, and number of animals served by the system.

For the purposes of this study, conceptual wildlife and livestock water components and associated facilities were created and located on parcels, allotments, and pastures for landowners who participated in the study. It was assumed that the typical project component consisted of a rubber tire stock tank providing approximately 1,200 gallons of livestock and wildlife water supplied by a well and solar pump via a high-density polyethylene (HDPE) pipeline. The stock tank would provide a volume of water for approximately 80 cattle per day assuming a daily requirement of 15 gallons per head per day. Additionally, closed storage tanks were included in the components since these tanks would allow better use of existing sources.

The project components in this study are conceptual only and are described in general for this report. Before installation, it is recommended to determine the actual locations, specifications, alignments, volumes, and lengths of pipelines, tanks, wells, and pumps. It is also recommended to install wildlife ramps in the proposed water tanks, and incorporating all valves, fittings, and appurtenances to facilitate management of flows and water levels.

4.5.2 Upland Wildlife/Livestock Water Development Projects

Study meetings held in Alcova and Casper provided an opportunity to meet interested landowners and grazing allotment permittees, gain study area input, hear local resource concerns, and answer questions about the study. Participation in the study was voluntary and a list of interested participants was created after these meetings. On-site, individual meetings were scheduled and conducted with study participants. During these meetings, the study team listened to concerns about water needs of the participants and visited potential project sites.

The participant meetings and the information about existing water sources resulted in identifying areas within the study area in need of upland water development and several conceptual water development projects. These proposed conceptual projects were created to provide reliable water sources for livestock and wildlife in areas lacking sufficient sources within the watershed. Several water source alternatives and conceptual project components are presented in Section 4.5.2.1 through Section 4.5.2.30. These project designs are conceptual only and, if initiated, would require additional design work before installation. The proposed projects and components in the watershed management plan are summarized in Table 4.2. Figure 4.4 displays the general location of all of the proposed livestock/wildlife water projects.

Because federal and state lands cover approximately 42 percent of the study area and are intermingled with private lands, many of the upland water development projects would involve coordination with the BLM, USFS, and OSLI before initiating construction. Additionally, some projects could potentially involve cooperation among multiple landowners because of the locations of wells and routes for pipelines. For these projects spanning multiple land owners, written agreements would be necessary to outline the specific responsibilities and liabilities of the parties involved with each individual project.

Moreover, environmental evaluations would be required for the potential impacts identified for a specific project or project component, especially on federal and state lands. Typically, the BLM or USFS conducts these evaluations on federal lands, although the NRCS or other agencies may provide assistance, particularly regarding archaeological or cultural resources. Therefore, implementing any project on federal land would depend on BLM and USFS workload and schedules before conducting the necessary evaluation and documentation.

Table 4.2. Summary of Livestock/Wildlife Upland Water Development Components (Page 1 of 3)

Plan Component	Project Name	Project Type	Solar Pump-Windmill	Well Construction	Spring Development	Pipeline	Stock Tank-Trough	Storage Tank	Stock Pond Rehabilitation Construction
L/W-01/01A	Stinking Water 1	Well/Pipeline		1		7,500	2	1	1
L/W-02	Middle Fork 2	Well/Pipeline	1	1		4,400	3		
L/W-03	Middle Fork 3	Well/Pipeline	1	1		12,400	4		
L/W-03A	Middle Fork 3A	Spring/Pipeline			1	2,100	1		
L/W-03B	Middle Fork 3B	Spring/Pipeline			1	2,100	1		
L/W-04	Middle Fork 4	Well/Pipeline	1	1		9,300	4		
L/W-04A	Middle Fork 4A	Pipeline/Tank				5,600	1		
L/W-05	Middle Fork 5	Well/Pipeline	1	1		4,800	2		
L/W-06	Shirley Ridge 1	Well/Pipeline	1	1		7,500	3	1	
L/W-07	Shirley Ridge 2	Well/Pipeline	1	1		4,700	3		
L/W-08	Shirley Ridge 3	Well/Pipeline	1	1		4,400	2		
L/W-09	Shirley Ridge 4	Well/Pipeline	1	1		4,000	2		
L/W-09A	Childers	Well/Pipeline	1	1		19,100	4		
L/W-10	McClanahan	Well/Pipeline	1	1		12,500	5	1	
L/W-11	Davidson 3 South	Well/Pipeline	1	1		4,700	2	1	
L/W-12	Davidson 3 North	Well/Pipeline	1	1		4,200	2		
L/W-13	Coyote Creek	Well/Pipeline	1	1		5,700	2		
L/W-14	Davidson 2	Well/Pipeline	1	1		7,700	2		
L/W-15	Davidson South	Well/Pipeline	1	1		400	1		
L/W-15A	Forgey East	Well/Pipeline	1	1		15,200	3		
L/W-16	Strohecker 1	Well/Pipeline	1	1		4,300	2		
L/W-17	Strohecker 2	Well/Pipeline	1	1		10,000	3	1	

Table 4.2. Summary of Livestock/Wildlife Upland Water Development Components (Page 2 of 3)

Plan Component	Project Name	Project Type	Solar Pump-Windmill	Well Construction	Spring Development	Pipeline	Stock Tank-Trough	Storage Tank	Stock Pond Rehabilitation Construction
L/W-18	Pine Mountain	Pipeline/Tank				6,400	2		
L/W-19	Strohecker 3	Well/Pipeline	1	1		6,400	3		1
L/W-20	South Fork Casper	Well/Pipeline	1	1		6,500	2		1
L/W-21	Strohecker 4	Well/Pipeline	1	1		4,100	2		
L/W-22	West Pine Mountain	Spring/Pipeline			1	400			
L/W-23	Strohecker 5	Well/Pipeline	1	1		6,400	2		
L/W-24	Eagle Ridge 1	Well/Pipeline	1	1		3,300	2		1
L/W-25	Eagle Ridge 2	Spring/Tank			1	400	1		
L/W-26	Gotheberg Draw	Well/Pipeline	1	1		5,200	2		
L/W-27	Eagle Ridge 3	Well/Pipeline	1	1		6,600	3		
L/W-28	Little Red	Well/Pipeline	1	1		9,600	3		
L/W-29	Eagle Ridge 4	Well/Pipeline	1	1		8,500	3		
L/W-30	Casper Mountain	Well/Pipeline	1	1		8,600	3		
L/W-31	Stinking Creek 1	Spring/Tank			1	1,500	1		
L/W-32	Stinking Creek 2	Well/Pipeline	1	1		3,900	2		
L/W-33	Stinking Creek 3	Well/Pipeline	1	1		5,100	2		1
L/W-34	Hunt Creek	Well/Pipeline	1	1		6,800	2		
L/W-35	Lone Tree	Well/Pipeline	1	1		800	2		
L/W-36	Bates Creek 1	Well/Pipeline	1	1		17,900	4	1	
L/W-37	Bates Creek 2	Spring/Tank			1	1,900	1		
L/W-38	Bolton Creek 1	Well/Pipeline	1	1		200	1		
L/W-39	Bolton Creek 1A	Stock Pond							1

Table 4.2. Summary of Livestock/Wildlife Upland Water Development Components (Page 3 of 3)

Plan Component	Project Name	Project Type	Solar Pump-Windmill	Well Construction	Spring Development	Pipeline	Stock Tank-Trough	Storage Tank	Stock Pond Rehabilitation Construction
L/W-40	Bolton Creek 2	Well/Tank	1	1		200	1		
L/W-41	Bates Creek 3	Well/Tank	1	1		200	1		
L/W-42	Bates Creek 4	Well/Tank	1	1		200	1		
L/W-43	Chalk Creek 1	Well/Pipeline	1	1		3,700	2		
L/W-44	Chalk Creek 2	Well/Pipeline	1	1		3,800	2		
L/W-45	Stinking Creek 4	Well/Tank	1	1		200	1		
L/W-46	Stinking Creek 5	Well/Pipeline	1	1		5,500	2		
L/W-47	Bolton Creek 3	Well/Tank	1	1		200	1		
L/W-48	Stinking Creek 6	Well/Tank	1	1		200	1		
L/W-49	Stinking Creek 7	Well/Tank	1	1		200	1		
L/W-50	Stinking Creek 8	Well/Tank	1	1		200	1		
L/W-51	Soap Creek 1	Well/Tank	1	1		200	1		
L/W-52	Cabin Creek 1	Well/Tank	1	1		200	1		
L/W-53	Cabin Creek 2	Well/Tank	1	1		200	1		
L/W-54	Horse Heaven 1	Spring/Tank			1	1,100	2		
L/W-55	Cabin Creek 3	Spring/Tank			1	1,400	2		
L/W-56	Soap Creek 2	Well/Tank	1	1		200	1		
L/W-57	Sand Spring Creek 1	Well/Tank	1	1		200	1		
L/W-58	Sand Spring Creek 2	Well/Tank	1	1		200	1		
L/W-59	Sand Spring Creek 3	Well/Tank	1	1		200	1		

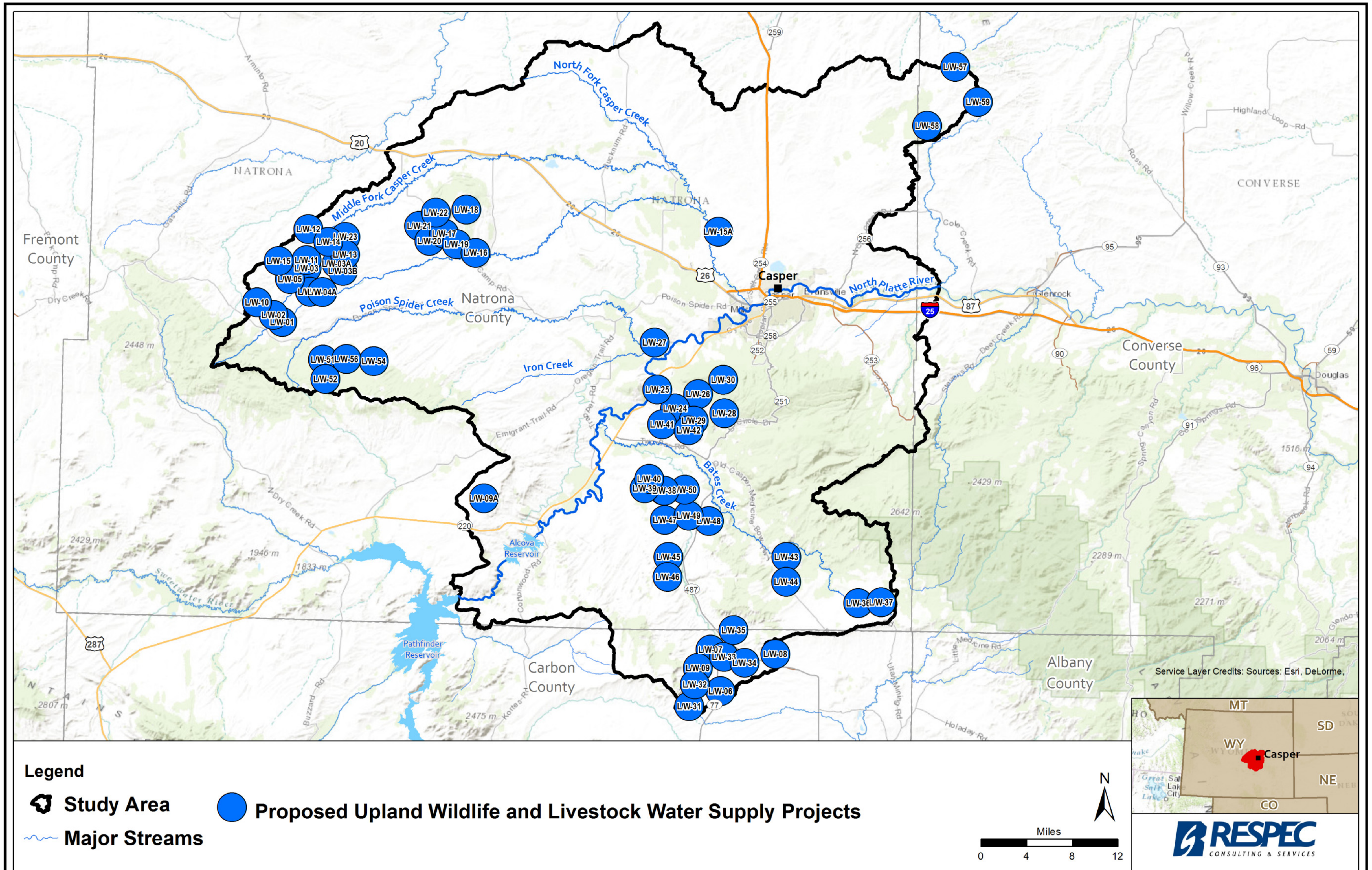

Figure 4.4. Proposed Upland Wildlife and Livestock Water Supply Projects Within the Study Area.

4.5.2.1 L/W-01: Stinking Water 1 Well and Pipeline Project

This alternative would involve drilling a replacement well near the existing “Barn well” and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.5 would be installed:

- An existing well would be replaced with a new well equipped with a pump and appurtenances would be included for management of pipeline flows.
- From the storage tank, two buried HDPE low-pressure pipelines would be installed.
- One pipeline would be aligned north to the top of the ridge to supply a storage tank (approximately 10,000-gallon capacity) and two stock tanks (1,200-gallon capacity each). This pipeline would require installing approximately 7,500 linear feet of 1½-inch pipeline.
- The other pipeline would be installed from the well and pump to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 100 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

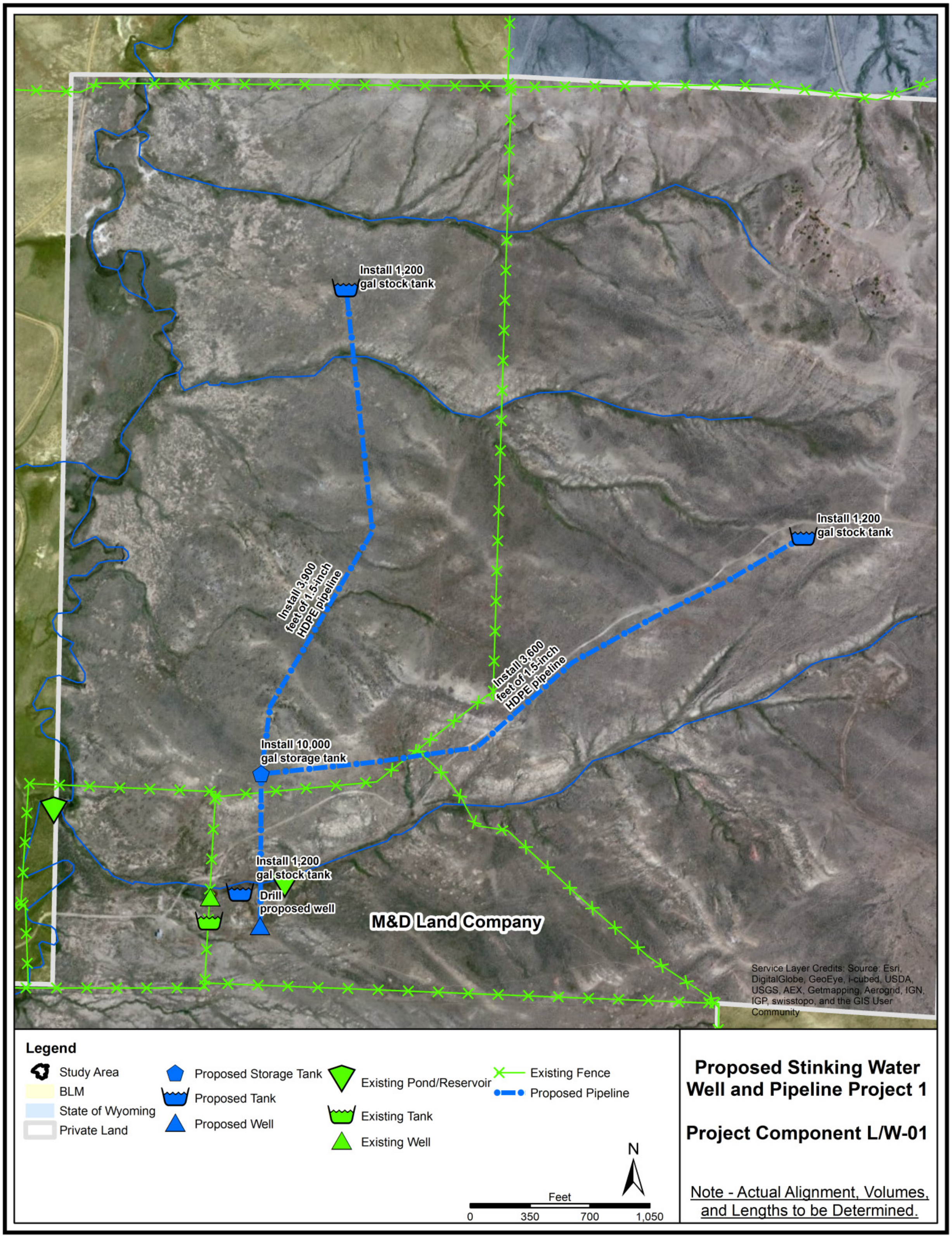

Figure 4.5. Proposed Stinking Water Well and Pipeline Project 1, Project Component L/W-01.

4.5.2.2 L/W-01A: Stinking Water 1 Stock Reservoir/Wetland Rehabilitation

This alternative would involve the rehabilitation of a stock reservoir and associated riparian wetlands. Currently, the landowner has an existing stock reservoir, embankment, and diversion ditch located in Section 20 of Township 33 North, Range 86 West in Natrona County. The diversion ditch inefficiently supplies water to a small irrigated pasture. In addition to the development of livestock and wildlife upland water sources described in the *L/W-01: Stinking Water 1 Well and Pipeline Project*, this alternative as shown in Figure 4.6 would provide for installing a drop inlet and outlet pipe structure in the reservoir embankment and stabilizing the installed structures with rock riprap. This project would entail inspecting the embankment and making repairs as needed; removing sediment; and installing a drop inlet, outlet pipe structure, and rock riprap stabilization. As delineated, the project involves privately owned lands only.

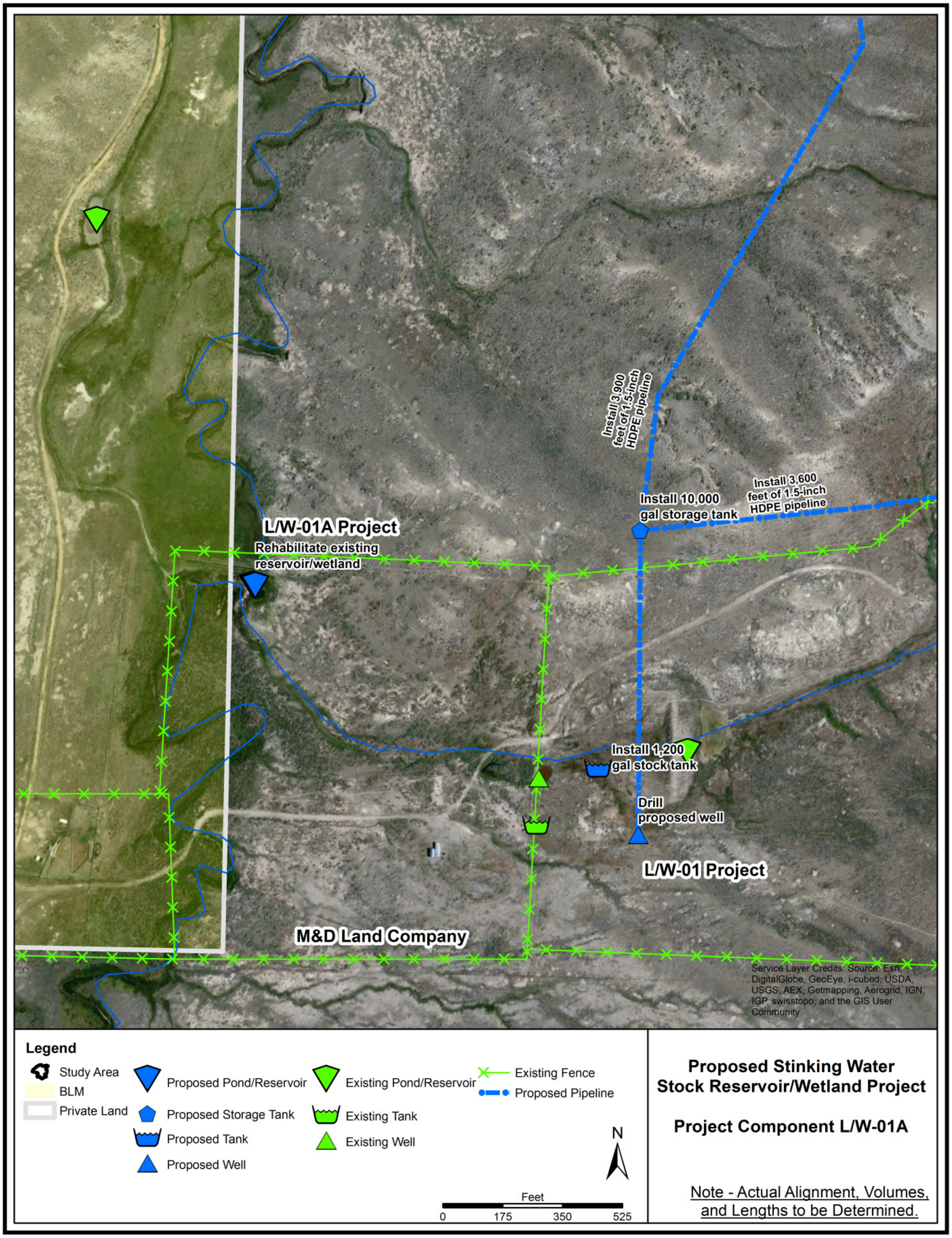

Figure 4.6. Proposed Stinking Water Stock Reservoir/Wetland Project, Project Component L/W-01A.

4.5.2.3 L/W-02: Middle Fork 2 Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.7 would be installed:

- A new well would be drilled to supply water. The well would be equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, two buried HDPE low-pressure pipelines would be installed.
- One pipeline would be aligned northeasterly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 1,900 linear feet of 1½-inch pipeline.
- The other pipeline would be installed easterly from the well and pump to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 2,500 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

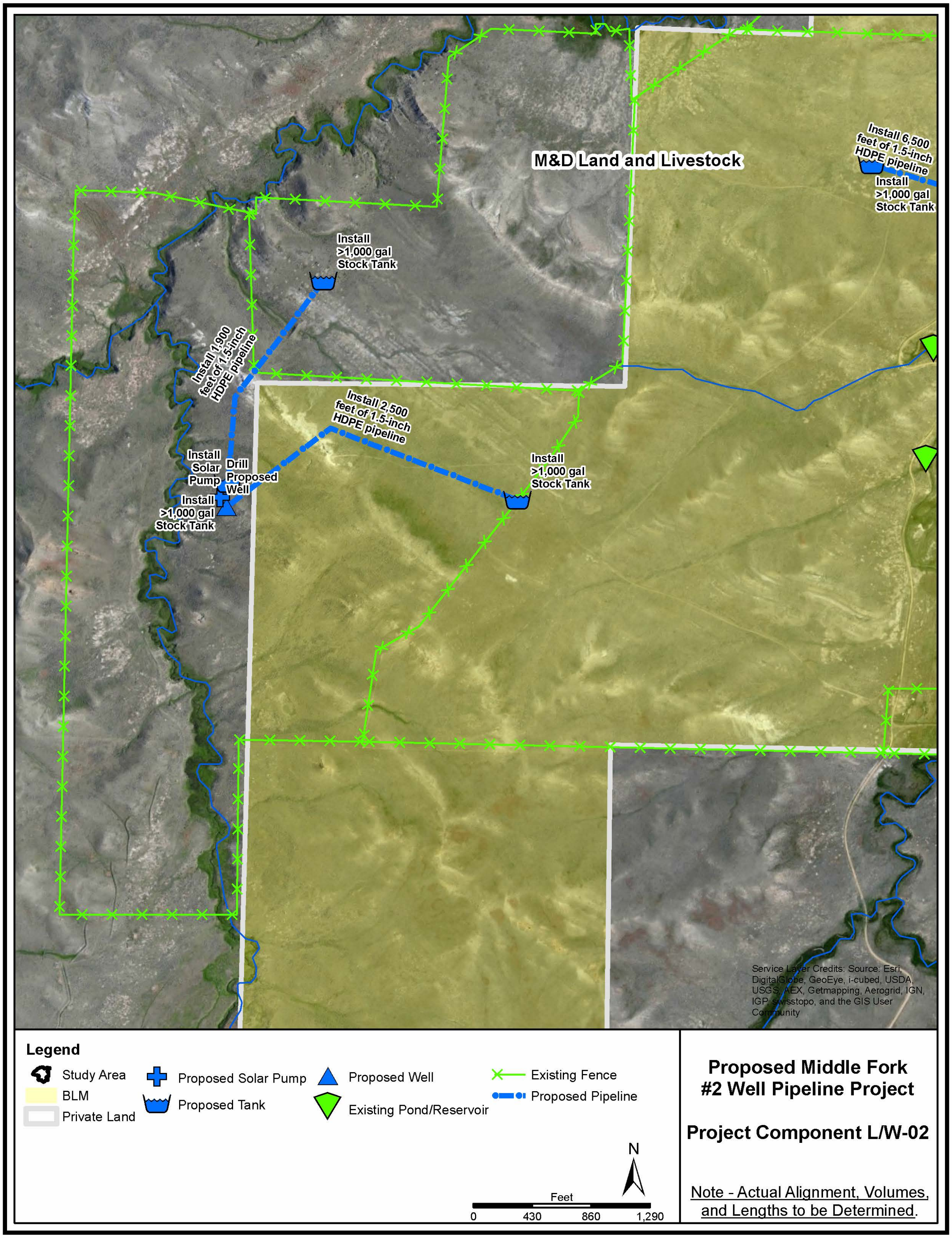

Figure 4.7. Proposed Middle Fork #2 Well Pipeline Project, Project Component L/W-02.

4.5.2.4 L/W-03: Middle Fork 3 Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.8 would be installed:

- A new well would be drilled to supply water and equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline and an aboveground HDPE pipeline would be installed.
- The pipeline would be aligned easterly to supply three stock tanks (1,200-gallon capacity each). This pipeline would require installing 7,500 linear feet of 1½-inch pipeline.
- The other pipeline would be installed aboveground from the third stock tank to supply a fourth stock tank (1,200-gallon capacity). This pipeline would require installing approximately 4,900 of aboveground pipe because of two existing buried energy supply pipelines.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

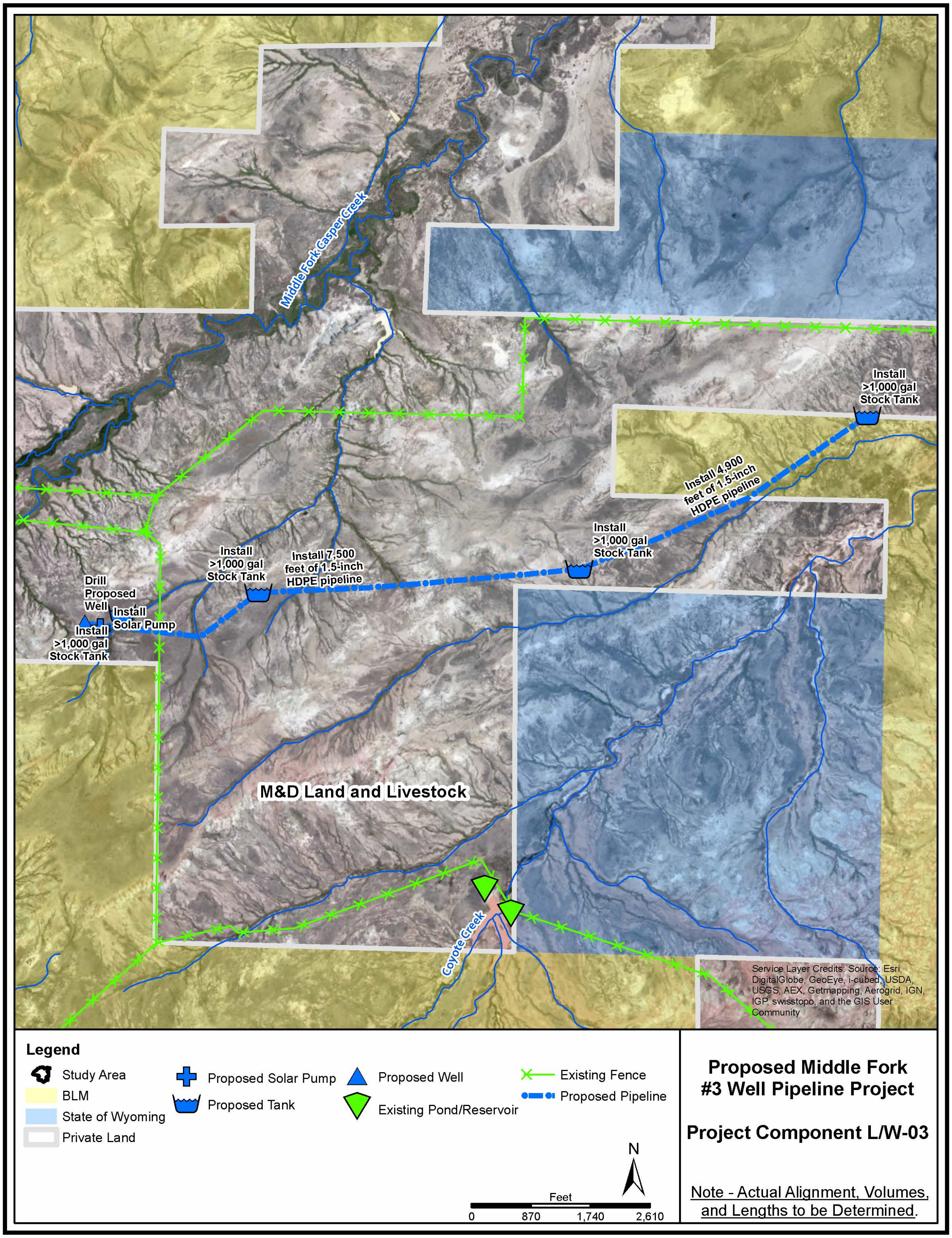

Figure 4.8. Proposed Middle Fork #3 Well Pipeline Project, Project Component L/W-03.

4.5.2.5 L/W-3A: Middle Fork 3A Spring Rehabilitation and Pipeline Project

This alternative would involve rehabilitating an existing spring development and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.9 would be installed:

- The existing spring would be rehabilitated.
- From the rehabilitated existing spring, a buried HDPE low-pressure pipeline would be installed.
- One pipeline would be installed northwesterly from the spring to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 2,100 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

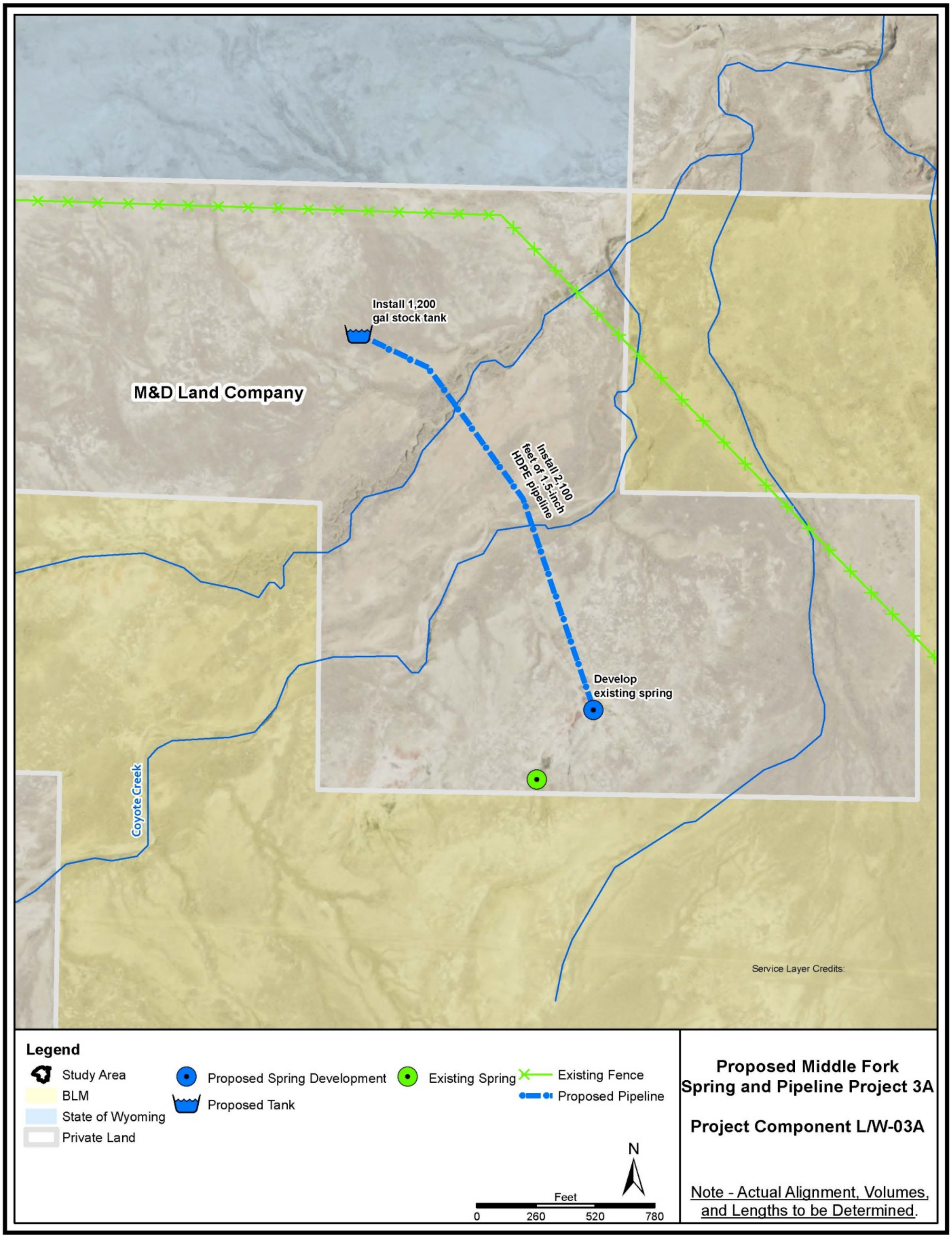

Figure 4.9. Proposed Middle Fork Spring and Pipeline Project 3A, Project Component L/W-03A.

4.5.2.6 L/W-3B: Middle Fork 3B Spring Rehabilitation and Pipeline Project

This alternative would involve rehabilitating an existing spring development and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.10 would be installed:

- The existing spring would be rehabilitated.
- From the rehabilitated existing spring, a buried HDPE low-pressure pipeline would be installed.
- One pipeline would be installed northwesterly from the spring to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 2,100 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

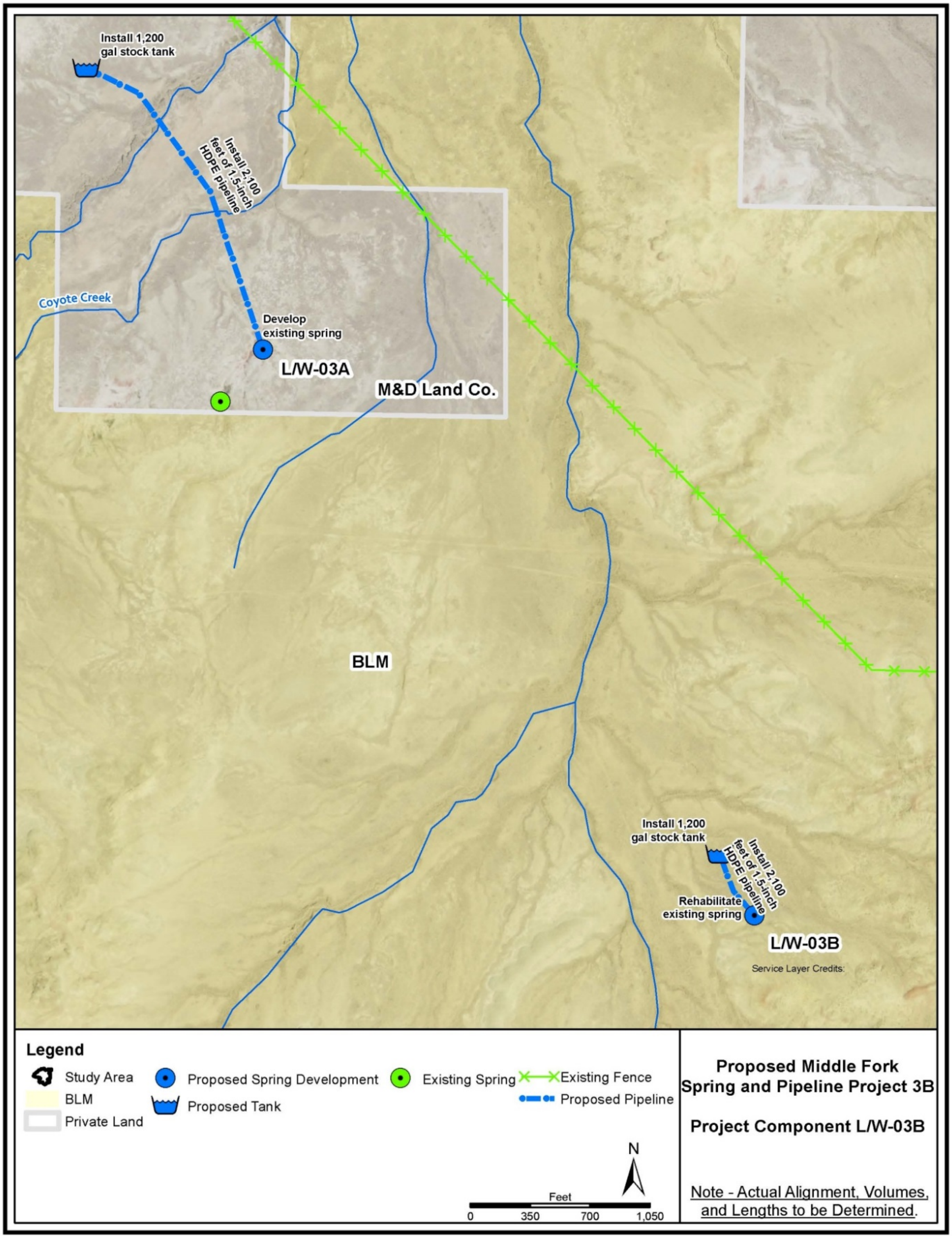

Figure 4.10. Proposed Middle Fork Spring and Pipeline Project 3B, Project Component L/W-03B.

4.5.2.7 L/W-04: Middle Fork 4 Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.11 would be installed:

- A new well would be drilled to supply water and be equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, two buried HDPE low-pressure pipelines would be installed.
- One pipeline would be aligned westerly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 4,500 linear feet of 1½-inch pipeline.
- The other pipeline would be installed easterly-northeasterly from the well and pump to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 4,800 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

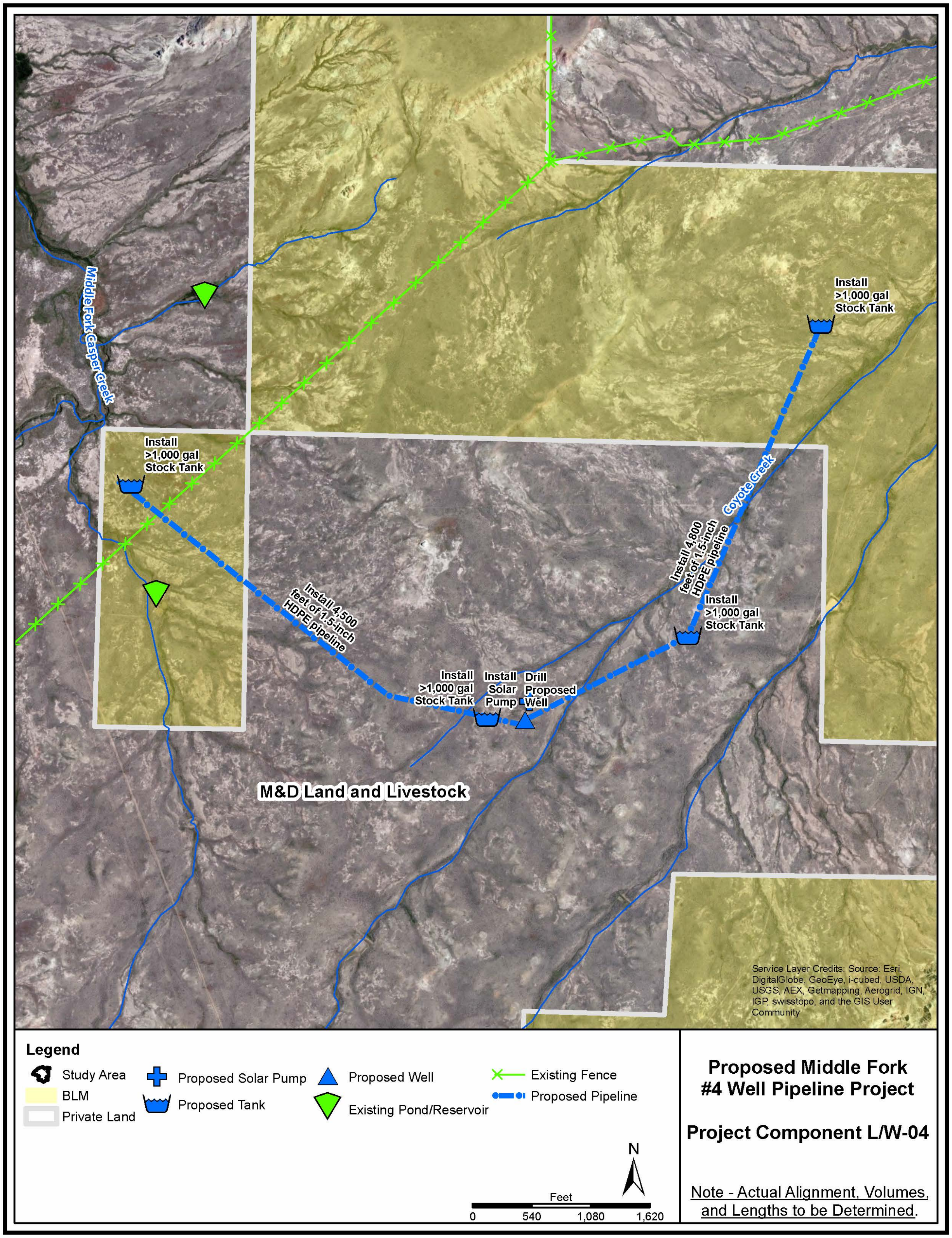

Figure 4.11. Proposed Middle Fork #4 Well Pipeline Project, Project Component L/W-04.

4.5.2.8 L/W-4A: Middle Fork 4A Pipeline and Tank Project

This alternative would involve supplying water from an existing well to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.12 would be installed:

- From an existing well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be installed southwesterly from the well and pump to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 5,600 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

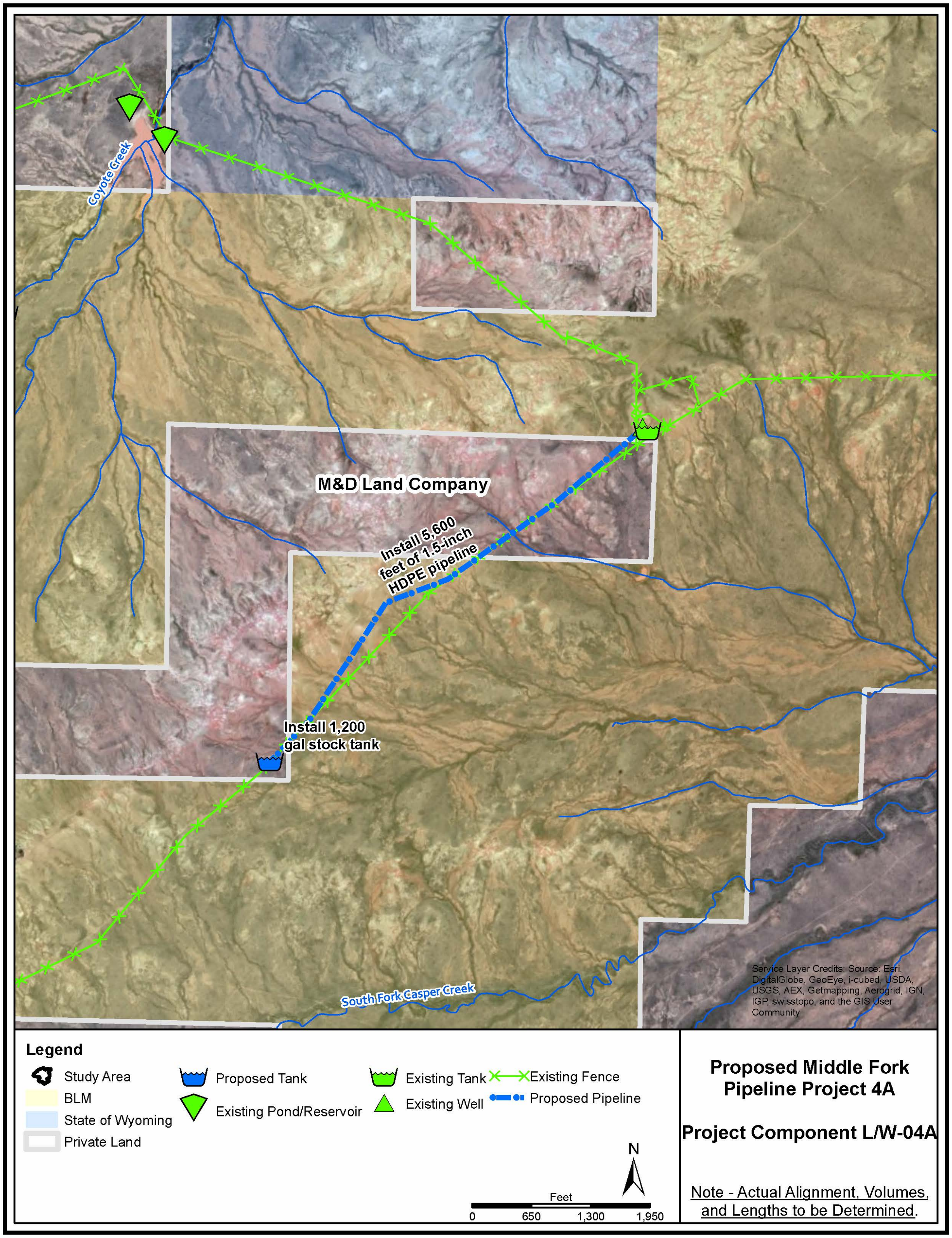

Figure 4.12. Proposed Middle Fork Pipeline Project 4A, Project Component L/W-04A.

4.5.2.9 L/W-05: Middle Fork 5 Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.13 would be installed:

- A new well would be drilled to supply water and equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be installed northeasterly from the well and pump to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 4,800 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

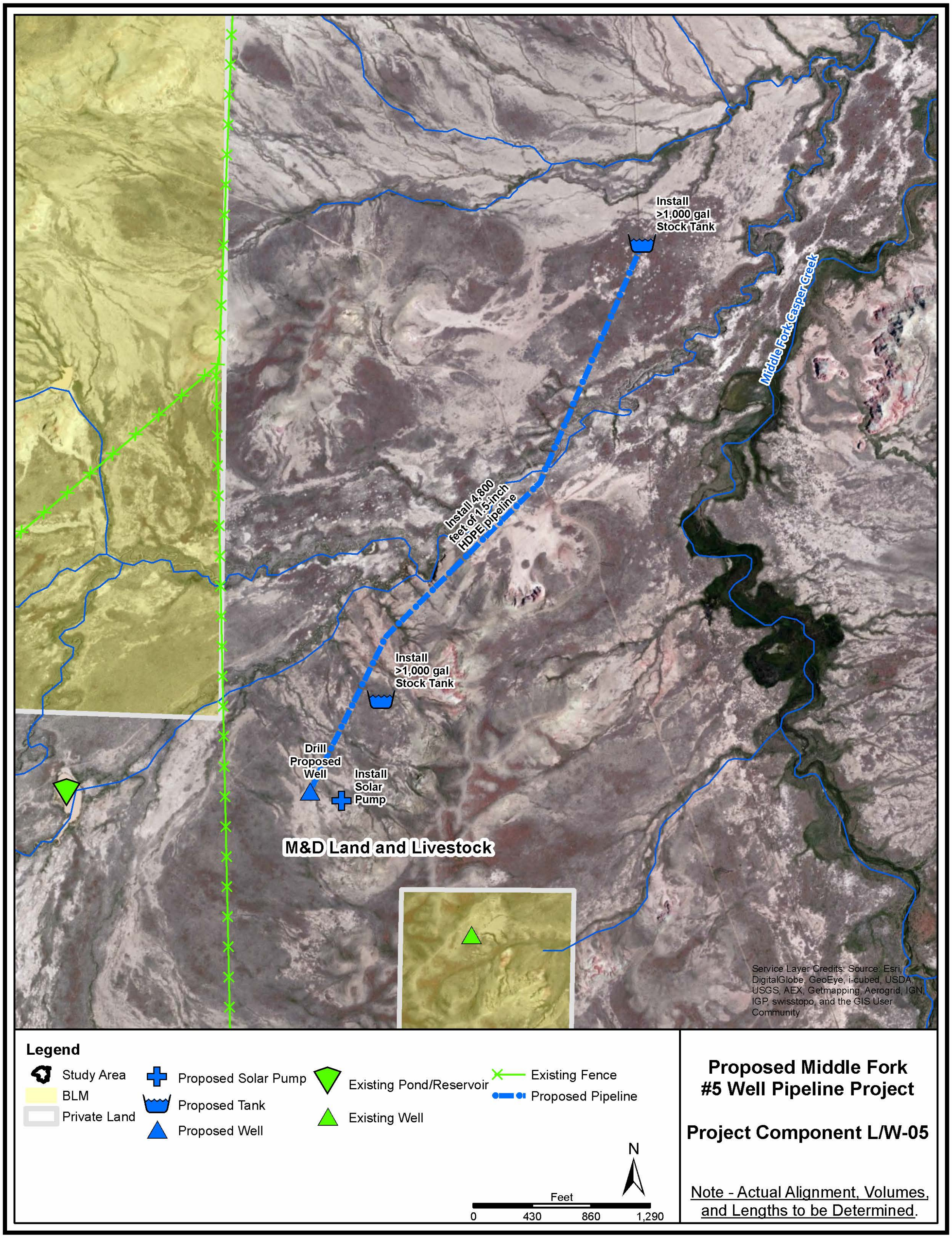

Figure 4.13. Proposed Middle Fork #5 Well Pipeline Project, Project Component L/W-05.

4.5.2.10 L/W-06: Shirley Ridge 1 Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.14 would be installed:

- A new well would be drilled to supply water and equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the storage tank, three buried HDPE low-pressure pipelines would be installed.
- One pipeline would be aligned east to the top of the ridge to supply a stock tank (1,200-gallon capacity) and a storage tank (~10,000-gallon capacity).
- The other two pipelines would require installing approximately 7,500 linear feet of 1½-inch pipeline from the storage tank to two stock tanks (1,200-gallon capacity each).
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

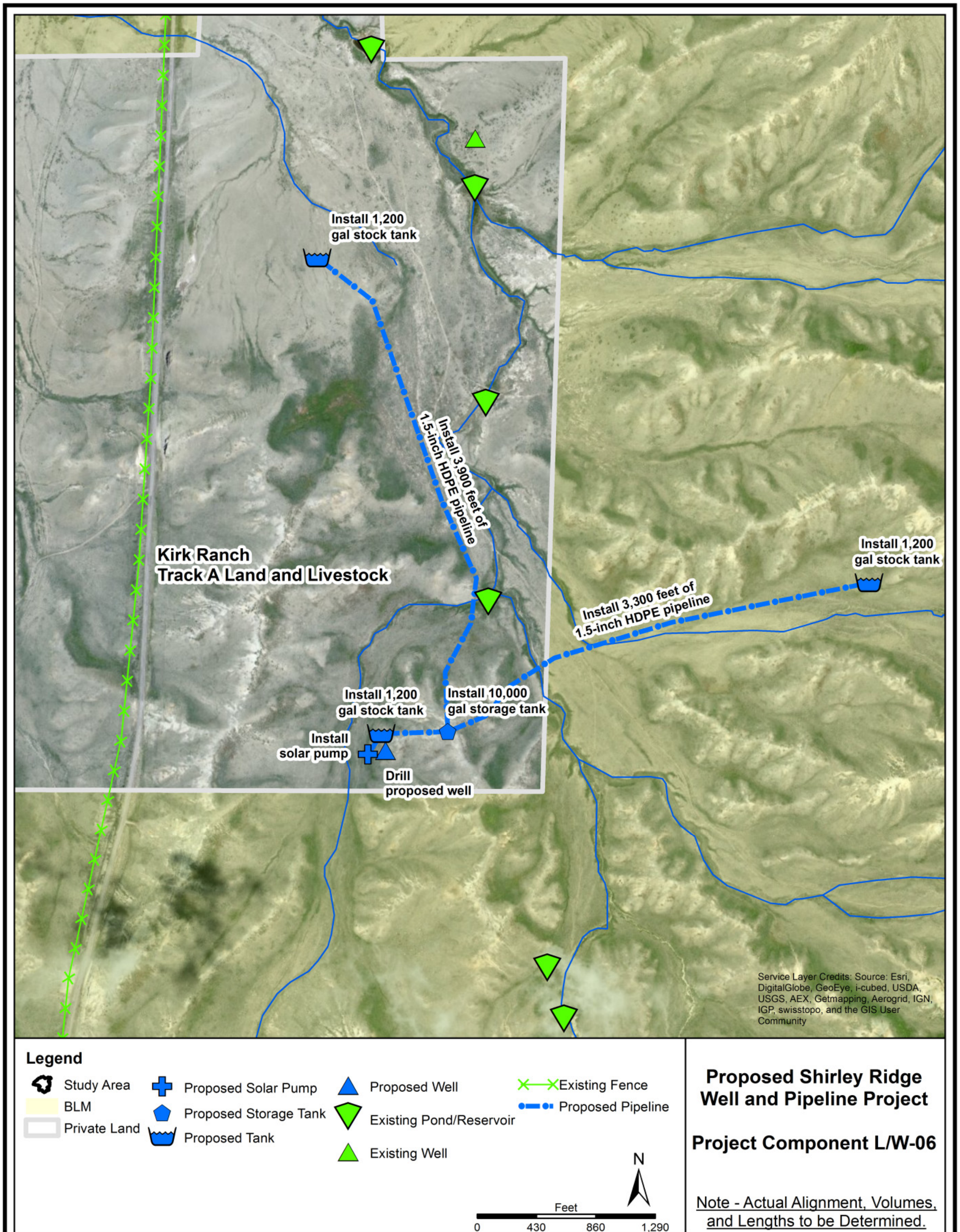

Figure 4.14. Proposed Shirley Ridge Well and Pipeline Project, Project Component L/W-06.

4.5.2.11 L/W-07: Shirley Ridge 2 Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.15 would be installed:

- A new well would be drilled to supply water and equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be installed north from the well and pump to supply three stock tanks (1,200-gallon capacity each). This pipeline would require installing 4,700 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

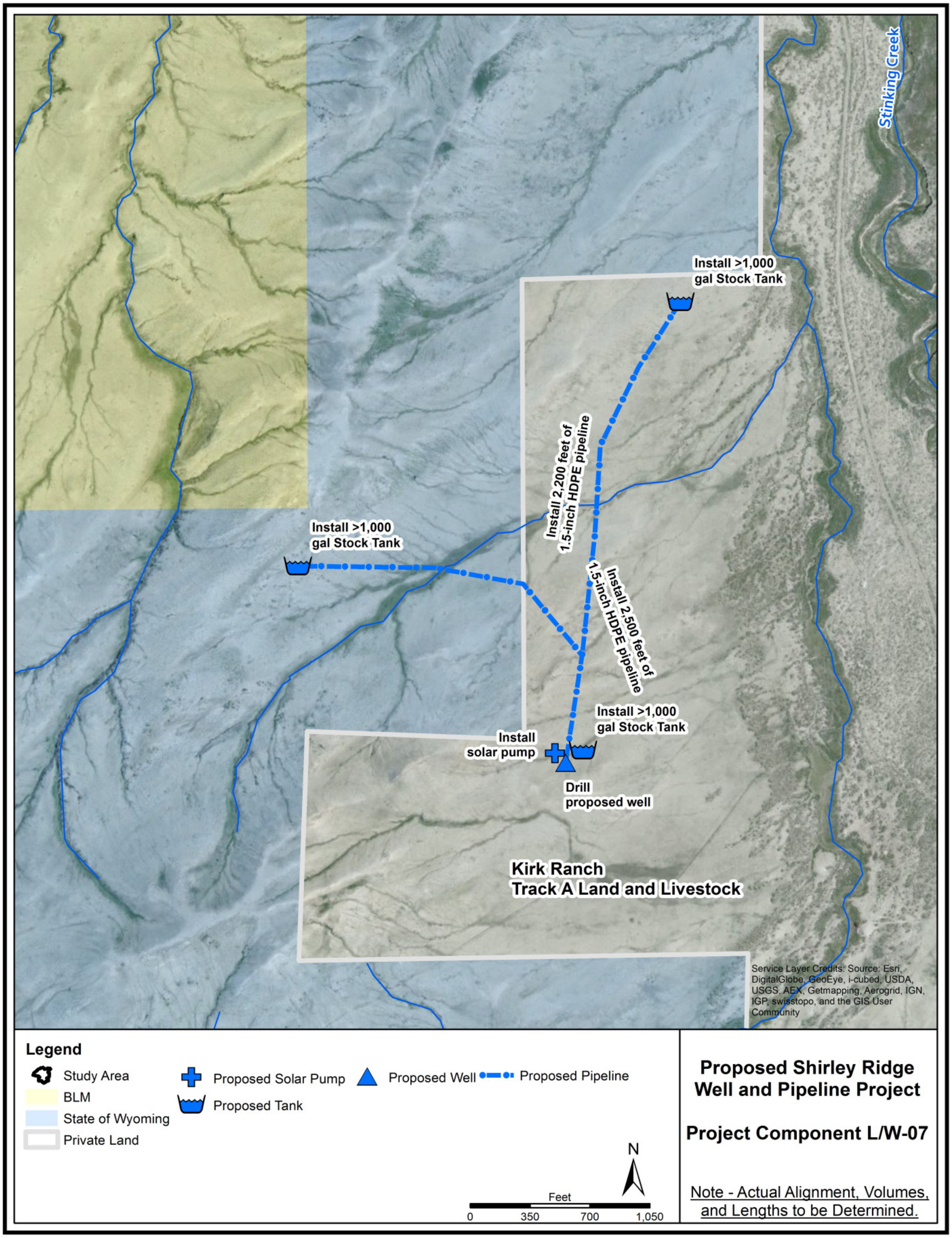

Figure 4.15. Proposed Shirley Ridge Well and Pipeline Project, Project Component L/W-07.

4.5.2.12 L/W-08: Shirley Ridge 3 Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.16 would be installed:

- A new well would be drilled to supply water and equipped with a solar platform consisting of solar panels; solar powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be installed northwesterly from the well and pump to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 4,400 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

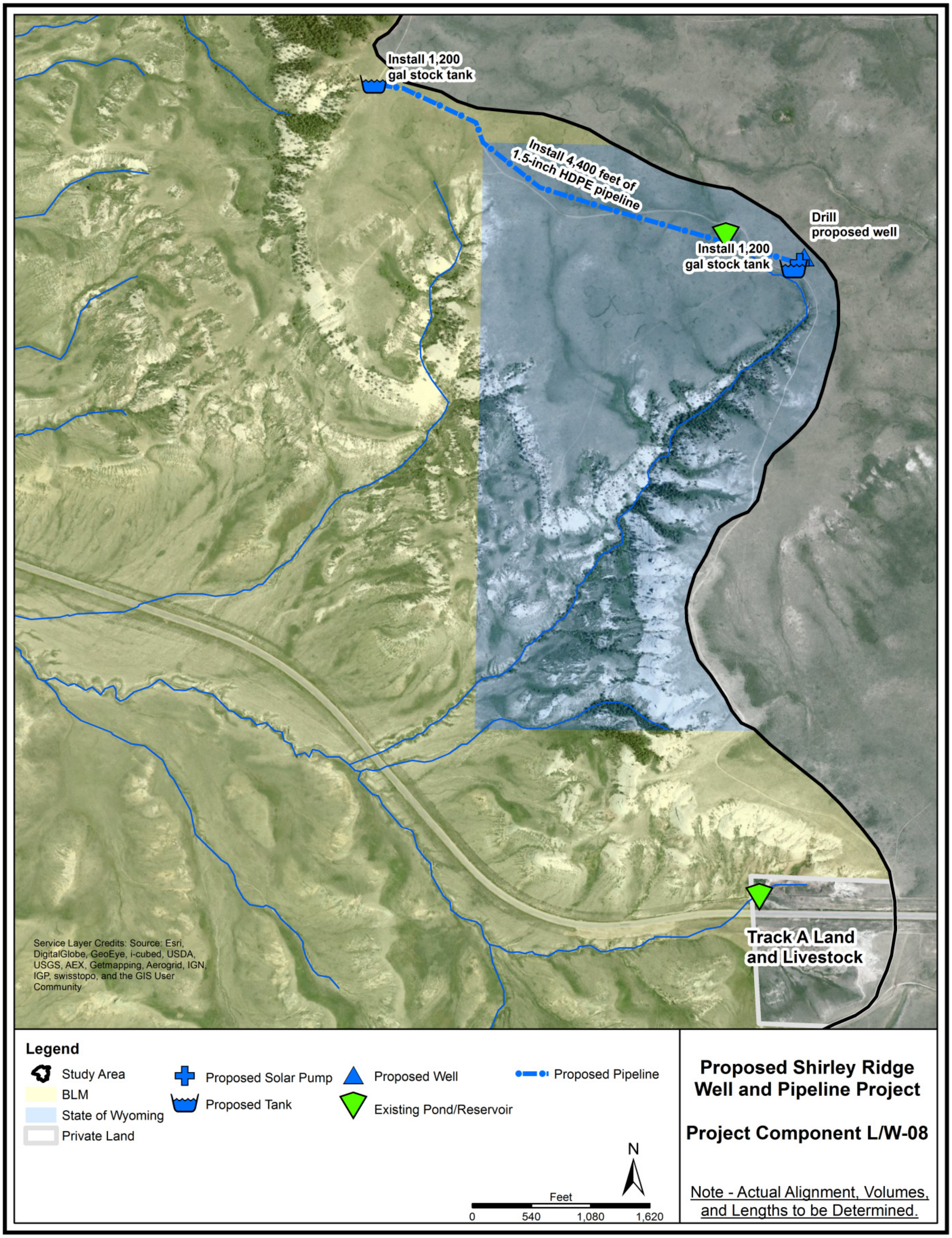

Figure 4.16. Proposed Shirley Ridge Well and Pipeline Project, Project Component L/W-08.

4.5.2.13 L/W-09: Shirley Ridge 4 Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.17 would be installed:

- A new well would be drilled to supply water and equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be installed northeasterly from the well and pump to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 4,000 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

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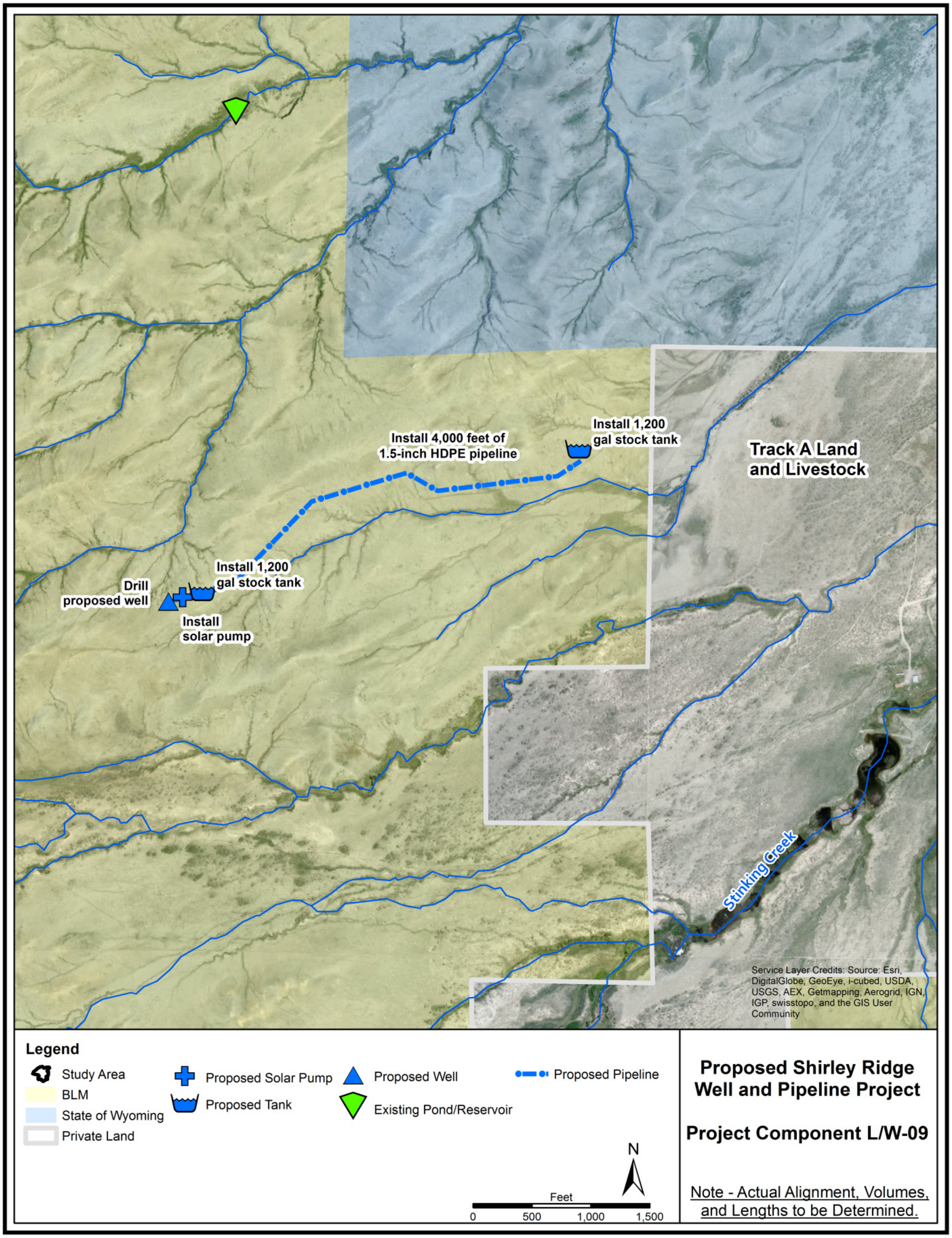

Figure 4.17. Proposed Shirley Ridge Well and Pipeline Project, Project Component L/W-09.

4.5.2.14 L/W-09A: Childers Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.18 would be installed:

- A new well would be drilled to supply water and equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, two buried HDPE low-pressure pipelines would be installed.
- One pipeline would be aligned northeasterly along the top of the ridge to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 13,200 linear feet of 1½-inch pipeline.
- The other pipeline would be aligned southeasterly and require installing approximately 5,900 linear feet of 1½-inch pipeline from the well and pump to two stock tanks (1,200-gallon capacity each).
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

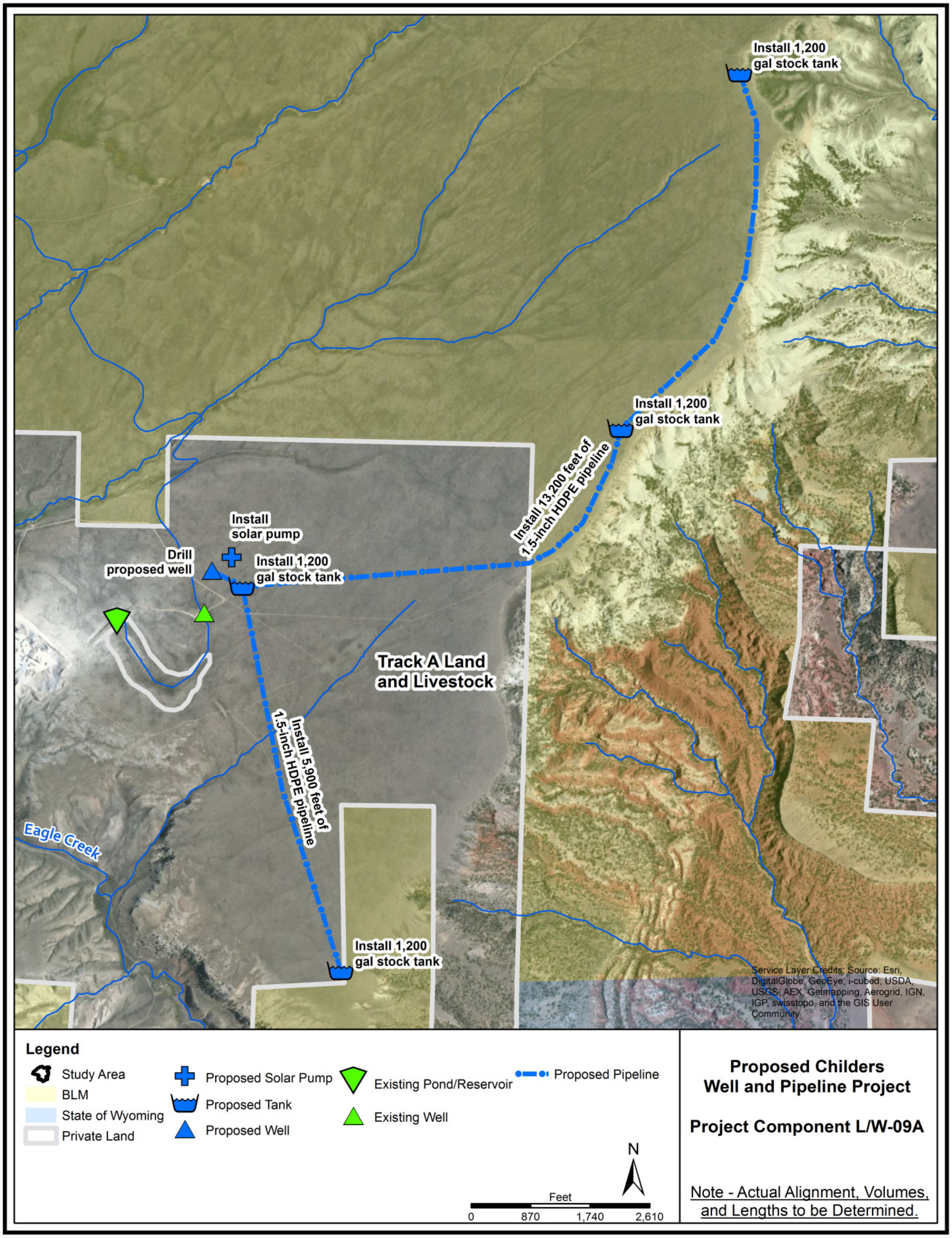

Figure 4.18. Proposed Childers Well and Pipeline Project, Project Component L/W-09A.

4.5.2.15 L/W-10: McClanahan Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.19 would be installed:

- A new well would be drilled to supply water and equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the storage tank, four buried HDPE low-pressure pipelines would be installed.
- One pipeline would be aligned northeasterly to the top of the ridge to supply a storage tank (~10,000-gallon capacity).
- Another two pipelines would require installing approximately 10,100 linear feet of 1½-inch pipeline north and northeasterly from the storage tank to three stock tanks (1,200-gallon capacity each).
- The other pipeline would require installing approximately 5,800 linear feet of 1½-inch pipeline southeasterly from the storage tank to two stock tanks (1,200-gallon capacity each).
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

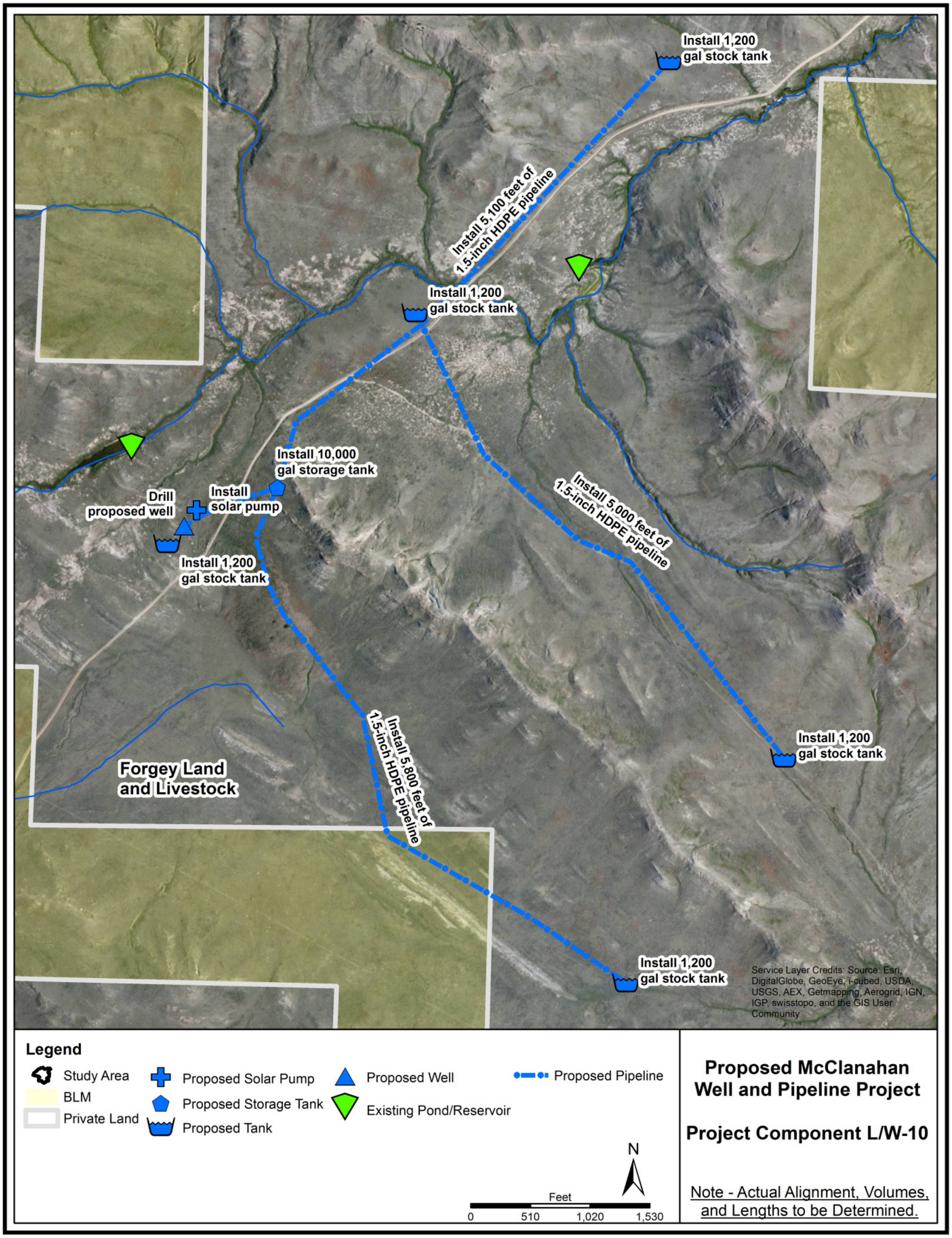

Figure 4.19. Proposed McClanahan Well and Pipeline Project, Project Component L/W-10.

4.5.2.16 L/W-11: Davidson 3 South Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.20 would be installed:

- A new well would be drilled to supply water and equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the storage tank, two buried HDPE low-pressure pipelines would be installed.
- One pipeline would be aligned west to the top of the ridge to supply a storage tank (~10,000-gallon capacity).
- From the storage tank, a pipeline would require installing approximately 4,700 linear feet of 1½-inch pipeline to a stock tank (1,200-gallon capacity).
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

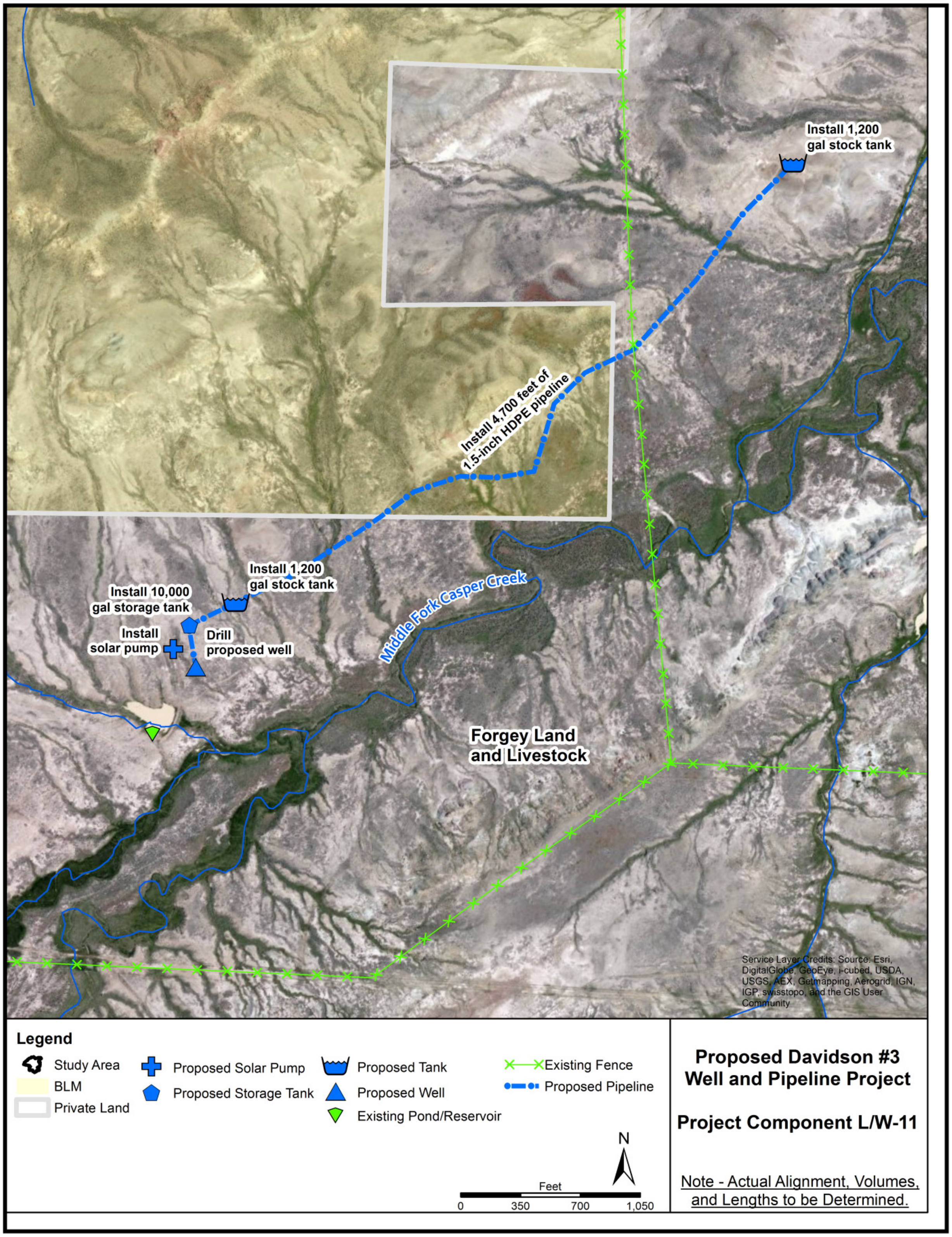

Figure 4.20. Proposed Davidson #3 Well and Pipeline Project, Project Component L/W-11.

4.5.2.17 L/W-12: Davidson 3 North Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.21 would be installed:

- A new well would be drilled to supply water and equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipelines would be installed.
- The pipeline would be installed northeasterly from the well and pump to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 4,200 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

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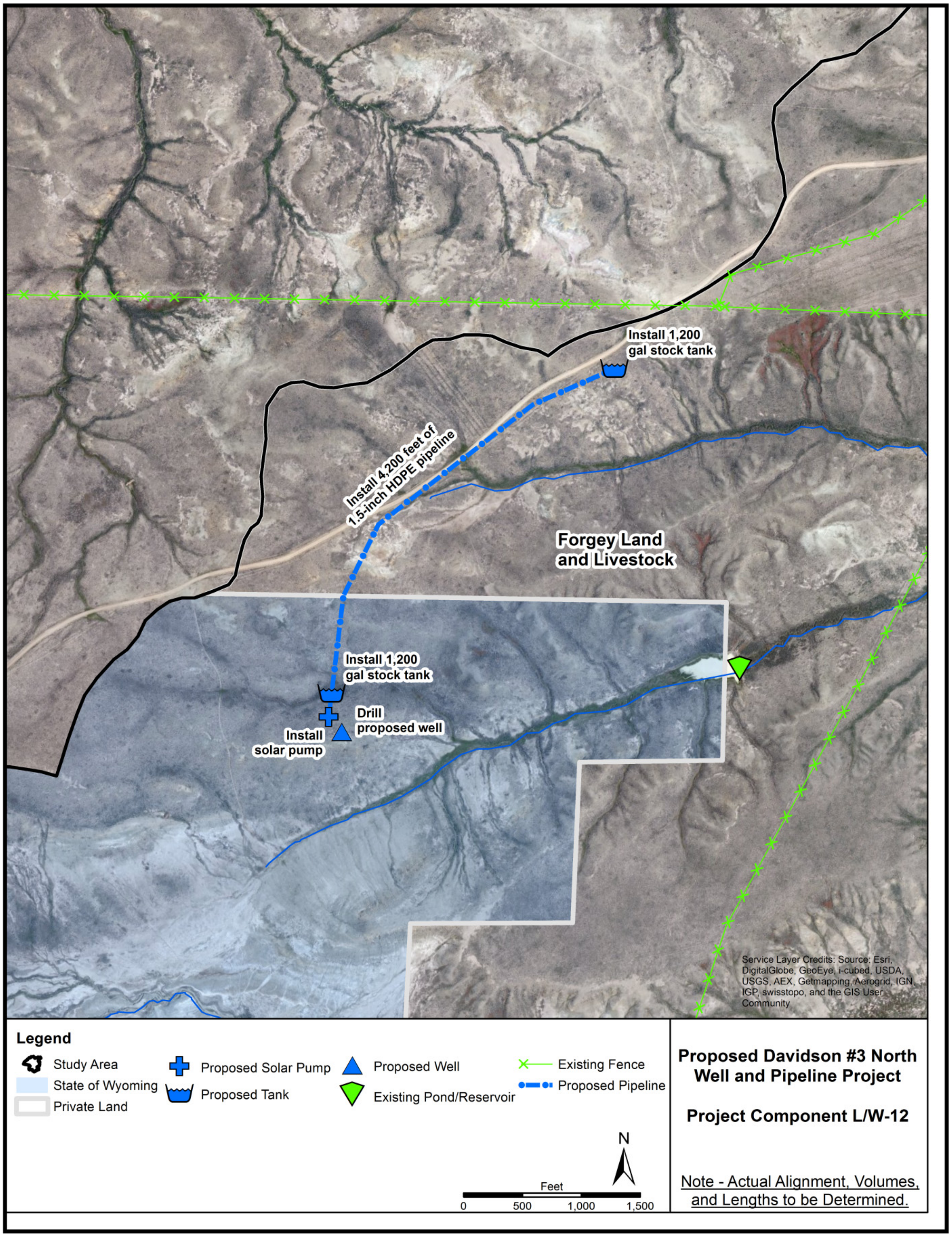

Figure 4.21. Proposed Davidson #3 North Well and Pipeline Project, Project Component L/W-12.

4.5.2.18 L/W-13: Coyote Creek Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.22 would be installed:

- A new well would be drilled to supply water and equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be installed north from the well and pump to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 5,700 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

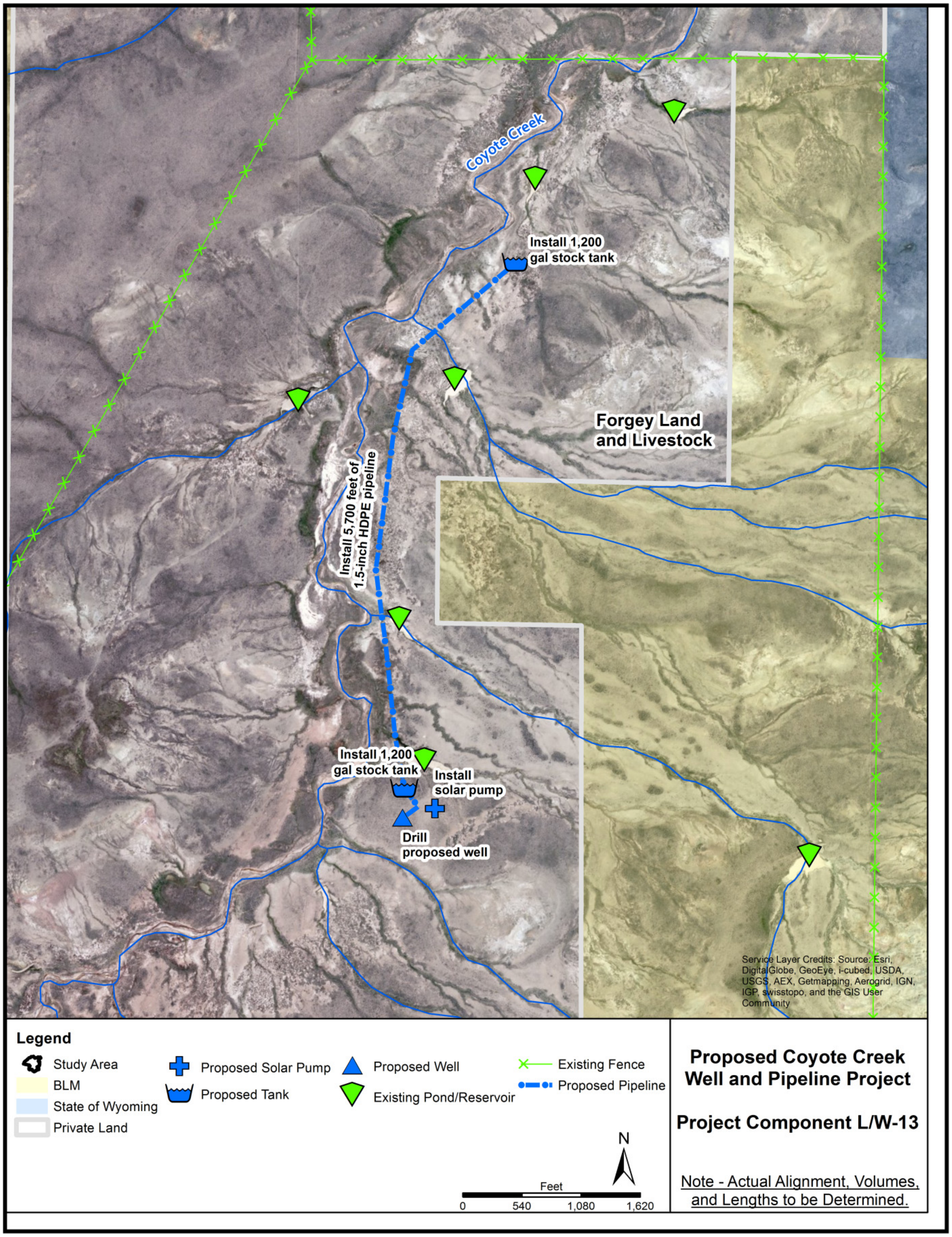

Figure 4.22. Proposed Coyote Creek Well and Pipeline Project, Project Component L/W-13.

4.5.2.19 L/W-14: Davidson 2 Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.23 would be installed:

- A new well would be drilled to supply water and equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be installed northeasterly from the well and pump to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 7,700 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

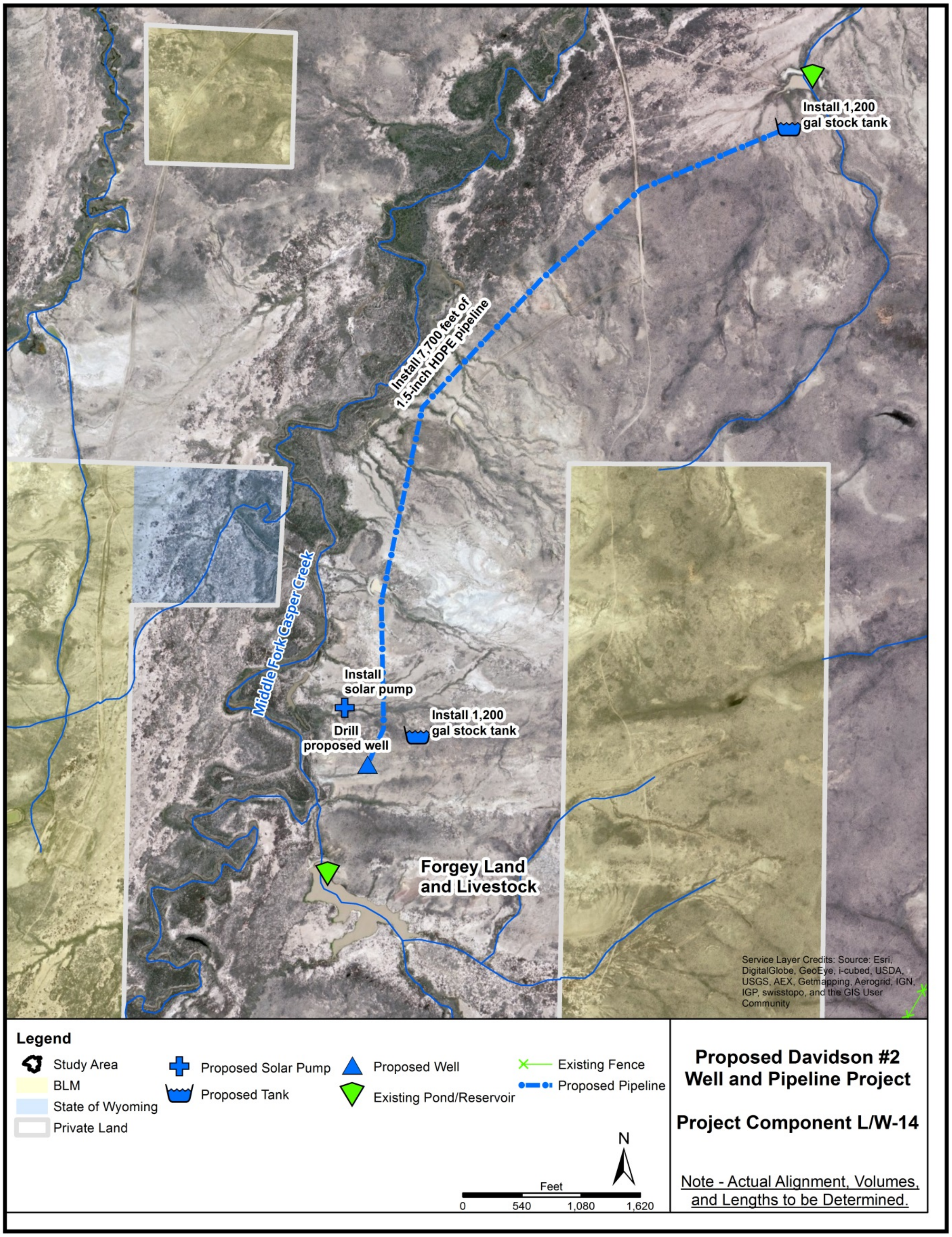

Figure 4.23. Proposed Davidson #2 Well and Pipeline Project, Project Component L/W-14.

4.5.2.20 L/W-15: Davidson South Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.24 would be installed:

- A new well would be drilled to supply water and equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be installed near the well and pump to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 400 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

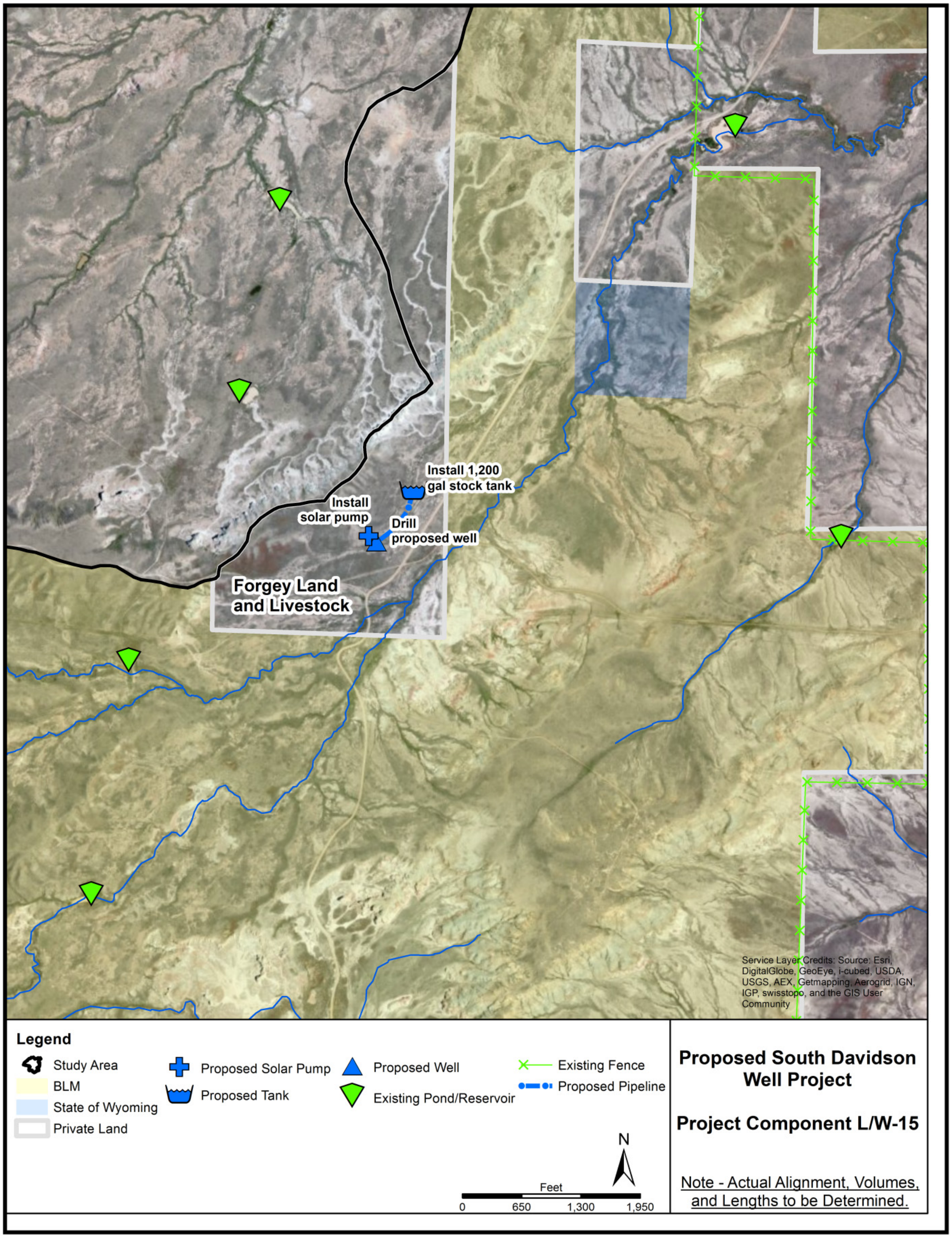

Figure 4.24. Proposed South Davidson Well Project, Project Component L/W-15.

4.5.2.21 L/W-15A: Forgey East Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.25 would be installed:

- A new well would be drilled and solar pump installed to supply water and equipped with a pump, controls, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be installed south from the well and pump to supply three stock tanks (1,200-gallon capacity each). This pipeline would require installing 15,200 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

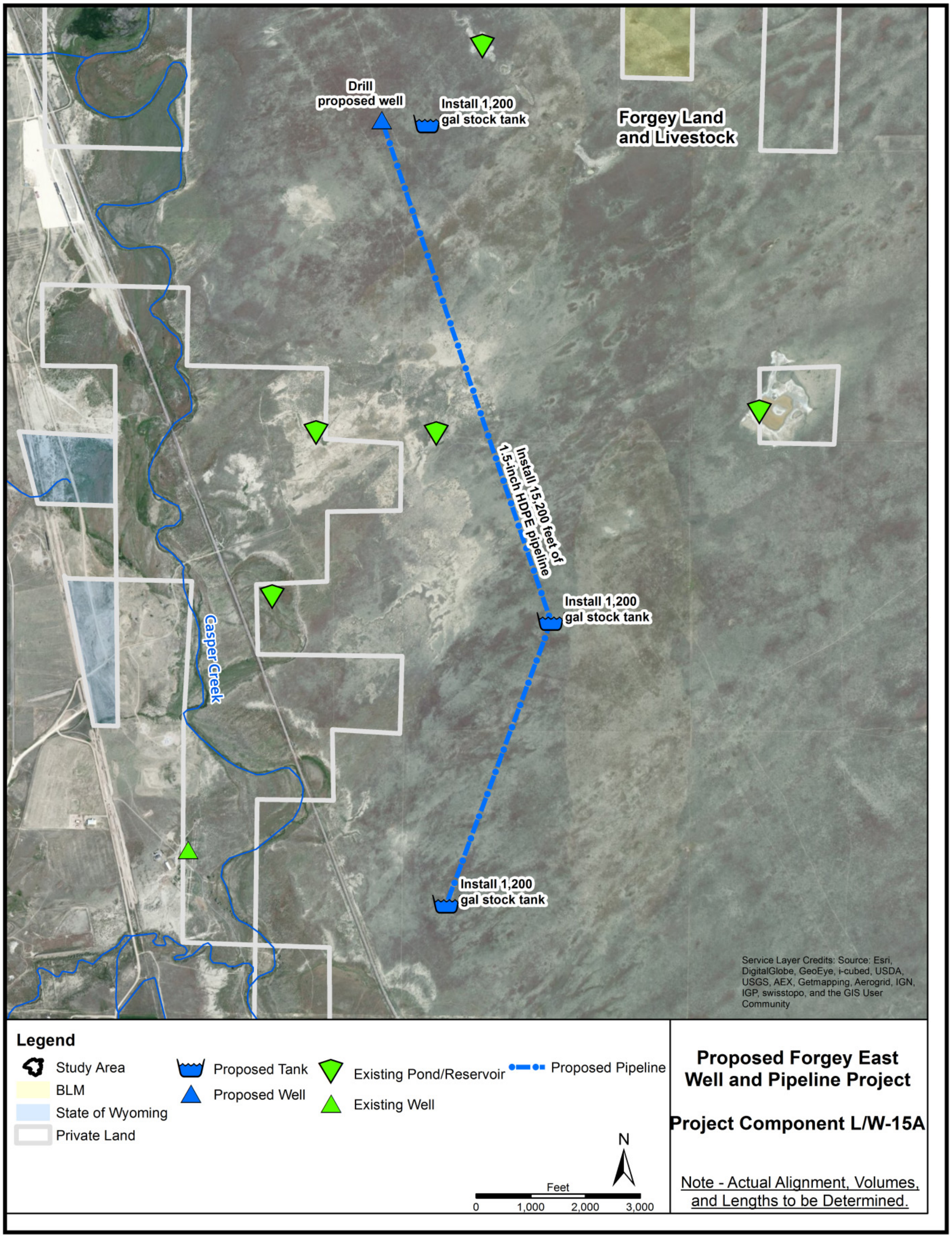

Figure 4.25. Proposed Forgey East Well and Pipeline Project, Project Component L/W-15A.

4.5.2.22 L/W-16: Strohecker 1 Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.26 would be installed:

- A new well would be drilled to supply water and equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be installed southwesterly from the well and pump to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 4,300 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

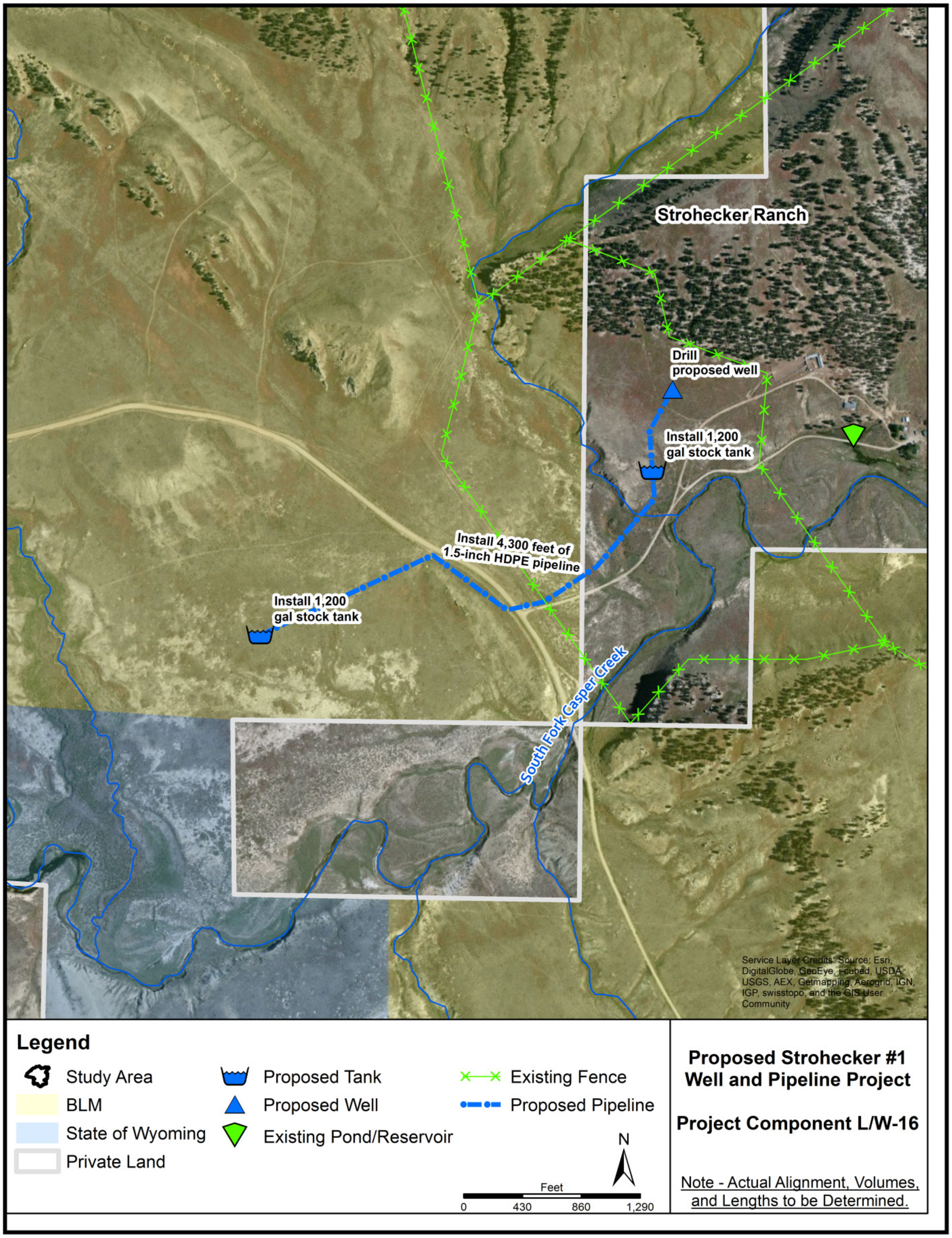

Figure 4.26. Proposed Strohecker #1 Well and Pipeline Project, Project Component L/W-16.

4.5.2.23 L/W-17: Strohecker 2 Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.27 would be installed:

- A new well would be drilled to supply water and equipped with a solar platform consisting of solar panels; solar-powered pump; batteries; and all regulators, connections, and appurtenances.
- From the storage tank, two buried HDPE low-pressure pipelines would be installed.
- One pipeline would be aligned south to the top of the ridge to supply a storage tank (~10,000-gallon capacity).
- From the storage tank, a pipeline would require installing approximately 10,000 linear feet of 1½-inch pipeline to three stock tanks (1,200-gallon capacity).
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

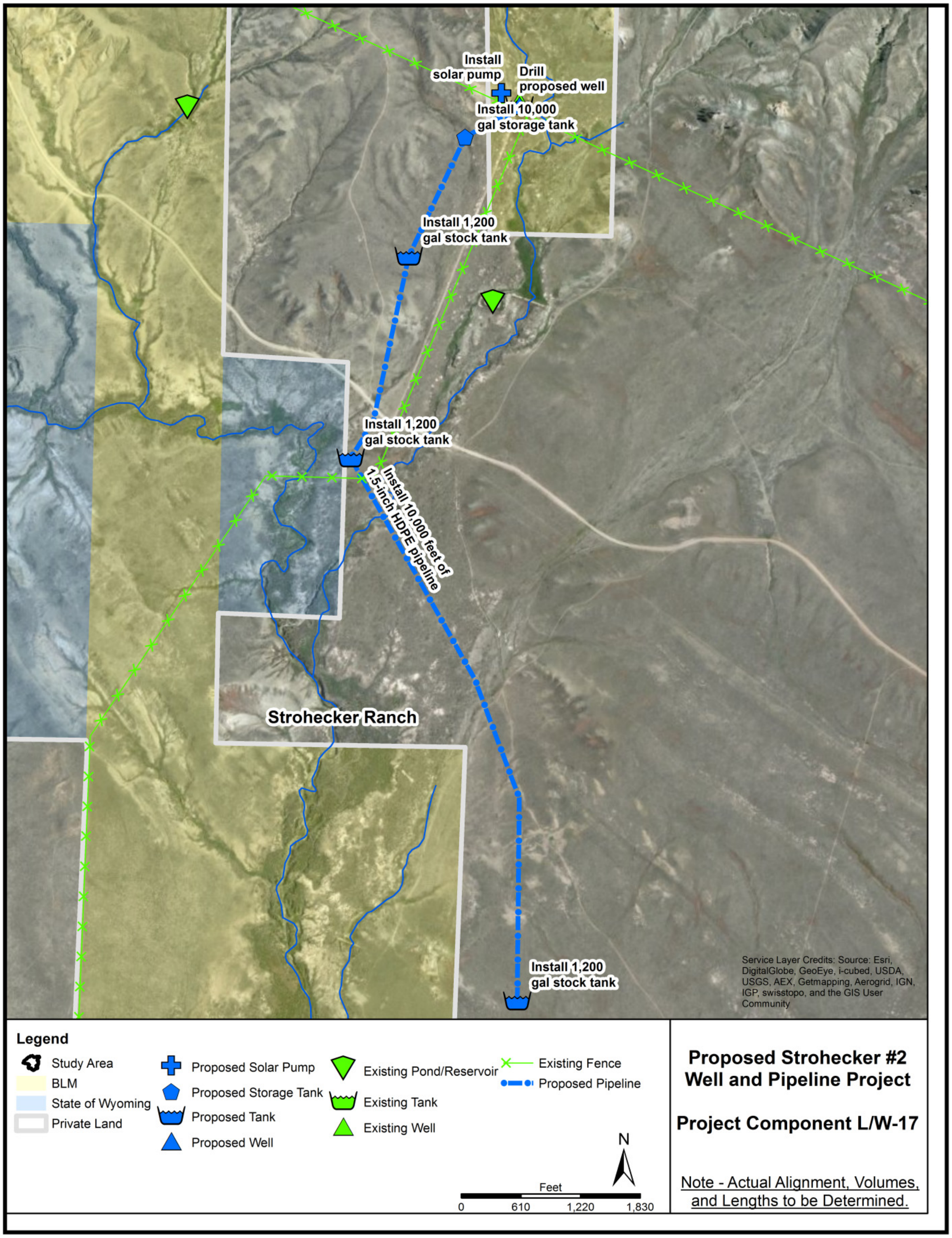

Figure 4.27. Proposed Strohecker #2 Well and Pipeline Project, Project Component L/W-17.

4.5.2.24 L/W-18: Pine Mountain Pipeline and Tank Project

This alternative would involve supplying water from an existing well to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.28 would be installed:

- From an existing well and pump, two buried HDPE low-pressure pipelines would be installed.
- One pipeline would be installed northeasterly from the well and pump to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 3,700 linear feet of 1½-inch pipeline.
- The other pipeline would be installed southeasterly from the well and pump to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 2,700 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

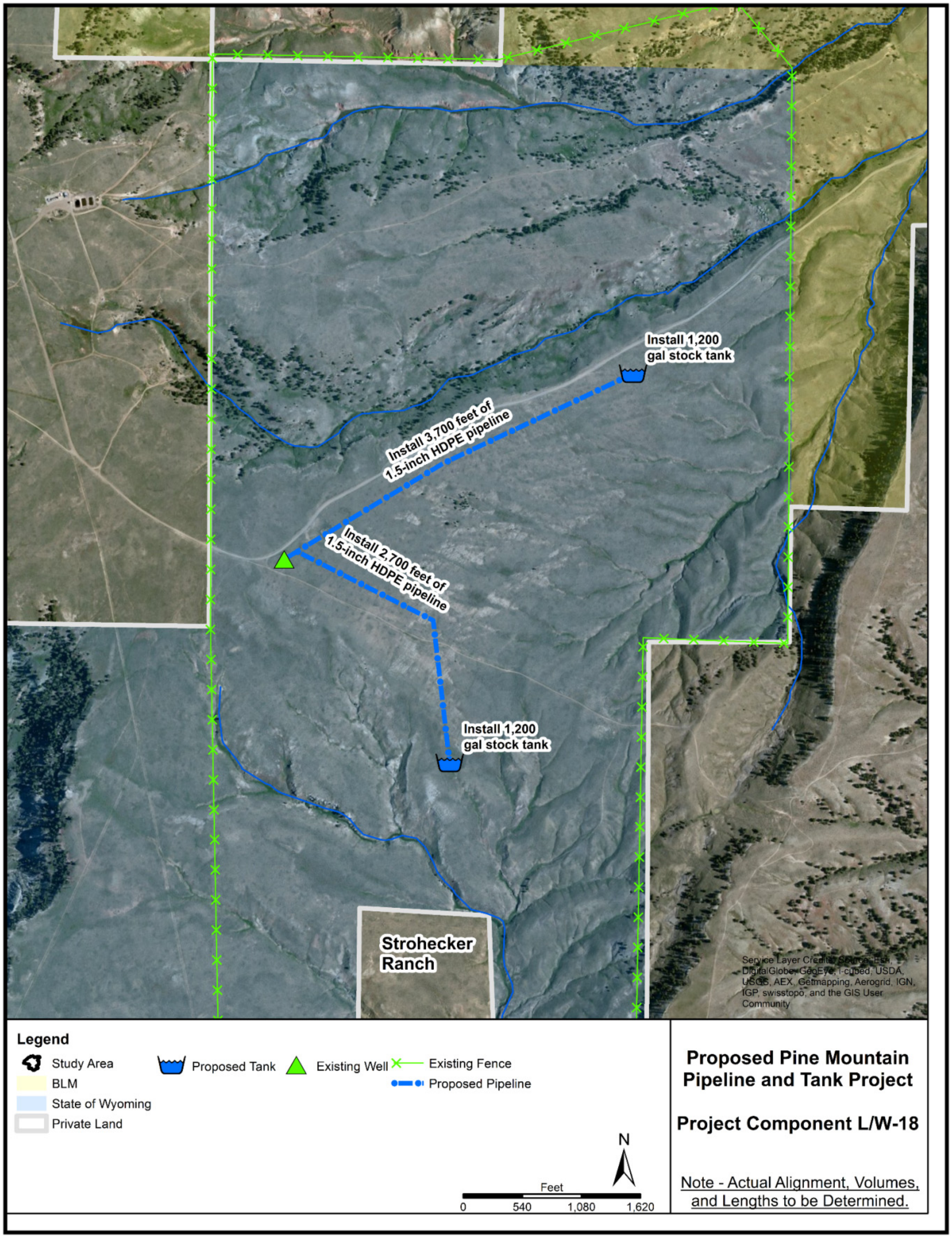

Figure 4.28. Proposed Pine Mountain Pipeline and Tank Project, Project Component L/W-18.

4.5.2.25 L/W-19: Strohecker 3 Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.29 would be installed:

- A new well would be drilled and solar pump installed to supply water and equipped with a pump, controls, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be installed south from the well and pump to supply three stock tanks (1,200-gallon capacity each). This pipeline would require installing 6,400 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.
- Rehabilitation of the stock pond/reservoir involves excavating existing sediment from the existing pond and would be sealed with agricultural grade bentonite at a rate of 4 pounds per square foot based upon NRCS guidelines. This project would entail inspecting the embankment and making necessary repairs as needed; removing sediment; and installing a drop inlet, outlet pipe structure, and rock riprap stabilization. As delineated, the project involves privately owned lands only. Several options exist to reduce seepage in small stock reservoirs, including Geotextile liners, bentonite mat liners, or placement of agricultural grade bentonite.

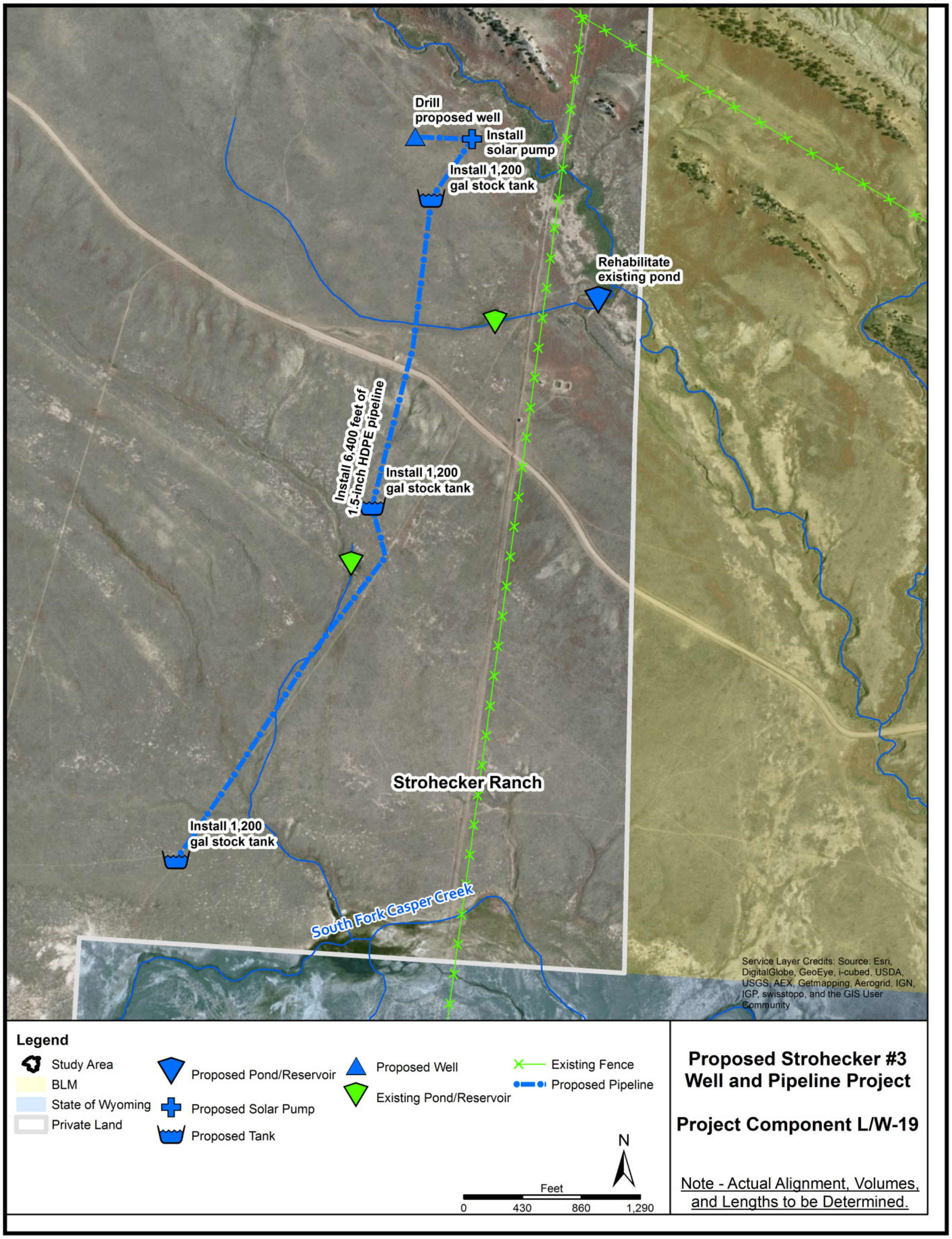

Figure 4.29. Proposed Strohecker #3 Well and Pipeline Project, Project Component L/W-19.

4.5.2.26 L/W-20: South Fork Casper Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.30 would be installed:

- A new well would be drilled and solar pump installed to supply water and equipped with a pump, controls, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be installed south from the well and pump to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 6,500 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.
- Rehabilitation of the stock pond/reservoir involves excavating existing sediment from the existing pond and would be sealed with agricultural grade bentonite at a rate of 4 pounds per square foot based upon NRCS guidelines. This project would entail inspecting the embankment and making necessary repairs as needed; removing sediment; and installing a drop inlet, outlet pipe structure, and rock riprap stabilization. As delineated, the project involves privately owned lands only. Several options exist to reduce seepage in small stock reservoirs, including Geotextile liners, bentonite mat liners, or placement of agricultural grade bentonite.

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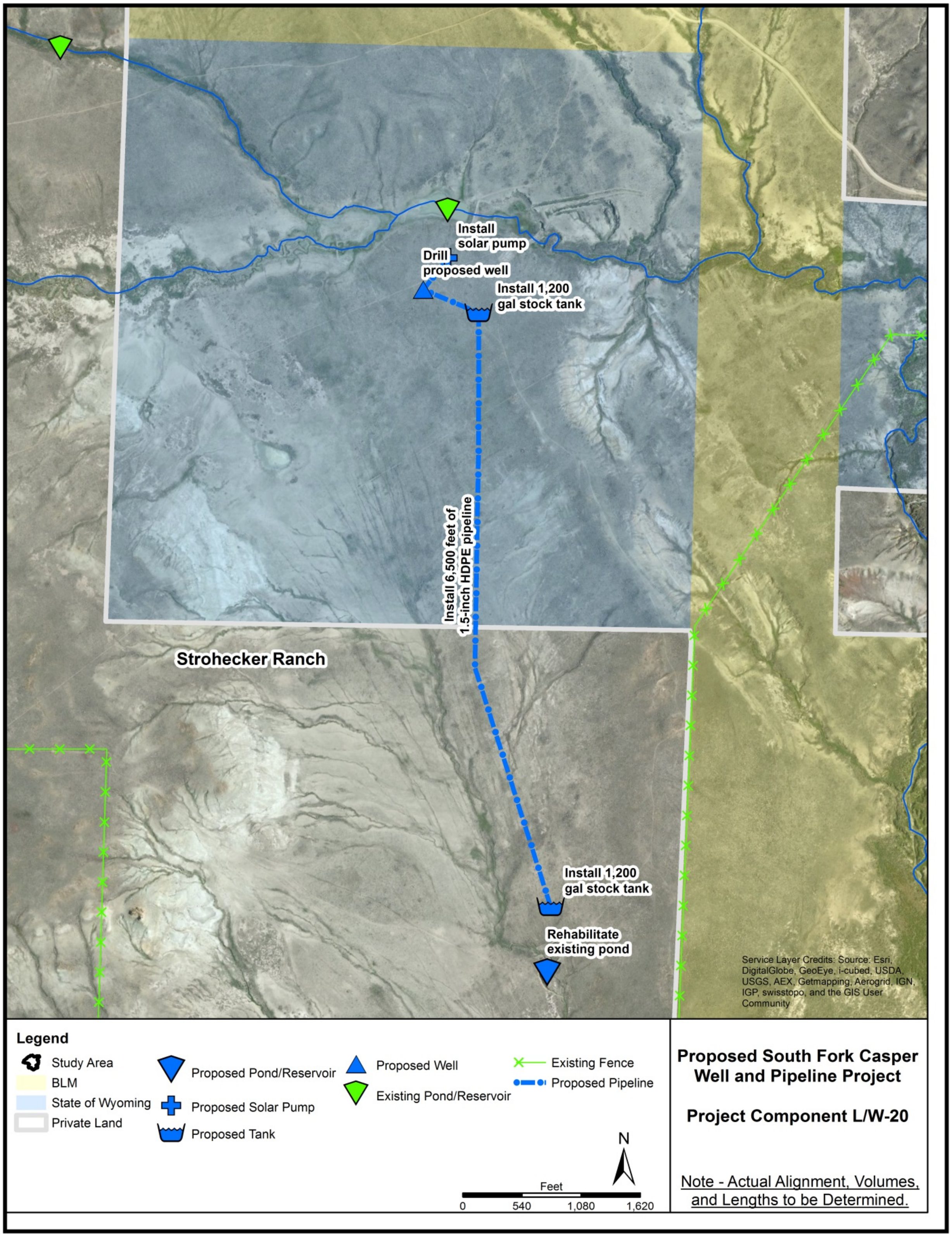

Figure 4.30. Proposed South Fork Casper Well and Pipeline Project, Project Component L/W-20.

4.5.2.27 L/W-21: Strohecker 4 Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.31 would be installed:

- A new well would be drilled and solar pump installed to supply water and equipped with a pump, controls, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be installed south from the well and pump to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 4,100 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

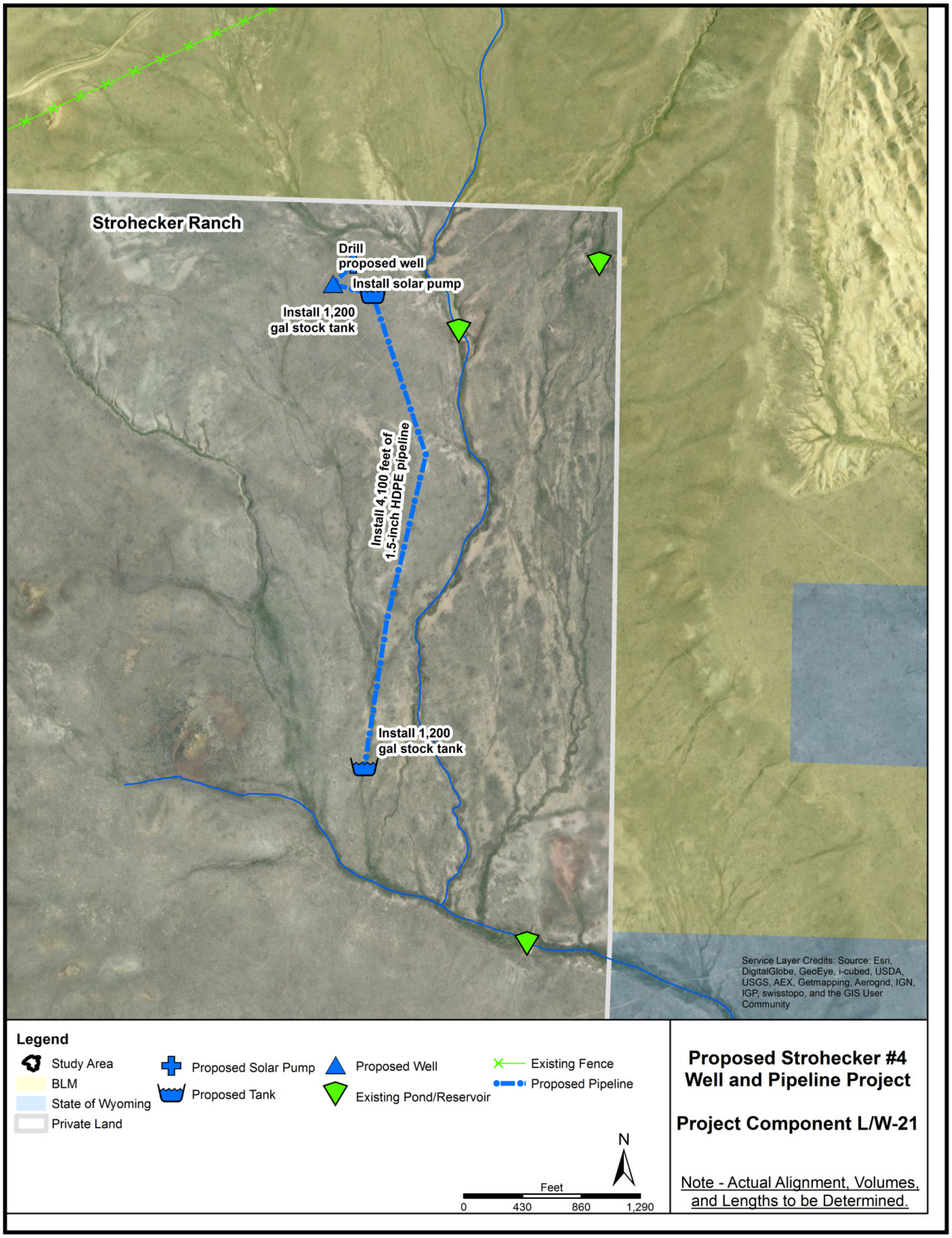

Figure 4.31. Proposed Strohecker #4 Well and Pipeline Project, Project Component L/W-21.

4.5.2.28 L/W-22: West Pine Mountain Spring Rehabilitation Project

This alternative would involve rehabilitating an existing spring development and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.32 would be installed:

- The existing spring would be rehabilitated.
- From the rehabilitated existing spring, a buried HDPE low-pressure pipeline would be installed.
- One pipeline would be installed south from the spring to supply an existing stock tank (1,200-gallon capacity). This pipeline would require installing 400 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

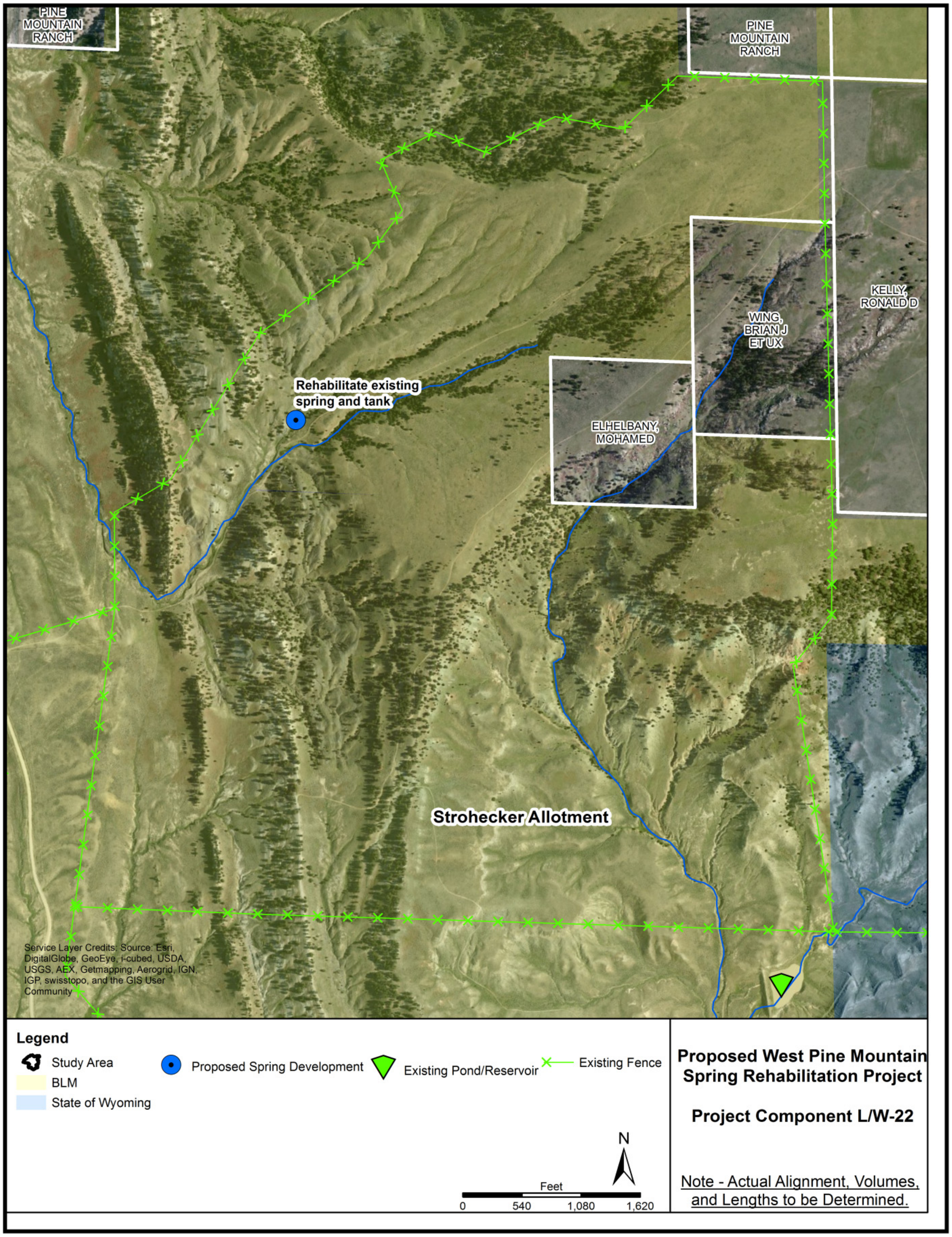

Figure 4.32. Proposed West Pine Mountain Spring Rehabilitation Project, Project Component L/W-22.

4.5.2.29 L/W-23: Strohecker 5 Well and Pipeline Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock and wildlife upland water sources. Under this alternative, the following components as shown in Figure 4.33 would be installed:

- A new well would be drilled and solar pump installed to supply water and equipped with a pump, controls, connections, and appurtenances.
- From the well and pump, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be installed south from the well and pump to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 6,400 linear feet of 1½-inch pipeline.
- Required valves, fittings, and appurtenances would be incorporated to facilitate management of flow, pressure, and water level.
- Wildlife escape ramps would be installed in all of the proposed stock tanks.

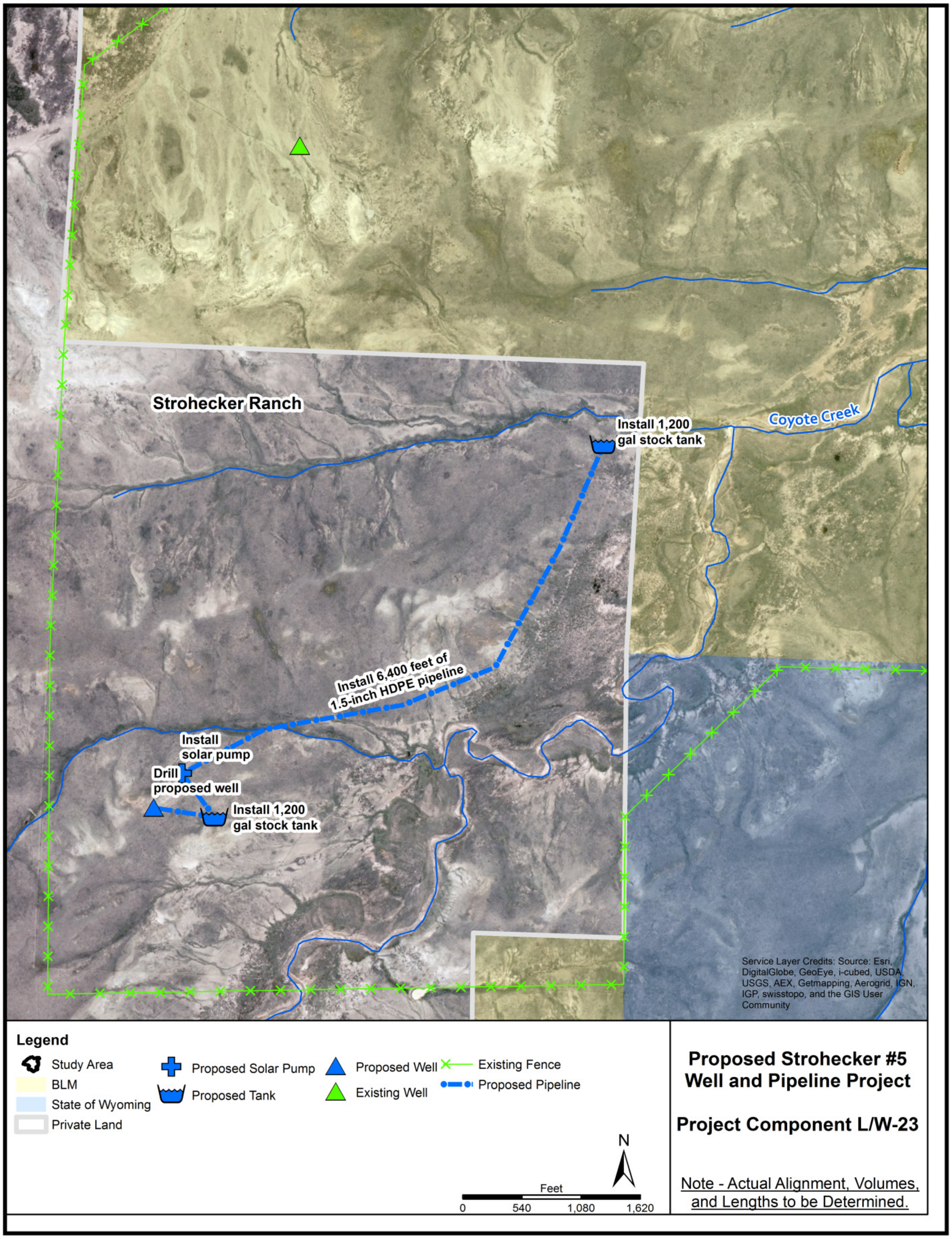

Figure 4.33. Proposed Strohecker #5 Well and Pipeline Project, Project Component L/W-23.

4.5.2.30 Natrona County Conservation District Project Recommendations LW-24 through LW-59

In addition to the 29 upland livestock/wildlife water developments described in Section 4.5.2.1 through Section 4.5.2.29, there are another 36 upland water supply projects including well construction, stock pond rehabilitation, and pipeline installation. Future upland livestock/wildlife water projects are eligible for application funding through the WWDC's SWPP because of their geographic location within the study area. However, these projects would need to be inventoried, mapped, and designed before applications are submitted to the WWDO.

4.5.3 Additional Upland Management Opportunities

Guzzlers are artificial catchments providing sources of water in remote areas for wildlife. Larger systems could be employed for livestock watering purposes. They rely entirely on precipitation; therefore, their reliability is only as good as can be expected in a water short region. Installing guzzler water systems may be considered in areas where wildlife water is needed and other options are unavailable. Figure 4.34 shows a guzzler near Thermopolis, Wyoming. The major components of a guzzler system include the following items:

- **Catchment apron** – typically made of textured HDPE; secured with rocks placed on a grid and protected by fencing from trampling by wildlife or livestock.
- **Catchment outlet** – pipe boot, clamps, and well screen.
- **HDPE pipe** – typically 1.5-inch to 2-inch, 160 psi, SDR 11.
- **Catchment tank** – HDPE tank sized to accommodate wildlife or livestock watering needs with integral drinker (ideally with no float valve required) and overflow adapter.
- **Small animal escape ladder** – installed in the storage tank.
- **Overflow pipe** – with erosion protection at discharge.

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Figure 4.34. An Example of an Installed Wildlife Guzzler System.

4.6 GRAZING MANAGEMENT OPPORTUNITIES

4.6.1 State and Transition Models

In Section 3.4.5.5 of Chapter 3.0, the ecological sites within the watershed were presented and the concept of the ESD was discussed. The ESD for a given ecological site contains a wealth of information pertaining to the site and its vegetative community. Within each ESD, there is a State and Transition Model (STM), which describes the patterns, causes, and indicators that cause vegetation to change from one plant community to a different group of plant species, and the management actions needed to restore to a desirable plant community. Simply, a STM is a diagram that shows the current understanding of vegetation responses on a given site to grazing practices, range management, or environmental disturbances. STMs help landowners and managers to determine changes in vegetation and soils that are reversible compared to changes that are costly or unlikely. In addition to grazing management, a STM can also be useful in developing management options for wildfire and prescribed burns, watershed infiltration and runoff, invasive and pest species, recreation, woodlands, and forests.

When landowners and managers become aware of the predicted responses shown in a STM on a particular range site, they can then use the information to develop appropriate rangeland treatments and implement necessary grazing practices to begin the transition from undesirable vegetation to a desirable plant community. The STM also includes a HCPC, which describes the potential plant community generally having the greatest forage production or ecological potential for a given site. The HCPC can be used to compare the current vegetation growing on a site to what plant community could potentially be grown on the site. Consequently, land management strategies can be developed resulting in the restoration of the HCPC given the right conditions. The ESDs and their associated STMs for the five predominant ESDs within the watershed were obtained directly from the NRCS and are detailed in the following Sections 4.6.1.1 through 4.6.1.5.

The five predominant ESDs within the mapped area of the watershed are likely to be one of the following:

- R034AY322WY Loamy (Ly) 10- to 14-inch Precipitation Zone, High Plains Southeast
- R034AY318WY Impervious Clay (IC) 10- to 14-inch Precipitation Zone, High Plains Southeast
- R058BY146WY Sands (Sa) 10- to 14-inch Northern Plains Precipitation Zone
- R034AY362WY Shallow Loamy (SwLy) 10- to 14-inch Precipitation Zone, High Plains Southeast
- R058BY150WY Sandy (Sy) 10- to 14-inch Northern Plains Precipitation Zone

4.6.1.1 Loamy (Ly) 10- to 14-Inch Precipitation Zone, High Plains Southeast

The most predominant ecological site in the watershed is the loamy (Ly) 10- to 14-inch precipitation zone High Plains Southeast (R034AY322WY), which covers 27.1 percent of the study area. The (STM for the loamy 10- to 14-inch High Plains Southeast ESD is shown Figure 4.35.

The interpretive plant community for this site is the HCPC. Potential vegetation is estimated at 80 percent grasses or grass-like plants, 10 percent forbs and 10 percent woody plants. The major grasses include rhizomatous wheatgrass, needle and thread, bluebunch wheatgrass, and green needlegrass. Big sagebrush and rubber rabbitbrush are the major woody plants.

A typical plant composition for this state consists of rhizomatous wheatgrass 30 to 40 percent, needle and thread 10 to 20 percent, bluebunch wheatgrass 5 to 15 percent, green needlegrass 5 to 10 percent, muttongrass 5 to 10 percent, perennial forbs 5 to 10 percent, and big sagebrush 5 to 15 percent. Ground cover, by ocular estimate, varies from 30 to 40 percent.

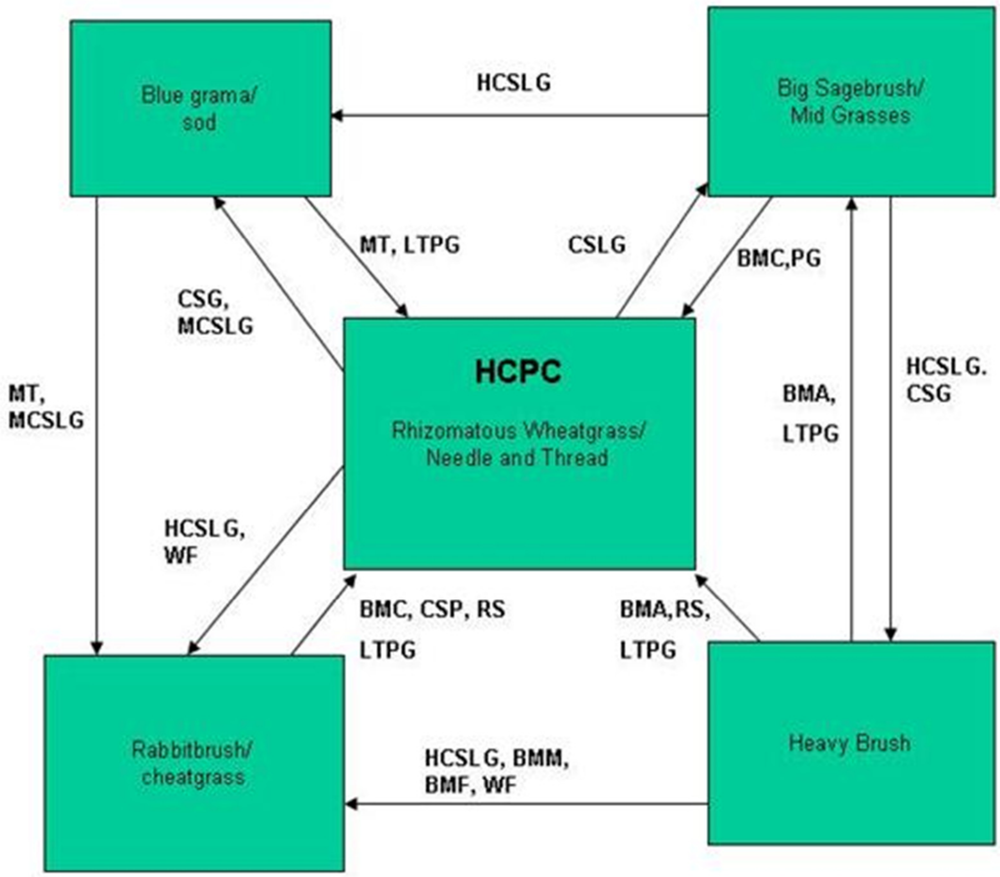
The total annual production (air-dry weight) of this state is approximately 1,100 pounds per acre, but it can range from approximately 600 pounds per acre in unfavorable years to approximately 1,400 pounds per acre in above average years. This state is extremely stable and well adapted to the Cool Central Desertic Basins and Plateaus climate. The diversity in plant species allows for high drought resistance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).

Transitions or pathways leading to other plant communities are as follows:

- Continuous season-long grazing will convert the plant community to the Big Sagebrush-Mid Grass Plant Community if big sagebrush is present at 5–10 percent.
- Moderate continuous season-long grazing or continuous spring grazing will convert the plant community to the Blue Grama Sod Plant Community.
- Heavy continuous season long grazing with wild fire will convert this plant community to the Rabbitbrush/Cheatgrass plant community.

Site Type: Rangeland
MLRA: 34A-Cool Central Desertic Basins and Plateaus

Loamy (Ly) 10-14SE
R034AY322WY



BMA – Brush Management (all methods)
BMC – Brush Management (chemical)
BMF – Brush Management (fire)
BMM – Brush Management (mechanical)
CSP – Chemical Seedbed Preparation
CSLG – Continuous Season-long Grazing
DR – Drainage
CSG – Continuous Spring Grazing
HB – Heavy Browse
HCSLG – Heavy Continuous Season-long Grazing
HI – Heavy Inundation
LPG – Long-term Prescribed Grazing
MT – Mechanical Treatment (chiseling, ripping, pitting)
MCSLG – Moderate Continuous Season Long Grazing

NF – No Fire
NS – Natural Succession
NWC – Noxious Weed Control
NWI – Noxious Weed Invasion
NU – Nonuse
P&C – Plow & Crop (including hay)
PG – Prescribed Grazing
RPT – Re-plant Trees
RS – Re-seed
SGD – Severe Ground Disturbance
SHC – Severe Hoof Compaction
WD – Wildlife Damage (Beaver)
WF – Wildfire

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Figure 4.35. State and Transition Model: Loamy 10- to 14-Inch High Plains Southeast.

4.6.1.2 Impervious Clay (IC) 10- to 14-Inch Precipitation Zone, High Plains Southeast

The second most predominant ecological site in the watershed is the impervious clay (IC) 10- to 14-inch Precipitation Zone, High Plains Southeast (R034AY318WY) covering 8.1 percent of the study area. The STM for the impervious clay 10- to 14-inch High Plains Southeast ESD is shown Figure 4.36.

The interpretive plant community for this site is the HCPC. Potential vegetation is estimated at 50 percent grasses or grass-like plants, 5 percent forbs and 45 percent woody plants. The major grasses include western wheatgrass, bottlebrush squirreltail, Indian ricegrass, and Sandberg bluegrass. Birdfoot sagebrush is the major woody plant. Other woody plants that may occur include Gardner's saltbush and winterfat.

A typical plant composition for this state consists of western wheatgrass 20 to 45 percent, bottlebrush squirreltail 10 to 20 percent, Indian ricegrass 10 to 20 percent, up to 5 percent Sandberg bluegrass, perennial forbs 1 to 5 percent, birdfoot sagebrush 25 to 40 percent, and 5 to 10 percent other woody species. Ground cover, by ocular estimate, varies from 30 to 45 percent.

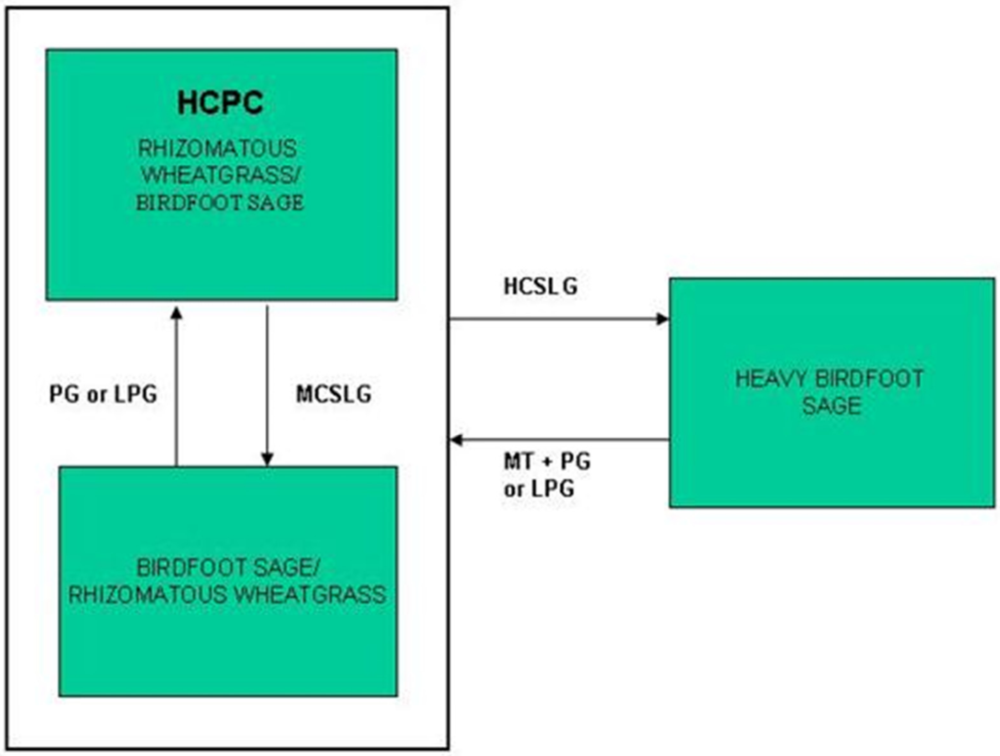
The total annual production (air-dry weight) of this state is approximately 500 pounds per acre, but it can range from approximately 350 pounds per acre in unfavorable years to approximately 700 pounds per acre in above average years. This state is extremely stable and well adapted to the Cool Central Desertic Basins and Plateaus climate. The diversity in plant species allows for high drought resistance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).

Transitions or pathways leading to other plant communities are as follows:

- Heavy continuous season-long grazing will convert the plant community to the Heavy Birdfoot Sage Plant Community.
- Moderate continuous season-long grazing will convert the plant community to the Birdfoot Sage/ Rhizomatous Wheatgrass Plant Community.

Site Type: Rangeland
MLRA: 34A-Cool Central Desertic Basins and Plateaus

Impervious Clay (IC) 10-14SE
R034AY318WY



BMA – Brush Management (all methods)
BMC – Brush Management (chemical)
BMF – Brush Management (fire)
BMM – Brush Management (mechanical)
CSP – Chemical Seedbed Preparation
CSLG – Continuous Season-long Grazing
DR – Drainage
CSG – Continuous Spring Grazing
HB – Heavy Browse
HCSLG – Heavy Continuous Season-long Grazing
HI – Heavy Inundation
LPG – Long-term Prescribed Grazing
MT – Mechanical Treatment (chiseling, ripping, pitting)
MCSLG – Moderate Continuous Season Long Grazing

NF – No Fire
NS – Natural Succession
NWC – Noxious Weed Control
NWI – Noxious Weed Invasion
NU – Nonuse
P&C – Plow & Crop (including hay)
PG – Prescribed Grazing
RPT – Re-plant Trees
RS – Re-seed
SGD – Severe Ground Disturbance
SHC – Severe Hoof Compaction
WD – Wildlife Damage (Beaver)
WF – Wildfire

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Figure 4.36. State and Transition Model: Impervious Clay 10- to 14-Inch High Plains Southeast.

4.6.1.3 Sands (Sa) 10- to 14-Inch Northern Plains Precipitation Zone

The third most predominant ecological site in the watershed is the sands (Sa) 10- to 14-inch precipitation zone High Plains Southeast (R058BY146WY) covering 6.8 percent of the study area. The STM for the Sandy 10- to 14-inch High Plains Southeast ESD is shown Figure 4.37.

The interpretive plant community for this site is the HCPC. This state evolved with grazing by large herbivores and is well suited for grazing by domestic livestock. Potential vegetation is approximately 85 percent grasses or grass-like plants, 10 percent forbs, and 5 percent woody plants. This state is a mix of warm and cool season midgrasses.

The major grasses include needleandthread, prairie sandreed, sand bluestem, and Indian ricegrass. Other grasses occurring in this state include Sandberg bluegrass, sand dropseed, and threadleaf sedge. Silver sagebrush is a conspicuous element of this state, occurs in a mosaic pattern, and makes up 5 to 10 percent of the annual production.

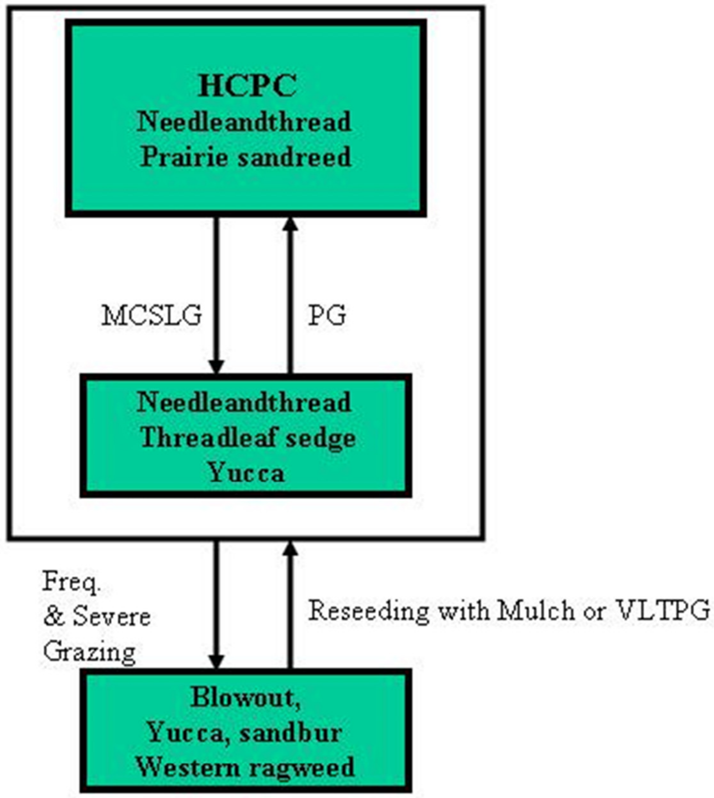
The total annual production (air-dry weight) of this state is approximately 1,400 pounds per acre, but it can range from approximately 900 pounds per acre in unfavorable years to approximately 1,700 pounds per acre in above average years. This plant community is extremely stable and well adapted to the Northern Great Plains climatic conditions. The diversity in plant species allows for high drought tolerance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).

Transitions or pathways leading to other plant communities are as follows:

- Moderate continuous season-long grazing will convert the plant community to the Needleandthread/ Threadleaf sedge/ Yucca Vegetation State.
- Frequent and severe grazing will convert the plant community to a blowout with a Yucca, Sandbur, and Western agweed Vegetation State.

Site Type: Rangeland
MLRA: 58B – Northern Rolling High Plains

Sands 10-14" P.Z.
R058BY146WY



BM - Brush Management (fire, chemical, mechanical)
Freq. & Severe Grazing - Frequent and Severe Utilization of the Cool-season Mid-grasses during the Growing Season
GLMT - Grazing Land Mechanical Treatment
LTPG - Long-tem Prescribed Grazing
MCSLG - Moderate, Continuous Season-long Grazing
NU, NF - No Use and No Fire
PG - Prescribed Grazing (proper stocking rates with adequate recovery periods during the growing season)
VLTPG - Very Long-term Prescribed Grazing (could possibly take generations)
Na - found adjacent to a saline site

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Figure 4.37. State and Transition Model: Sands 10- to 14-Inch Northern Plains.

4.6.1.4 Shallow Loamy (SwLy) 10- to 14-Inch Precipitation Zone, High Plains Southeast

The fourth most predominant ecological site in the watershed is the shallow loamy (SwLy) 10- to 14 inch precipitation zone High Plains Southeast (R034AY362WY) covering 6.7 percent of the study area. The STM for the shallow loamy 10- to 14-inch High Plains Southeast ESD is shown Figure 4.38.

The interpretive plant community for this site is the HCPC. Potential vegetation is approximately 70 percent grasses or grass-like plants, 10 percent forbs, and 20 percent woody plants. The major grasses include bluebunch wheatgrass, western wheatgrass, needleandthread, and Indian ricegrass. Other grasses include, Sandberg and mutton bluegrass, prairie junegrass, bottlebrush squirreltail, plains reedgrass, and threadleaf sedge. Black sagebrush, big sagebrush, and green rabbitbrush are the major woody plants.

A typical plant composition for this state consists of bluebunch wheatgrass 15 to 30 percent, western wheatgrass 15 to 25 percent, needleandthread 5 to 10 percent, muttongrass 5 to 10 percent other grasses and grass-like plants 10 to 20 percent, perennial forbs 5 to 15 percent, black sagebrush 5 to 10 percent, and other shrubs 5 to 10 percent Ground cover, by ocular estimate, varies from 15 to 25 percent.

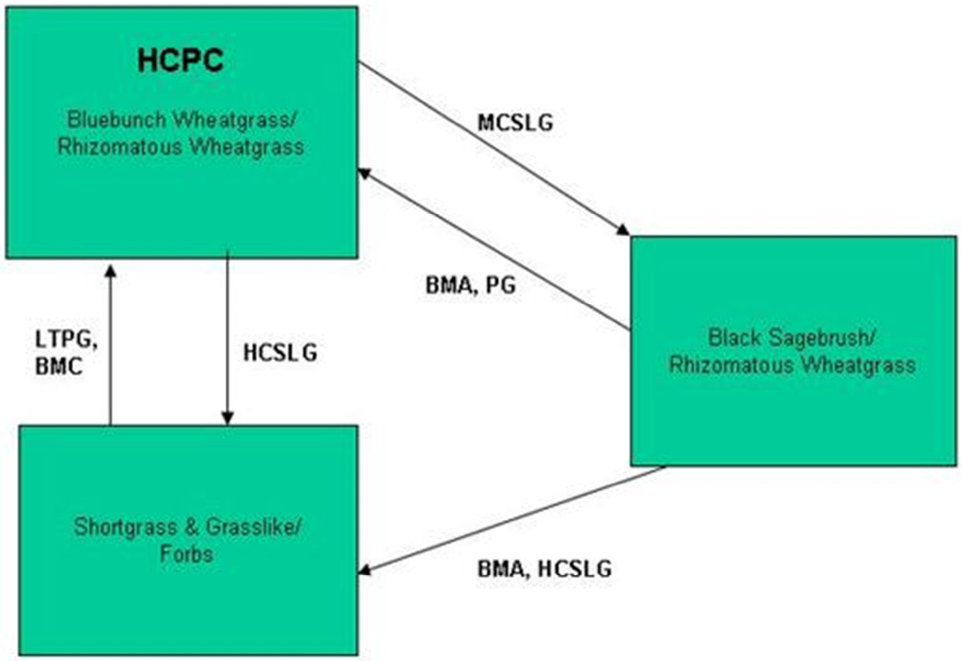
The total annual production (air-dry weight) of this state is approximately 900 pounds per acre, but it can range from approximately 700 pounds per acre in unfavorable years to approximately 1,200 pounds per acre in above average years. The state is stable and well adapted to the Cool Central Desertic Basins and Plateaus climatic conditions. The diversity in plant species allows for high drought resistance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).

Transitions or pathways leading to other plant communities are as follows:

- Moderate Continuous Season Long Grazing will convert this plant community to the Black Sagebrush/Rhizomatous Wheatgrass Plant Community.
- Heavy Continuous Season-long Grazing will convert this plant community to the Short Grass and Grasslike/Forb plant community.

Site Type: Rangeland
MLRA: 34A-Cool Central Desertic Basins and Plateaus

Shallow Loamy (SwLY) 10-14SE
R034AY362WY



BMA – Brush Management (all methods)
BMC – Brush Management (chemical)
BMF – Brush Management (fire)
BMM – Brush Management (mechanical)
CSP – Chemical Seedbed Preparation
CSLG – Continuous Season-long Grazing
DR – Drainage
CSG – Continuous Spring Grazing
HB – Heavy Browse
HCSLG – Heavy Continuous Season-long Grazing
HI – Heavy Inundation
LPG – Long-term Prescribed Grazing
MT – Mechanical Treatment (chiseling, ripping, pitting)
MCSLG – Moderate Continuous Season Long Grazing

NF – No Fire
NS – Natural Succession
NWC – Noxious Weed Control
NWI – Noxious Weed Invasion
NU – Nonuse
P&C – Plow & Crop (including hay)
PG – Prescribed Grazing
RPT – Re-plant Trees
RS – Re-seed
SGD – Severe Ground Disturbance
SHC – Severe Hoof Compaction
WD – Wildlife Damage (Beaver)
WF – Wildfire

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Figure 4.38. State and Transition Model: Shallow Loamy 10- to 14-Inch High Plains Southeast.

4.6.1.5 Sandy (Sy) 10- to 14-Inch Northern Plains Precipitation Zone

The fifth most predominant ecological site in the watershed is the sandy (Sy) 10- to 14-inch precipitation zone Northern Plains (R058BY150WY) covering 6.2 percent of the study area. The STM for the Sandy 10- to 14-inch North Plains ESD is shown Figure 4.39.

The interpretive plant community for this site is the HCPC. This state evolved with grazing by large herbivores and is well suited for grazing by domestic livestock. Potential vegetation is approximately 75 percent grasses or grass-like plants, 15 percent forbs, and 10 percent woody plants. The state is a mix of warm and cool season midgrasses.

The major grasses include needleandthread, prairie sandreed, little bluestem, and Indian ricegrass. Other grasses occurring in the state include rhizomatous wheatgrasses, Sandberg bluegrass, blue grama, and threadleaf sedge. Silver sagebrush and green rabbitbrush are conspicuous components of this state.

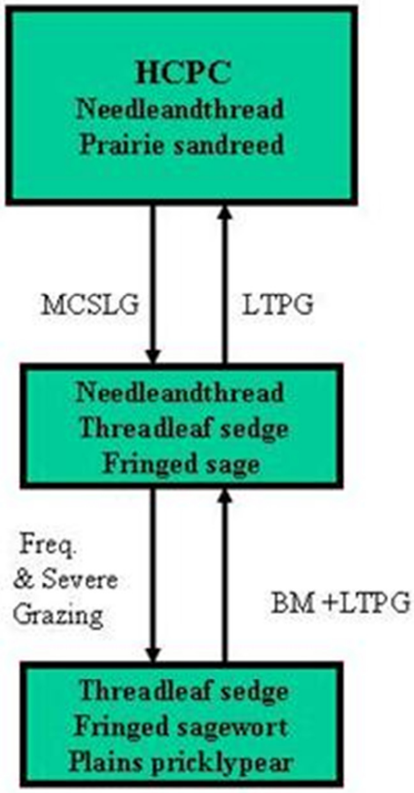
The total annual production (air-dry weight) of this state is approximately 1,200 pounds per acre, but it can range from approximately 750 pounds per acre in unfavorable years to approximately 1,600 pounds per acre in above average years. The state is stable and well adapted to the Northern Great Plains climatic conditions. The diversity in plant species allows for high drought resistance. This is a sustainable plant community (site/soil stability, watershed function, and biologic integrity).

Transitions or pathways leading to other plant communities are as follows:

- Moderate, Continuous Season-Long grazing will convert the plant community to the Needleandthread/ Threadleaf sedge/ Fringed sagewort Vegetation State.
- Frequent and Severe grazing will convert the plant community to the Threadleaf sedge/ Fringed sagewort/ Plains Pricklypear Vegetation State.

Site Type: Rangeland
MLRA: 58B – Northern Rolling High Plains

Sandy 10-14" P.Z.
R058BY150WY



BM - Brush Management (fire, chemical, mechanical)
Freq. & Severe Grazing - Frequent and Severe Utilization of the Cool-season Mid-grasses during the Growing Season
GLMT - Grazing Land Mechanical Treatment
LTPG - Long-tem Prescribed Grazing
MCSLG - Moderate, Continuous Season-long Grazing
NU, NF - No Use and No Fire
PG - Prescribed Grazing (proper stocking rates with adequate recovery periods during the growing season)
VLTPG - Very Long-term Prescribed Grazing (could possibly take generations)
Na - found adjacent to a saline site

Figure 4.39. State and Transition Model: Sandy 10- to 14-Inch Northern Plains.

4.6.2 Range and Grazing Management Components of the Watershed Plan

Based on the information presented above, the following items are presented for inclusion in the watershed management plan:

Watershed Plan Component G-1: Water developments can be used to expand grazing distribution to areas that do not currently have reliable water. Riparian area plant community condition can be enhanced by development of water into upland areas.

Watershed Plan Component G-2: Fencing can be used to enhance grazing management options and to facilitate the planned grazing system.

Watershed Plan Component G-3: Strategic salting and herding are other tools that can be used to enhance grazing distribution.

Watershed Plan Component G-4: Most range improvement practices which improve watershed condition, may also improve wildlife habitat. Wildlife needs should be considered when installing practices such as wildlife friendly fences, wildlife escape ramps from tanks, and wildlife watering facilities.

Watershed Plan Component G-5: Strategies recommended in the state and transition models associated with NRCS descriptions of the ecological sites found within the watershed should be adopted and employed to optimize range conditions through prescribed grazing management and best management practices.

Watershed Plan Component G-6: Prescribed fire may be used as a tool to assist in the restoration of range health areas benefitting by this treatment according to the state and transition models. Delineation of specific areas potentially benefitting from this practice was beyond the scope of this Level I project. However, based upon input from landowners and land managers and observations made during the completion of this investigation, it is evident that there are areas which would likely benefit from prescribed fires.

Watershed Plan Component G-7: Application of chemicals may be utilized as a tool to assist in the restoration of range health areas benefitting by this treatment according to the state and transition models. Delineation of specific areas potentially benefitting from this practice was beyond the scope of this Level I project. However, based upon input from landowners and land managers and observations made during the completion of this investigation, it is evident that there are areas which would likely benefit from chemical application for control of range (e.g., Big Sagebrush).

These tools can be used to maintain and/or improve watershed function particularly when coupled with implementation of appropriate grazing management strategies.

4.7 SURFACE WATER STORAGE OPPORTUNITIES

4.7.1 Bates Creek Reservoir Inventory

The investigation of Bates Creek Reservoir was initiated with a field inspection of the existing facilities including the dam embankment, emergency spillway, outlet structure/ facilities, and inlet ditch from East Fork Bates Creek. As indicated in Table 3.37, Bates Creek Reservoir has the capacity and water rights to store 4,717 ac-ft. The reservoir embankment exceeds 4,000 feet in length and is located in the channel of the Dry Fork Bates Creek. In addition to water captured from the Dry Fork Bates Creek, the reservoir stores water diverted from the East Fork Bates Creek. At the maximum high water associated with 4,717 ac-ft of storage, the surface area of the reservoir is approximately 786 acres and the maximum depth is 14 feet. The emergency spillway consists of an earthen embankment crest and spillway channel that is 200 feet wide. The outlet facility consists of a 24-inch concrete outlet pipe with a steel gate to control the release of water from the reservoir.

The field investigation and subsequent review of existing information revealed several problems related to the dam embankment and outlet facilities. These problems included seepage areas evident directly downstream of the reservoir embankment, spalling and failing concrete slope revetment, and deterioration and seepage associated with the outlet structure and conveyance pipe. The reservoir is relatively shallow and annual evaporation volumes are relatively high given the surface area of the reservoir. Because of the existing problems, the reservoir is not capable of providing carryover storage. Photographs of the dam embankment, concrete slope revetment, and seepage are illustrated in Figures 4.40, 4.41, and 4.42.

Figure 4.40. Dam Embankment on Bates Creek Reservoir.

RSI-2129-14-068

Figure 4.41. Concrete Slope Revetment Failure on Dam.

RSI-2129-14-070

Figure 4.42. Seepage Below the Dam Embankment.

Major components of the reservoir also include the diversion and inlet ditch from the East Fork Bates Creek. These facilities include the diversion dam on the creek, headgate facilities, earthen diversion/inlet ditch, culvert crossings of the diversion/inlet ditch, and corrugated metal pipe (CMP) drains to spill water from the ditch.

Conversations with water users indicated the following problems with these facilities:

- The diversion/inlet ditch often fills with snow, which precludes diversion of early spring flows into the reservoir.
- Runoff from the drainage channel/gullies in the tributary watershed above the diversion/inlet ditch periodically spills into the ditch and threatens the integrity of the conveyance facilities.
- Drain pipes have been installed above the normal high water line to convey the water spilled into the ditch.

The field inventory found the diversion dam and headgate structure to be functional with regular maintenance required. Given the potential for blockage of the ditch with snow, major shortcomings were noted with the culvert crossings and CMP drains with respect to the long-term integrity of the ditch and the capability to convey water during the spring runoff. Figure 4.43 provides an illustration of the culvert crossing the ditch. Figure 4.44 illustrates a typical CMP drain along the ditch.

RSI-2129-14-071

Figure 4.43. Corrugated Arch Pipe Crossing of the Diversion/Inlet Ditch.

Figure 4.44. Typical Drain Pipe Installed Within the Diversion/Inlet Ditch.

4.7.2 Bates Creek Reservoir Alternatives

The inventory of existing facilities identified the need to rehabilitate the facilities associated with Bates Creek Reservoir. Three alternatives were identified to mitigate the deficiencies with the reservoir embankment, outlet structure and inlet ditch and are listed below:

- **Alternative 1:** Bates Creek Reservoir and Inlet Ditch Rehabilitation
- **Alternative 2:** Bates Creek Reservoir Relocation to Downstream Location
- **Alternative 3:** Bates Creek Reservoir Relocation to East Fork Bates Creek

Concept drawings and major construction components for each alternative are discussed in the following paragraphs.

4.7.2.1 Alternative 1: Bates Creek Reservoir and Inlet Ditch Rehabilitation

This alternative involves the rehabilitation of the existing facilities associated with Bates Creek Reservoir and the inlet ditch from the East Fork Bates Creek. Seepage along with the structural integrity of the existing dam embankment has been problematic and demonstrates the need for rehabilitation of the embankment and the outlet facilities. Rehabilitation efforts on the embankment focus on the replacement of the existing concrete slope revetment and placement of embankment protection from the erosion associated with wave action. Consequently, the entire embankment has not been identified for rehabilitation.

Note that seepage through the embankment may warrant more extensive replacement/rehabilitation of the embankment and should be verified with a geotechnical investigation commensurate with a Level II-Phase I study. Furthermore, complete replacement of the existing embankment, emergency spillway, and outlet facilities may be warranted to ensure storage of the 4,717 acre-feet associated with the adjudicated storage rights. The cost associated with replacement of the existing facilities will greatly increase the cost associated with this alternative and will likely include construction of zoned earthfill dam similar to Alternatives 2 and 3. As indicated in Figure 4.45, rehabilitation of the Bates Creek Reservoir and inlet ditch will involve the following major components:

- Removal of the existing concrete slope protection; placement of additional fill material on the upstream embankment to maintain a 3H:1V slope; placement of rock riprap along the embankment, as shown in Figure 4.46.
- Replacement of the existing 24-inch outlet pipe and slide gate.
- Replacement of the inlet ditch from East Fork Bates Creek with a 42-inch PVC pipeline.

At a minimum, rehabilitation of the inlet ditch should include the following improvements:

- Installation of a conveyance pipeline (minimum diameter equal to 42 inches) from the headgate at East Fork Bates Creek to the ditch outlet at Bates Creek Reservoir. Pipeline capacity should be not less than 100 cfs.
- Construction of an inlet structure to the pipeline.
- Construction of an outlet structure from the pipeline.
- Stabilization of the gullies that cross the inlet ditch pipeline.

4.7.2.2 Alternative 2: Bates Creek Reservoir Relocation to Downstream Location on Bates Creek

Alternative 2 involves relocation of the storage reservoir to a site located further downstream on Bates Creek and below the confluence of Bates Creek and East Fork Bates Creek. It should be noted that the dam embankment is located on lands owned by the state of Wyoming. However, the area inundated by the reservoir will encroach onto privately owned property. As indicated on Figure 4.47, the pertinent statistics for the reservoir include the following:

- Maximum reservoir volume: approximately 4,700 acre-feet
- Maximum surface area: 370 acres
- Maximum dam height: 70 feet
- Embankment Length: approximately 300 feet.

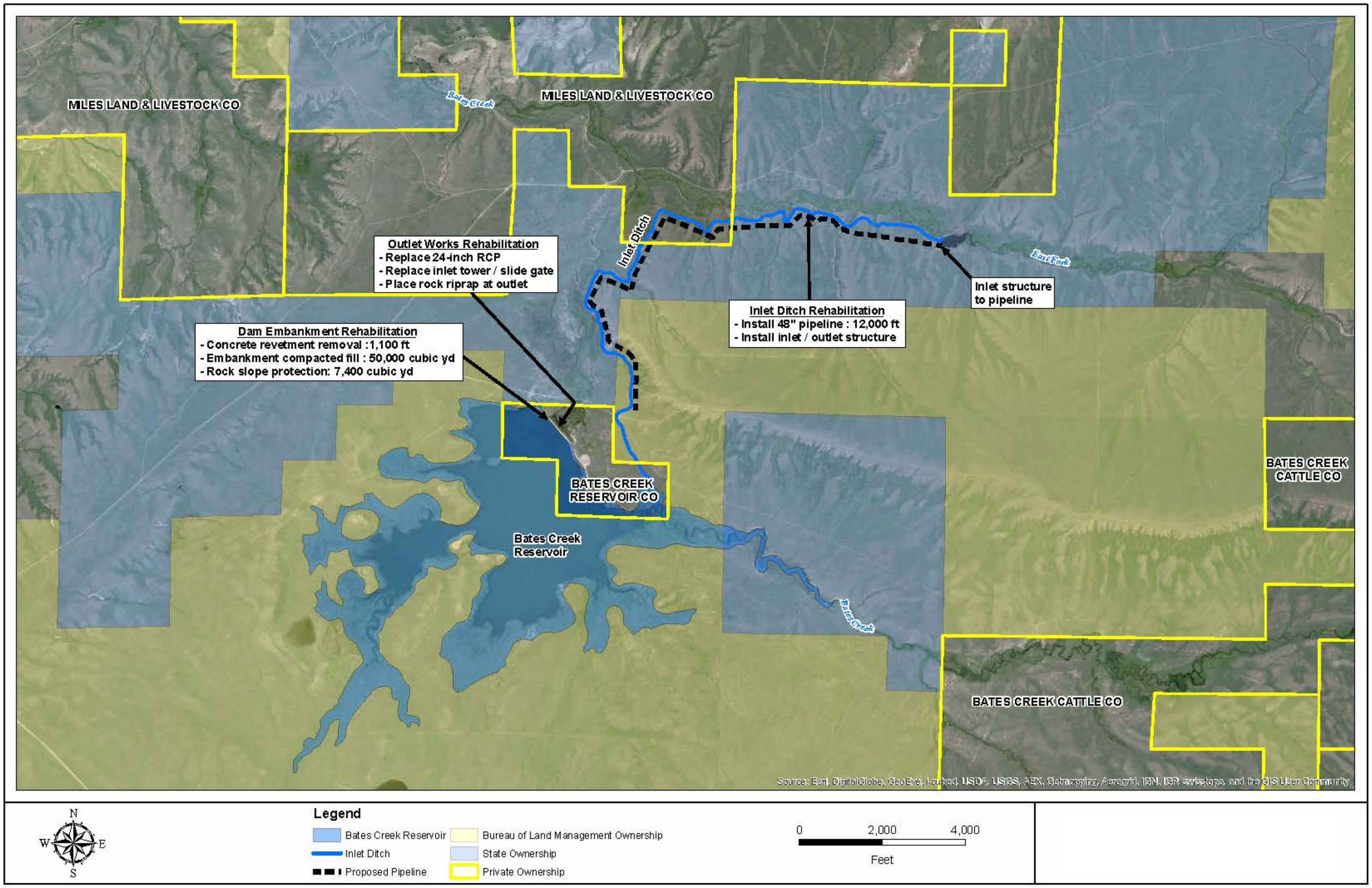


Figure 4.45. Alternative 1: Bates Creek Reservoir and Inlet Ditch Rehabilitation-Concept Design.

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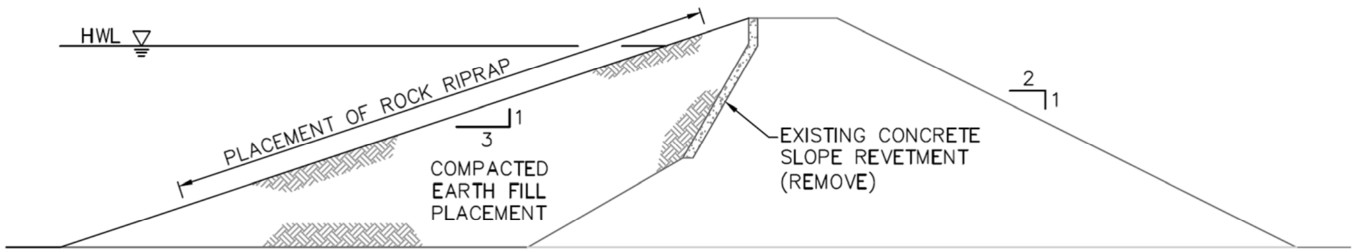

Figure 4.46. Rehabilitation of Bates Creek Reservoir Embankment.

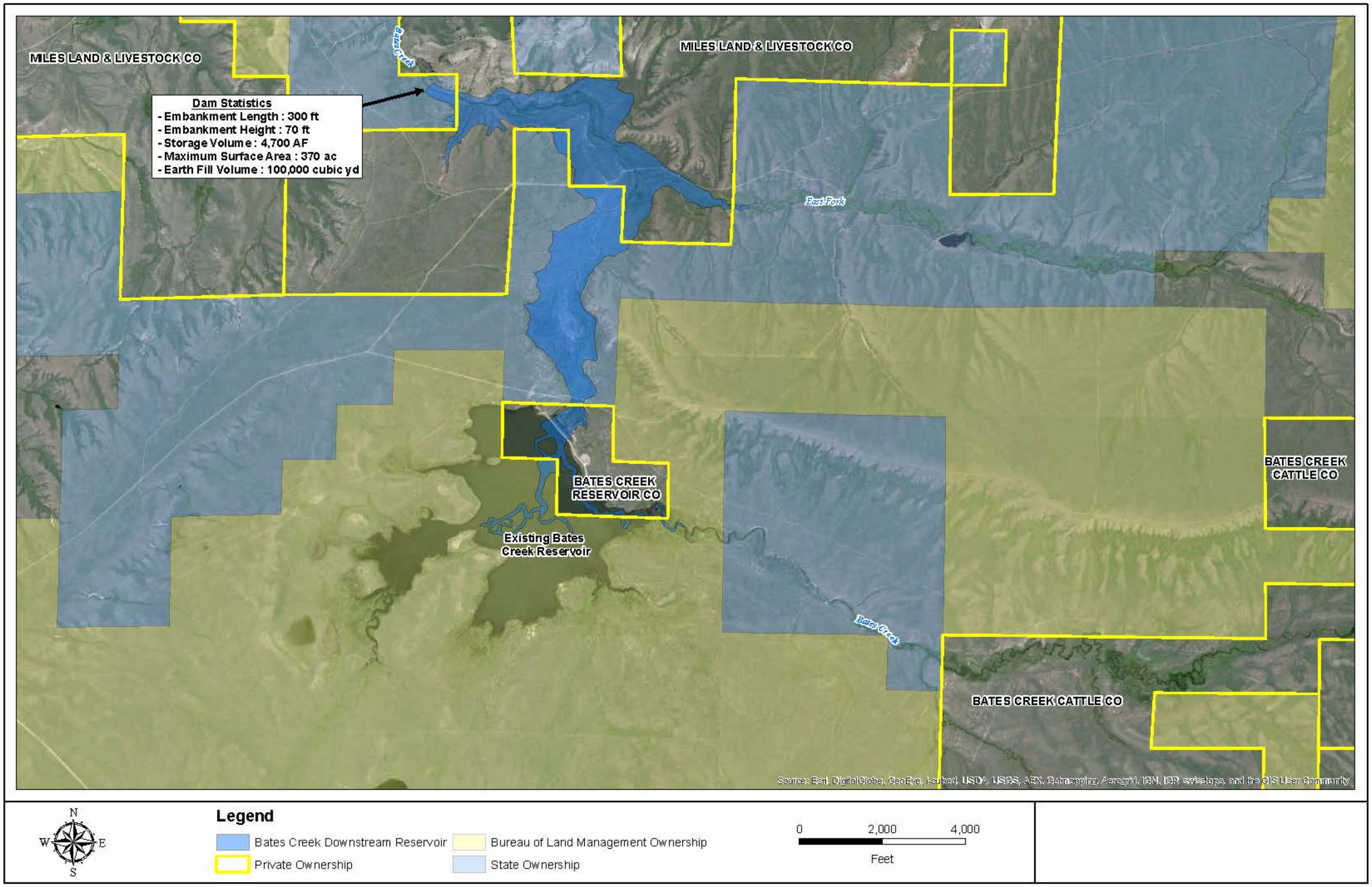

Figure 4.47. Alternative 2: Bates Creek Reservoir Relocation to Downstream Bates Creek Location-Concept Design.

RSI-2129-14-116

Construction components of the reservoir will include the following:

- Zoned earth-fill dam embankment including core trench, chimney filter drain, and blanket drain, as illustrated in Figure 4.48.
- Riprap erosion protection on upstream embankment slope.
- Emergency spillway.
- Outlet facilities.

Construction of a new reservoir at this location will require a more detailed investigation of geologic structure in the vicinity of the dam embankment, soils suitable for construction of the embankment, and rock sources for riprap slope protection as a minimum. This work can be accomplished through an evaluation of all reservoir alternatives via completion of a Level II-Phase I study funded by the WWDC.

In conversations with representatives of the Wyoming SEO, it is our understanding that Bates Creek Reservoir can be relocated to the proposed location on Bates Creek. Additional coordination with the SEO should be conducted to confirm this information and the permitting requirements. In addition, any relocation alternative will require more significant permitting through the USACE. Finally, as mentioned previously in this report, Alternative 2 will inundate privately owned lands which must be considered in any future studies related to the Bates Creek Reservoir alternatives.

4.7.2.3 Alternative 3: Bates Creek Reservoir Relocation to East Fork Bates Creek

Alternative 3 involves relocation of the storage reservoir to a site located on East Fork Bates Creek downstream of the diversion dam and inlet ditch to Bates Creek Reservoir. As indicated on Figure 4.49, the pertinent statistics for the reservoir include the following:

- Maximum reservoir volume: approximately 4,700 acre-feet
- Maximum surface area: 205 acres
- Maximum dam height: 70 feet
- Embankment Length: approximately 1,000 feet.

Similar to Alternative 2, the construction components of the reservoir will include the following:

- Zoned earth-fill dam embankment including core trench, chimney filter drain, and blanket drain.
- Riprap erosion protection on upstream embankment slope.
- Emergency spillway.
- Outlet facilities.

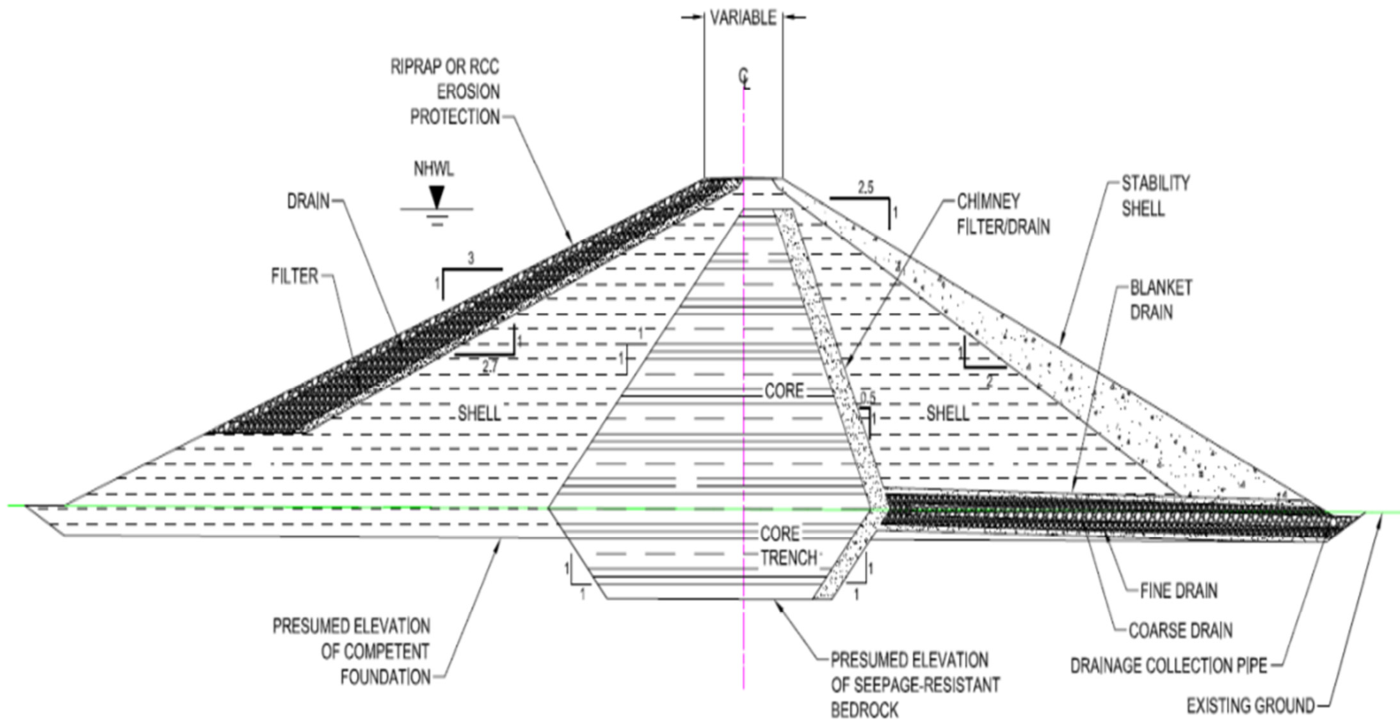

Figure 4.48. Zoned Earth-Fill Embankment.

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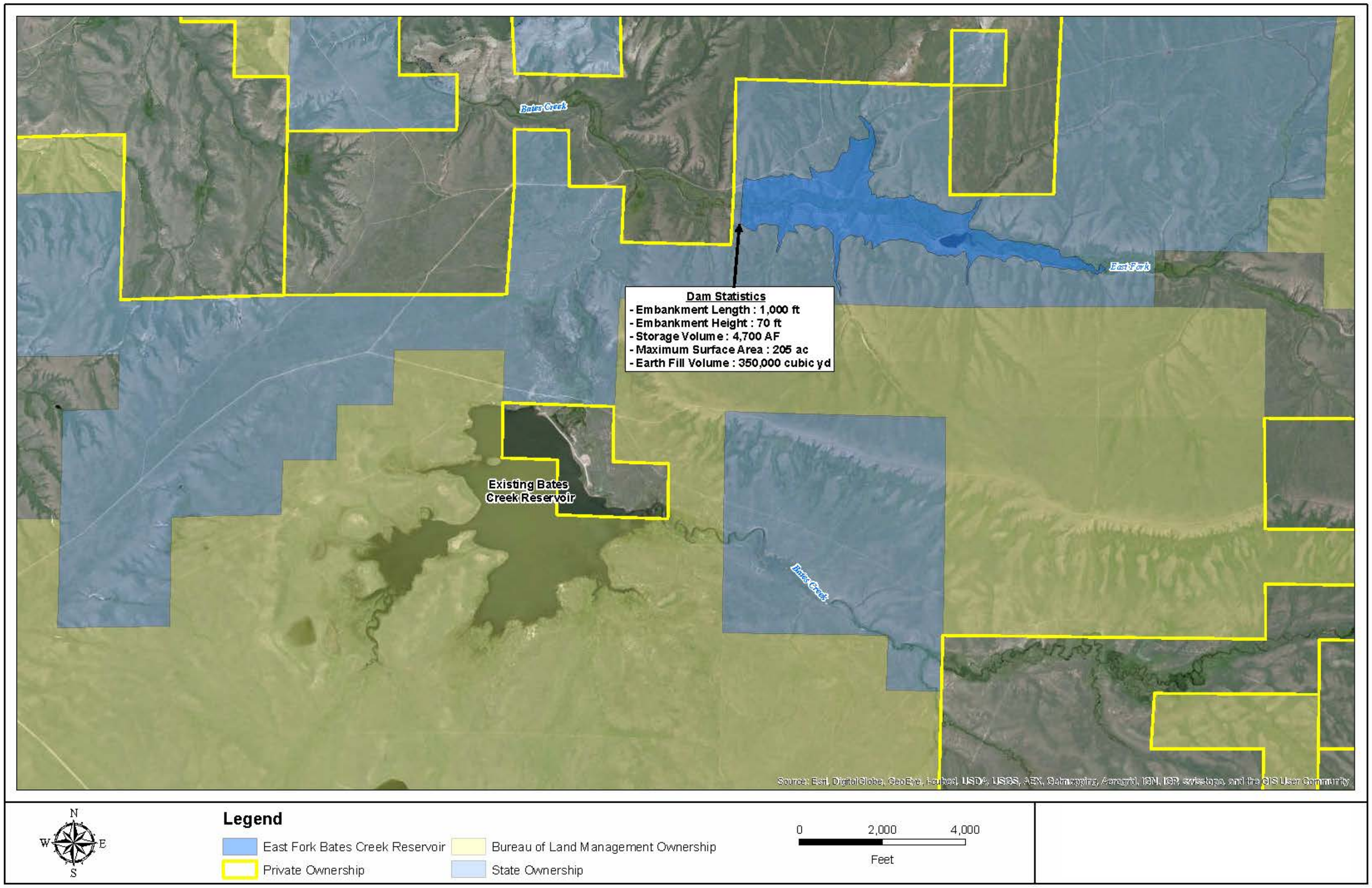

Figure 4.49. Alternative 3: Bates Creek Reservoir Relocation to East Fork Bates Creek Location-Concept Design.

At this location, the source of surface water available for storage is limited to that provided by East Fork Bates Creek. Similar to Alternative 2, the dam embankment is located on lands owned by the state of Wyoming. For this reservoir, the area inundated by the reservoir does not encroach onto privately owned property and is contained within lands owned by the state of Wyoming.

Alternative 3 also involves construction of a new reservoir at this location. Consequently, a detailed investigation of geologic structure should be completed along with identification of the permitting requirements. As stated previously, this work can be accomplished through an evaluation of all reservoir alternatives via completion of a Level II-Phase I study funded by the WWDC. Compared to the other alternatives, this alternative is limited to storage provided by East Fork Bates Creek. However, it is also noteworthy to mention that this reservoir embankment and storage pool are contained within lands owned by the state of Wyoming.

4.8 STREAM CHANNEL CONDITION AND STABILITY

4.8.1 Stream Channel Rehabilitation

With respect to overall stream stabilization efforts, various approaches can be taken during channel restoration and stabilization efforts, including “hard” engineering, “soft” approaches, and combinations of the two. Examples of “hard” approaches include constructing channel structures or reconstructing channels themselves. Selecting the appropriate mitigation and restoration technique depends upon site-specific information and critical review of hydrologic and hydraulic data. Installing an inappropriate type of structure or improper installation could exacerbate conditions.

For instance, methods of restoring incised channels may include constructing gradient restoration facilities (i.e., drop structures and check structures) within the incised channel. Figure 4.50 is a diagram of a typical stream channel stabilization strategy for a small channel experiencing minor downcutting or bank erosion. A vortex weir can be placed within a problematic reach to serve as a grade-control structure as well as directing and centralizing streamflow. Weir configuration can be varied to provide additional functions such as facilitating irrigation diversions. Figure 4.51 is a photograph of a typical installation.

Reestablishing preincision channel elevations can be accomplished by means of check dams. The photograph in Figure 4.52 is a large-scale check dam on Muddy Creek near Baggs, Wyoming. This structure is a good example of how gradient restoration strategies can be used to restore diversion capabilities at irrigation headgates that are rendered inoperable by changes in channel configuration.

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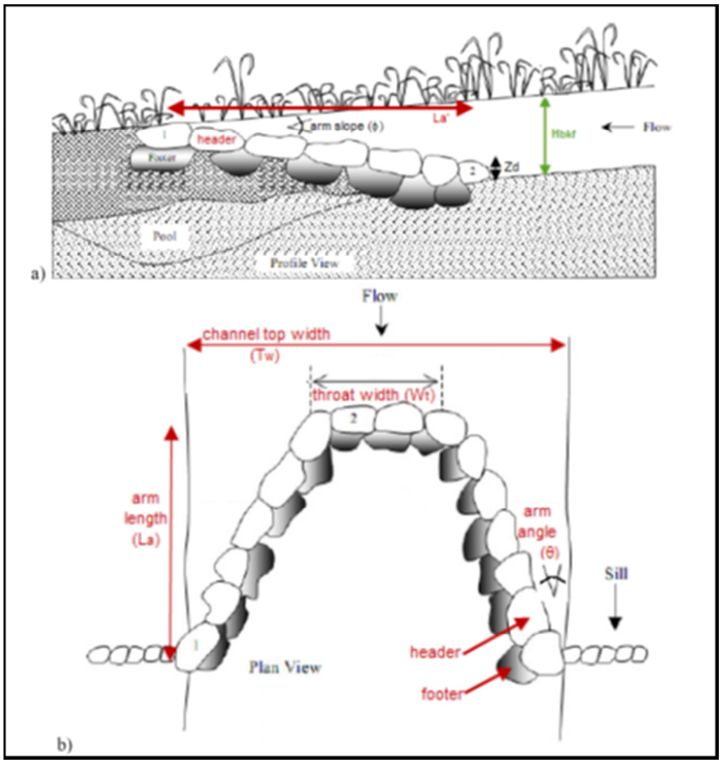

Figure 4.50. Rock Vortex Weir Structure Diagram (Adapted From Rosgen [2006]).

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Figure 4.51. Stream Stabilization Structure: Rock Vortex Weir.

Figure 4.52. Channel Gradient Restoration Feature on Muddy Creek Near Baggs, Wyoming. Photograph on the left is viewed downstream from the dam at incised channel; photograph on the right is viewed upstream at restored gradient.

Examples of “soft” approaches include a variety of BMPs. Examples of potentially applicable BMPs designed for channel restoration activities include those that result in reducing or, at least temporarily excluding, wildlife and livestock from accessing designated riparian zones, and establishing riparian buffers. The proposed wildlife/livestock water developments discussed previously (and others that may be identified in the future) can be considered elements of a range management BMP that will help restore over time those areas of channel impairment that have resulted from overusing riparian areas or adjacent upland range. Figure 4.53 is a photograph of willow fascine installation; this strategy could be employed on many of the perennial channels or intermittent where sufficient flow exists to support the vegetation to restore riparian habitat and stabilize streambanks.

These examples of “hard” and “soft” approaches represent both extremes of the continuum of channel restoration strategies that exist. In practice, a combination of strategies that are integrated into a cohesive plan provides the most effective solution. Table 4.3 presents a summary of some of these channel restoration strategies that can be employed during future restoration efforts. Developing more specific projects and BMPs was beyond the scope of this Level I study. Such projects can be identified and developed on the basis of more detailed geomorphic analysis of impaired stream reaches.

Several stream reaches were identified (Poison Spider Creek, Bates Creek, South Fork Casper Creek, Middle Fork Casper Creek, and Muddy Creek) that would benefit from site-specific stream restoration strategies. These stream segments were either classified as F-type channels in Section 3.7.2 or were brought to the attention of the study team during completion of field investigations or study meetings. This list is not intended to be all-inclusive. Stream segments throughout the watershed could benefit from stream restoration activities.

Figure 4.53. Willow Fascine Installation.

Table 4.3. Summary of Stream Channel Stabilization and Restoration Techniques

Flow-Redirection Techniques	**Biotechnical Techniques**
Vanes	Woody Plantings
Groins	Herbaceous Cover
Buried Groins	Soil Reinforcement
Barbs	Coir Logs
Engineered Log Jams	Bank Reshaping
Drop Structures	**Internal Bank-Drainage Techniques**
Porous Weirs	Subsurface Drainage Systems
Structural Techniques	**Avulsion-Prevention Techniques**
Anchor Points	Floodplain Roughness
Roughness Trees	Floodplain Grade Control
Riprap	Floodplain Flow Spreaders
Log Toes	**Other Techniques**
Roughened-Rock Toes	Channel Modifications
Log Cribwalls	Riparian-Buffer Management
Manufactured Retention Systems	Spawning-Habitat Restoration
	Fish Ladders/Bypass Structures
	Fish Screens/Entrainment Prevention

In addition, the Oregon Trail Drain and Emigrant Gap Draw, which were discussed in Sections 3.7.5 and 3.10.2.1, should be investigated to determine a practical and feasible means of stabilizing the highly erosive conditions found within the lower channel to reduce a significant source of selenium and sediment to the North Platte River. Based on the information presented above, the following items are presented for inclusion in the Watershed Management Plan:

Channel Stabilization Recommendation 1: Install stream channel degradation/incision mitigation measures based upon site-specific evaluation of conditions. Appropriate measures could be “hard” engineering, “soft” approaches, or combinations of both.

Channel Stabilization Recommendation 2: Install stream bank erosion mitigation measures based upon site-specific evaluation of conditions. Appropriate mitigation measures could be “hard” engineering, “soft” approaches, or combinations of both.

Channel Stabilization Recommendation 3: Initiate routine monitoring of completed stream restoration projects to determine their effectiveness and viability. Repairs should be made as necessary or as soon as is practical.

Additionally, as discussed in Section 3.7.5, the City of Casper's North Platte River Environmental Restoration Master Plan provided an assessment of existing conditions and proposed restoration strategies for the 13.5-mile stretch of the North Platte River that flows through the city [Stantec, 2012]. Stream restoration concepts for seven sites on the North Platte River were included in the plan to repair incised channels and restore channel stability, and floodplain characteristics. Based on the information reviewed and presented in the North Platte River Environmental Restoration Plan, the following item is presented for inclusion in the Watershed Management Plan:

Channel Stabilization Recommendation 4: Place in-stream structures, stabilizing banks, planting native vegetation, restoring floodplains, and enhancing riparian areas and wetlands.

4.9 WETLANDS ENHANCEMENT OPPORTUNITIES

Wetland creation and enhancement opportunities exist within the watershed. As explained in Section 3.5.5, existing wetland locations represent a variety of sites where wetlands could either be established or enhanced by restoring channel or hydric soil conditions. Some sites are disconnected floodplains and associated wetland features along the North Platte River corridor and its tributaries. Wetlands in the watershed have been influenced by regulated flows, geomorphic changes, and agricultural and urban activities, but they still provide important wildlife habitat.

Figure 3.33 delineates the existing wetlands, hydric soils, and Cretaceous Formations within the watershed to delineate areas where wetland enhancement could occur. However, it is recommended that potential wetland creation and enhancement projects in the study area consider the concentration of selenium (Se) in the contributing surface water, groundwater, soil, and underlying geologic formation. Artificially creating a wetland area could result in high selenium concentrations in the wetland and its associated plants and animals caused by evaporative and bioaccumulation conditions. Selenium can be toxic at high levels and can cause illness or mortality in livestock, wildlife, and humans and impair reproduction for aquatic birds and fish.

4.10 OTHER WATERSHED MANAGEMENT OPPORTUNITIES

4.10.1 Noxious Weed and Undesirable Plant Control

The Weed and Pest Districts in Converse, Natrona, and Carbon Counties have expansive, effective, and impressive programs for detecting, treating, and controlling noxious and invasive weeds and pests. The districts are very adept at encouraging landowners and managers to participate in control and treatment programs, including mapping and inventorying, product discounts and cost-share incentives, and work days or workshops. Based on the information presented in Chapter 3.0, the following items are presented for inclusion in the Watershed Management Plan:

Watershed Management Recommendation 1: Coordinate with the NCWP where noxious weed control is needed in small acreages and provide improved grazing management techniques or planting of preferred trees, shrubs, and grasses that could help prevent weed reinfestation.

Watershed Management Recommendation 2: Coordinate with the NCWP and the City of Casper where invasive species, such as Russian olive, need to be controlled and preferred and native vegetation could be restored along the North Platte River corridor.

Watershed Management Recommendation 3: Coordinate with the weed and pest districts, landowners, the NRCS, and the BLM on cheatgrass control areas where livestock water development and improved grazing techniques could avoid reinfestation and improve preferred forage vegetation.

Watershed Management Recommendation 4: Coordinate with the NCWP and the CAID to identify weed infestations on canals or laterals where ditches could be converted to underground pipelines and eliminate the need for weed control while improving conveyance efficiencies.

4.10.2 Urban Drainage and Flood Control

In March 2013, an updated SWMMP was prepared by WLC Engineering, Surveying and Planning and URS Corporation on behalf of the City of Casper's Department of Public Services [WLC Engineering, Surveying and Planning, 2013] as discussed in Section 3.9.2. The goal for the City of Casper's SWMMP is to minimize flood damage, improve facility operation and maintenance, create public opportunities, and enhance wildlife corridors and wetlands. The SWMMP effort inventoried existing and potential storage facilities and conveyance systems within 13 major drainages in the planning area surrounding Casper, Mills, and Evansville. Fifty-seven ponds, including stock ponds, irrigation reservoirs, flood-control detention ponds, and inadvertent detention areas, were identified within the SWMMP planning area. The SWMMP included many recommendations and conceptual designs including these items incorporated as part of the Watershed Management Plan:

- **Watershed Management Recommendation 5:** Stabilize all major drainageways as the watersheds urbanize, rehabilitate existing degraded reaches of the major drainageways and their tributaries, and aggressively control erosion and sediment transport during construction activities.
- **Watershed Management Recommendation 6:** Preserve the existing natural drainageways as much as possible when development occurs.
- **Watershed Management Recommendation 7:** Require new land development, significant redevelopment, and publicly funded projects to provide runoff volume control whenever site conditions permit.
- **Watershed Management Recommendation 8:** Coordinate projects that have beneficial effects (e.g., Emigrant Gap Draw) with the Natrona County Conservation District.
- **Watershed Management Recommendation 9:** Investigate potential projects that require increasing the necessary flood-control volumes by raising existing embankments; improving flood conveyance systems; and grading within existing reservoir footprints in the Claude Creek, Eastdale Creek, Elkhorn Creek, Emigrant Gap Draw, Garden Creek, Sage Creek, and Squaw Creek drainage basins.
- **Watershed Management Recommendation 10:** Initiate a new detailed study of Emigrant Gap Draw from its confluence to the limit of the current SWMMP planning area.

4.11 THE MIDDLE NORTH PLATTE RIVER STUDY AREA MANAGEMENT PLAN

The information presented in this section provides recommendations for improvements associated with the following:

- Irrigation system rehabilitation components
- Livestock/wildlife upland watering opportunities
- Grazing management opportunities
- Storage opportunities
- Stream channel condition and stability
- Wetland enhancement opportunities
- Other watershed management opportunities.

Table 4.4 lists the itemized components of the Middle North Platte Watershed Management Plan. The conceptual cost estimates are tabulated in Chapter 6.0 of this report.

Table 4.4. Middle North Platte Watershed Management Plan (Page 1 of 3)

Irrigation System Components		
Rehabilitation Item Number	**Description**	**Priority**
I-01	Replace a large diversion/check structure	1
I-01	Rehabilitate a delivery ditch and replacement of an outlet pipe	2
I-01	Install approximately 6,200 feet of buried 15-inch PIP low-pressure irrigation PVC pipeline	1
I-02	Replace a headgate	1
I-02	Replace and enlarge siphon downstream of headgate	2
I-03	Rehabilitate a diversion/check structure	1
I-03	Replace a headgate	2
I-03	Protect a siphon by placing rock around the structure	2
I-03	Rehabilitate a headgate and diversion structure	2
I-04	Construct a storage pond to regulate irrigation water supply	1
I-04	Install approximately 10,200 feet of buried 12-inch PIP low-pressure irrigation PVC pipeline	1
I-04	Rehabilitate a diversion dam structure	2
I-05	Install approximately 1,800 feet of buried 12-inch PIP low-pressure irrigation PVC pipeline	1
I-05	Install approximately 2,300 feet of buried 12-inch PIP low-pressure irrigation PVC pipeline	2
Livestock/Wildlife Water Supply Projects		
Plan Component	**Description**	**Priority**
L/W-01	Stinking Water 1 Well and Pipeline	1
L/W-01A	Stinking Water Stock Reservoir/Wetland Rehabilitation	1
L/W-02	Middle Fork 2 Well and Pipeline	2
L/W-03	Middle Fork 3 Well and Pipeline	2
L/W-03A	Middle Fork 3A Spring Development	2
L/W-03B	Middle Fork 3B Spring Development	2
L/W-04	Middle Fork 4 Well and Pipeline	2
L/W-04A	Middle Fork 4A Pipeline and Tank	2
L/W-05	Middle Fork 5 Well and Pipeline	2
L/W-06	Shirley Ridge 1 Well and Pipeline	1

Table 4.4. Middle North Platte Watershed Management Plan (Page 2 of 3)

Livestock/Wildlife Water Supply Projects *(Continued)*		
Plan Component	**Description**	**Priority**
L/W-07	Shirley Ridge 2 Well and Pipeline	2
L/W-08	Shirley Ridge 3 Well and Pipeline	2
L/W-09	Shirley Ridge 4 Well and Pipeline	2
L/W-09A	Childers Well and Pipeline	2
L/W-10	McClanahan Well and Pipeline	1
L/W-11	Davidson 3 South Well and Pipeline	2
L/W-12	Davidson 3 North Well and Pipeline	2
L/W-13	Coyote Creek Well and Pipeline	2
L/W-14	Davidson 2 Well and Pipeline	2
L/W-15	Davidson South Well and Pipeline	2
L/W-15A	Forgey East Well and Pipeline	2
L/W-16	Strohecker 1 Well and Pipeline	1
L/W-17	Strohecker 2 Well and Pipeline	2
L/W-18	Pine Mountain Pipeline and Tank	2
L/W-19	Strohecker 3 Well and Pipeline	1
L/W-20	South Fork Casper Well and Pipeline	2
L/W-21	Strohecker 4 Well and Pipeline	2
L/W-22	West Pine Mountain Spring Development	2
L/W-23	Strohecker 5 Well and Pipeline	2
L/W-24	Eagle Ridge 1 Well and Pipeline	2
L/W-25	Eagle Ridge 2 Spring Development	2
L/W-26	Gotheberg Draw Well and Pipeline	2
L/W-27	Eagle Ridge 3 Well and Pipeline	2
L/W-28	Little Red Well and Pipeline	2
L/W-29	Eagle Ridge 4 Well and Pipeline	2
L/W-30	Casper Mountain Well and Pipeline	2
L/W-31	Stinking Creek 1 Spring Development	2
L/W-32	Stinking Creek 2 Well and Pipeline	2
L/W-33	Stinking Creek 3 Well and Pipeline	2
L/W-34	Hunt Creek Well and Pipeline	2

Table 4.4. Middle North Platte Watershed Management Plan (Page 3 of 3)

Livestock/Wildlife Water Supply Projects *(Continued)*		
Plan Component	**Description**	**Priority**
L/W-35	Lone Tree Well and Pipeline	2
L/W-36	Bates Creek 1 Well and Pipeline	2
L/W-37	Bates Creek 2 Spring Development	2
L/W-38	Bolton Creek 1 Well and Pipeline	2
L/W-39	Bolton Creek 1A Stock Pond	2
L/W-40	Bolton Creek 2 Well and Tank	2
L/W-41	Bates Creek 3 Well and Tank	2
L/W-42	Bates Creek 4 Well and Tank	2
L/W-43	Chalk Creek 1 Well and Pipeline	2
L/W-44	Chalk Creek 2 Well and Pipeline	2
L/W-45	Stinking Creek 4 Well and Tank	2
L/W-46	Stinking Creek 5 Well and Pipeline	2
L/W-47	Bolton Creek 3 Well and Tank	2
L/W-48	Stinking Creek 6 Well and Tank	2
L/W-49	Stinking Creek 7 Well and Tank	2
L/W-50	Stinking Creek 8 Well and Tank	2
L/W-51	Soap Creek 1 Well and Tank	2
L/W-52	Cabin Creek 1 Well and Tank	2
L/W-53	Cabin Creek 2 Well and Tank	2
L/W-54	Horse Heaven 1 Spring Development	2
L/W-55	Cabin Creek 3 Spring Development	2
L/W-56	Soap Creek 2 Well and Tank	2
L/W-57	Sand Spring Creek 1 Well and Tank	2
L/W-58	Sand Spring Creek 2 Well and Tank	2
L/W-59	Sand Spring Creek 3 Well and Tank	2
L/W-60	Wildlife Guzzlers	2

4.12 POTENTIAL EFFECTS AND BENEFITS OF WATERSHED MANAGEMENT PLAN COMPONENTS

In the following sections, the potential effects and benefits associated with key BMPs and conservation practices are discussed in relation to the various plan components: Livestock/Wildlife water supply (Components L/W), irrigation system rehabilitation (Components I), and storage (Components S). The intent of this discussion is to provide the decision makers with the background necessary to make informed decisions regarding future planning efforts.

The NRCS prepares NEDs of conservation practices or BMPs which act together to achieve desired purposes. The NEDs "are flow charts of direct, indirect and cumulative effects resulting from installation of the practices. Completed network diagrams are an overview of expert consensus on the direct, indirect and cumulative effects of installing proposed practice installation. They show the potential positive and negative outcomes of practice installation, and are useful as a reference point for next steps, and as a communication tool with partners and the public" [Natural Resources Conservation Service, 2014].

Benefits associated with a particular conservation practice or BMP can be classified as direct, indirect or cumulative. Direct and indirect benefits would be considered measureable or tangible benefits. For example, construction of a reservoir designed to augment late season irrigation water supplies provides the direct or measurable benefit, of providing a supply of water commensurate with its storage capacity. An indirect benefit could be the habitat provided to wildlife. Likewise, the same reservoir could provide the cumulative benefit of increased income to producers and improved health of the local economy.

As previously discussed, such benefits can be either quantitative or qualitative or both. Benefits can be local or global and specific or surrogate, depending on multiple factors unique and specific to the BMP, ecological site, watershed, or major land resource area. Project benefits can be related to ecological enhancement, water quantity, economic stability, stream corridor or riverine stability, or maintenance of open spaces. Where appropriate, the NRCS NED for the conservation practice is presented within this document.

4.12.1 Irrigation Rehabilitation Projects

The Watershed Management Plan includes seven recommendations. These projects include various forms of irrigation improvements and rehabilitation projects.

Irrigation Water Conveyance—Pipeline

The rehabilitation and replacement of existing irrigation system delivery conveyance structures help to efficiently deliver or convey water from a source of supply or diversion structures to areas of application or storage to facilitate management of irrigation water. The practice reduces erosion, conserves water, and protects water quality. Underground pipelines serve as an integral part of the irrigation water distribution system and significantly improve the overall efficiency of the system.

Strategies defining placement of irrigation water conveyance pipelines typically involve:

- Rehabilitation/replacement of existing structures
- Mitigation of seepage losses
- Enhanced delivery of irrigation water
- Reduction in annual operation and maintenance costs
- Improvement in ditch management and efficiency through water management
- Facilitation of irrigation water management plans
- Economic practicality
- Physical feasibility.

Effects and benefits of rehabilitating and improving water conveyance for irrigation systems are numerous and are displayed in the NRCS's NED in Figure 4.54. As shown in this figure, direct and indirect benefits associated with this BMP include:

- Water availability for irrigation
    - — Plant growth and productivity
- Infiltration and evaporation losses
    - — Increased plant growth and productivity
    - — Decreased leaching of nutrients
- Erosion associated with practice
    - — Decreased sediment delivery to surface waters

Cumulative effects/benefits of provision of reliable water supplies are described as:

- Positive impacts to income and stability of individual producers and the community
- Improved aquatic health of humans, domestic animals and wildlife
- Improved stream fauna and environmental quality.

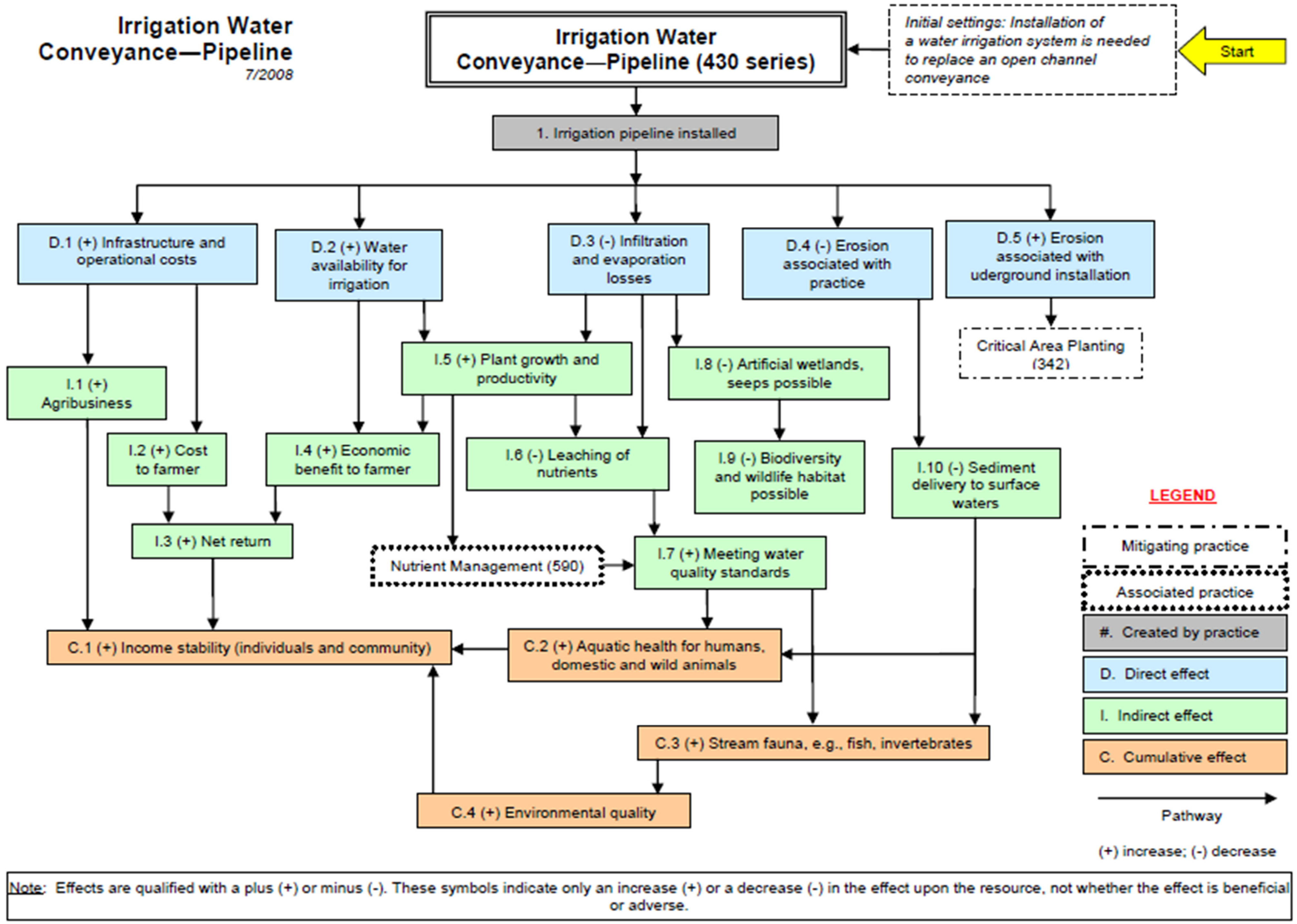


Figure 4.54. Network Effects Diagrams for Irrigation Conveyance—Pipeline.

4.12.2 Livestock/Wildlife Water Supply Projects

The Watershed Management Plan includes 36 recommendations. These projects include various forms of water facilities, water wells, spring developments, pipelines, and stock ponds.

Water Facilities

The development of reliable watering facilities in areas otherwise lacking reliable sources of water for livestock and wildlife, help to promote improved rangeland conditions in several ways. Water facilities may be associated with wells, springs, streams, ponds or hauled water. ***Reliable sources of water are integral aspects of any range management plan involving distribution of livestock.***

Strategies defining placement of water facilities typically involve:

- Facilitation of prescribed grazing management plans
- Alternative water supplies to riparian sources
- Provision of a reliable source where no other sources may exist
- Optimization of upland range resources.

Benefits of providing reliable water facilities for livestock and wildlife are numerous and are displayed in the NRCS's NED in Figure 4.55. As shown in this figure, direct and indirect benefits associated with this BMP include:

- Controlled access to streams, ponds, water supplies, and sensitive areas (when combined with proper fencing),
  - Decreased loading of pathogens, sediments, and nutrients to existing surface waters,
- Improved water quality, quantity and distribution of livestock and wildlife
  - Increased plant productivity
  - Improved wildlife habitat
  - Increased species diversity
  - Increased livestock food sources

Cumulative benefits of provision of reliable water supplies are described as:

- Positive impacts to income and stability of individual producers and the community,
- Improved aquatic health of humans, domestic animals and wildlife, and
- Improved health of humans, domestic animals and wildlife.

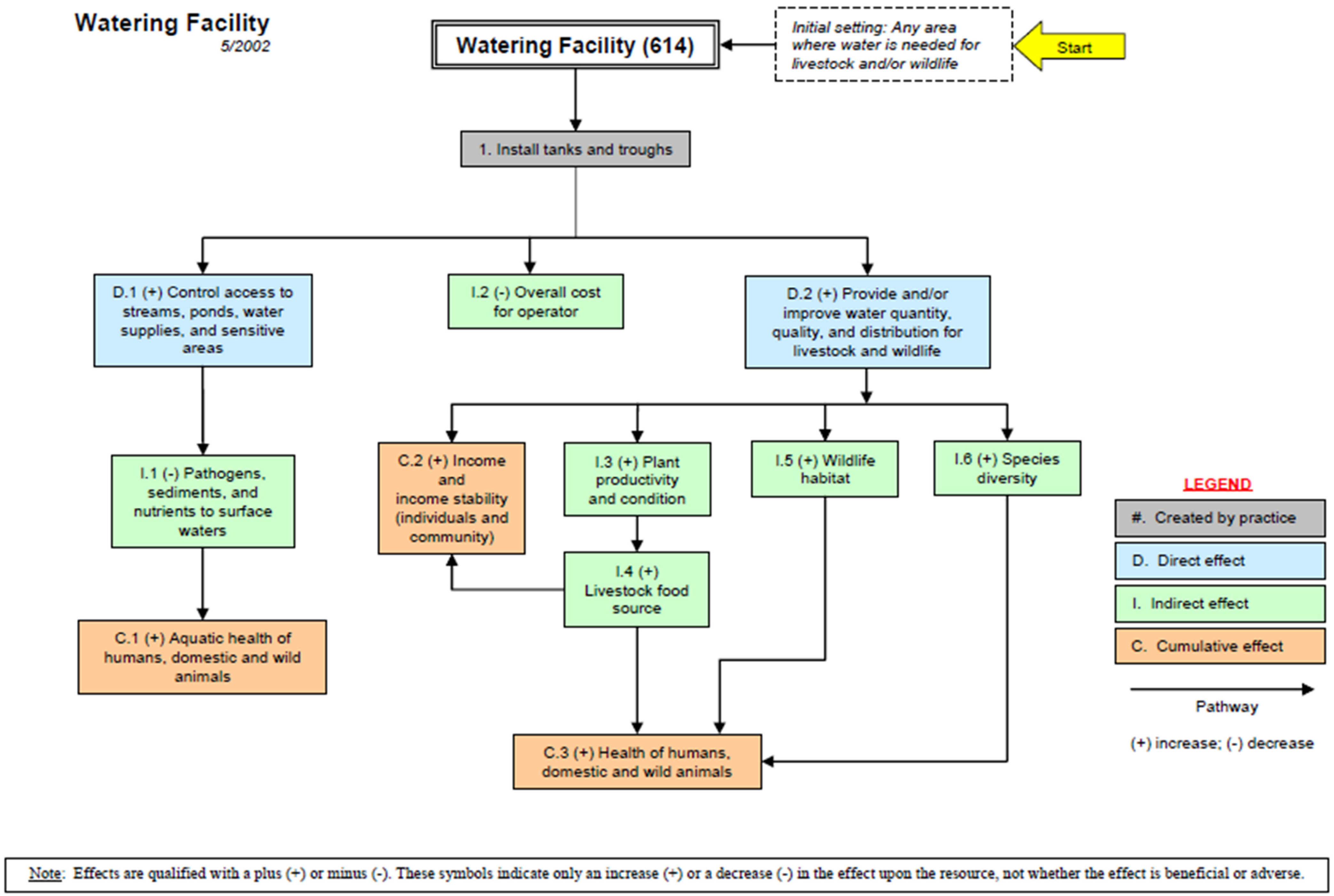


Figure 4.55. Network Effects Diagrams for Watering Facility.

4.12.3 Grazing Management Alternatives

The Watershed Management Plan includes 7 recommendations. These alternatives include conservation practices and BMPs such as water developments, fencing, salting and herding, ecological sites and state and transition models, prescribed fire, and application of chemicals along with other tools that can be used to facilitate and enhance grazing distribution and optimize range conditions through prescribed grazing practices.

Prescribed Grazing

Prescribed grazing is the controlled harvest of vegetation with grazing animals managed with the intent to achieve a specific objective. Prescribed grazing may be applied on lands where grazing and/or browsing animals are managed. A grazing schedule is prepared for allotments, pastures to be grazed. Removal of vegetation by the grazing animals is in conformity with realistic yield goals, plant growth needs, and management goals. Duration and intensity of grazing is based on desired plant health and expected productivity of the forage species to meet management objectives.

Strategies for applying prescribed grazing involve managing the intensity, frequency, duration, distribution, and season of grazing by:

- Defining landowner and/or manager goals and objectives
- Identifying needs for reliable water sources and supplies
- Feed and forage inventories and analyses
- Range condition and health evaluations and assessments
- Managing desirable and undesirable plant communities to meet grazing objectives

Benefits of implementing prescribed grazing and associated BMPs and conservation practices are numerous and are displayed in the NRCS's NED in Figure 4.56. As shown in this figure, direct and indirect benefits associated with this BMP include:

- Increased control of livestock grazing, feeding, watering locations
    - — Decreased loading of pathogens, sediments, and nutrients to surface waters,
- Increased manure distribution
    - — Increased soil quality
    - — Reduced contaminants, pathogens, sediments to receiving waters
- Soil erosion and compaction

- Increased plant productivity and maintenance
    - — Increased livestock production and health
    - — Increased wildlife health and populations

Cumulative benefits of implementing prescribing grazing could include:

- Positive impacts to income and stability of individual producers and the community
- Improved water quality and aquatic habitat
- Improved health of humans, domestic animals and wildlife.

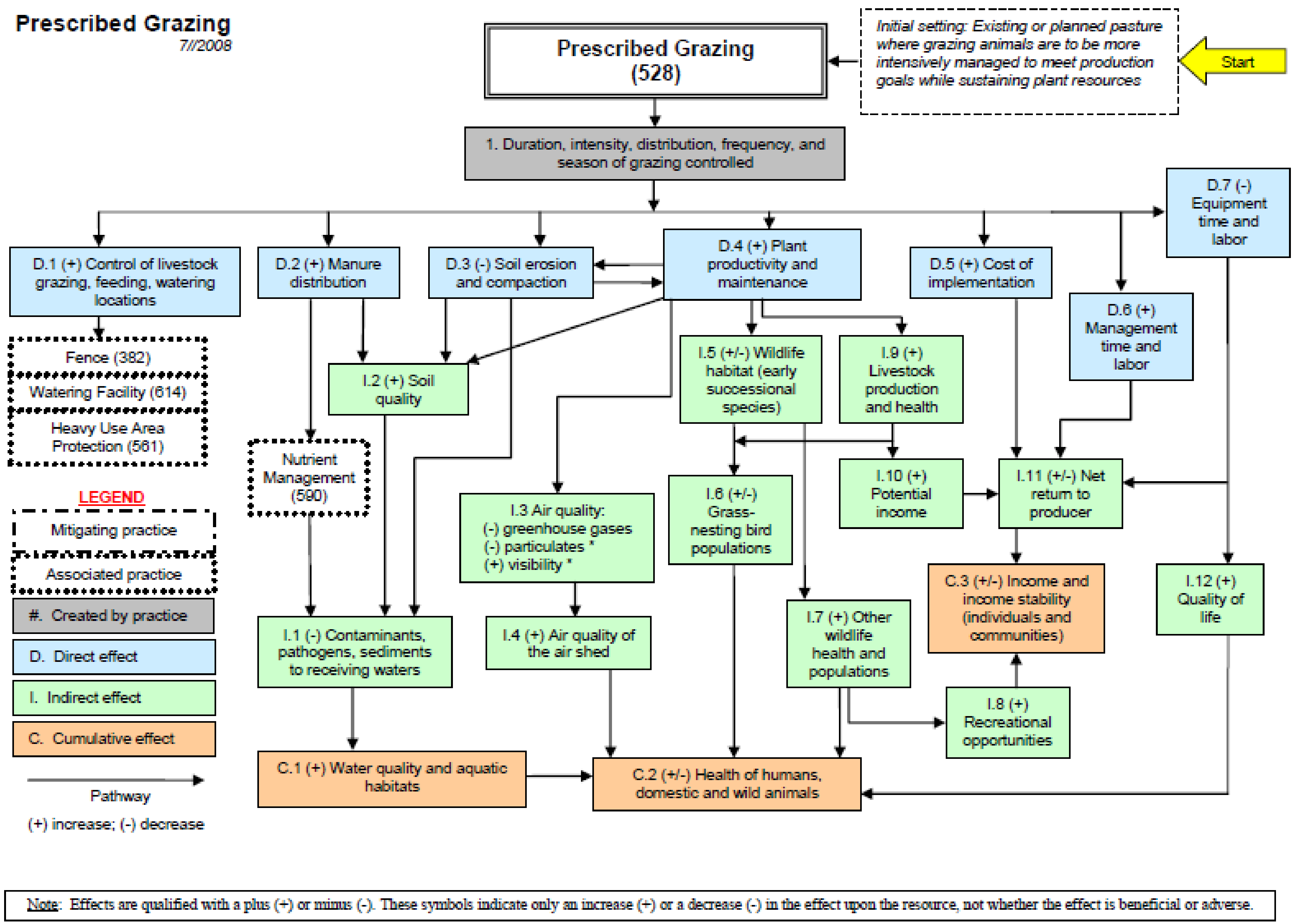


Figure 4.56. Network Effects Diagrams for Prescribed Grazing.

4.12.4 Stream Channel Restoration Projects

The Watershed Management Plan includes 4 recommendations. These alternatives include conservation practices and BMPs such as installation of stream channel degradation/incision and streambank erosion mitigation measures based upon site-specific evaluation of conditions along with routine monitoring of completed stream projects to identify necessary maintenance repairs and determine their effectiveness. Appropriate measures could be 'hard' engineering, 'soft' approaches, or combinations of both.

Streambank and Shoreline Protection

Streambank and shoreline protection is the stabilization and protection of streambanks, constructed channels, and shorelines of lakes and reservoirs.

Strategies for applying streambank and shoreline protection involve:

- Streambanks of natural or constructed channels and shorelines of lakes and reservoirs where they are susceptible to erosion.
- Various materials may be used for protection of streambanks and shorelines,
- A site-specific assessment should be conducted to determine if the causes are local or systemic and used to select appropriate treatment to achieve the desired objective,
- Functional and stable treatments for design flows and sustainable for higher flows.
- Preventing the loss of adjacent land or damage to land uses or other facilities
- Protecting historical, archeological, and traditional cultural properties
- Reducing the offsite or downstream effects of sediment resulting from bank erosion
- Improving the stream corridor for fish and wildlife habitat, aesthetics, and recreation

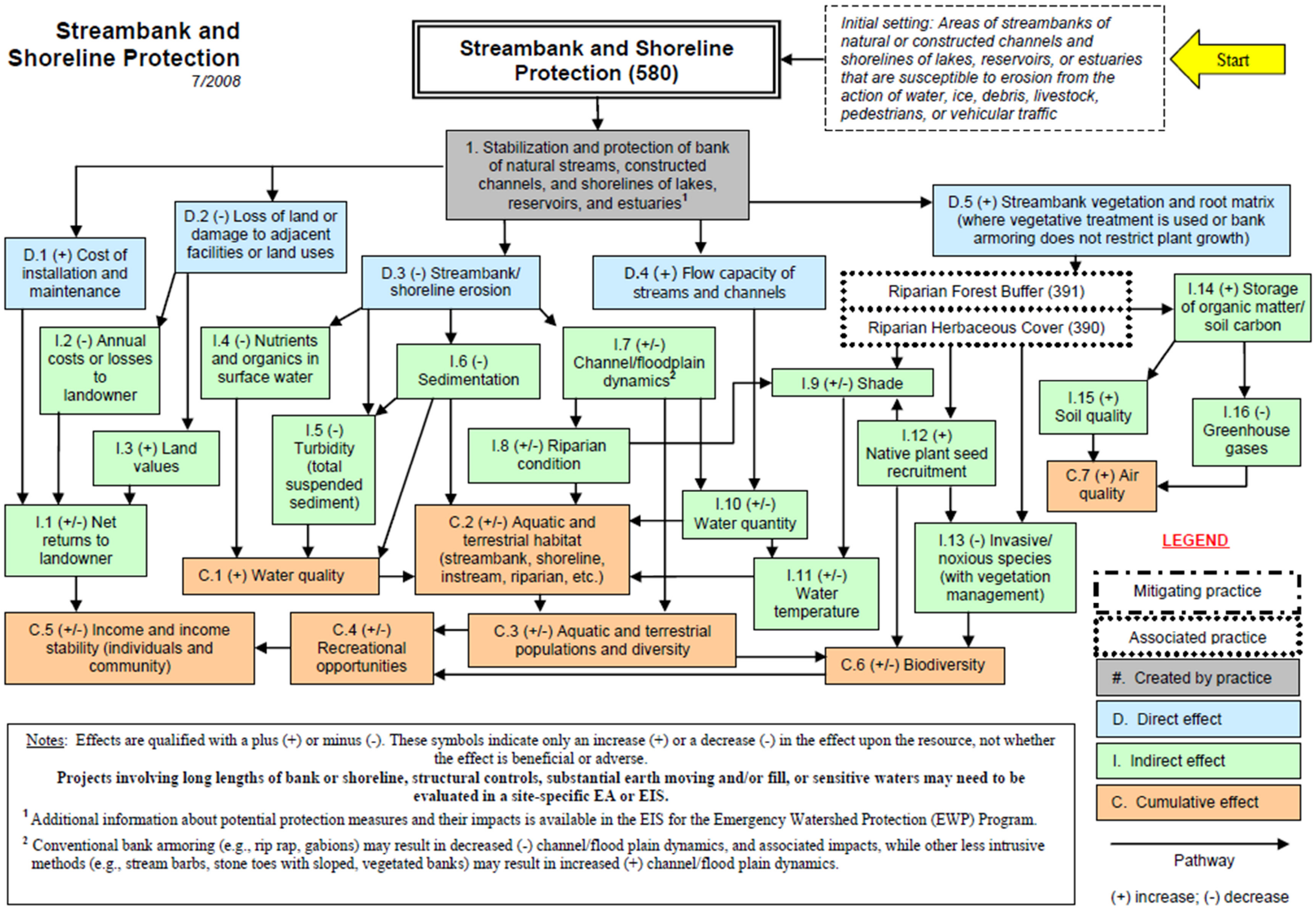
Benefits of implementing streambank and shoreline protection and associated BMPs and conservation practices are numerous and are displayed in the NRCS's NED in Figure 4.57. As shown in this figure, direct and indirect benefits associated with this BMP include:

- Decreased streambank and/or shoreline erosion
  - Increased soil quality
  - Decreased sedimentation
- Increased flow capacity of streams and channels
- Increased streambank vegetation and root matrices
  - Increased soil quality

- Increased native plant recruitment
- Decreased invasive/noxious species

Cumulative benefits of implementing streambank and shoreline protection could include:

- Positive impacts to income and stability of individual producers and the community,
- Improved water quality and aquatic and/or terrestrial habitat,
- Improved recreational opportunities.



Notes: Effects are qualified with a plus (+) or minus (-). These symbols indicate only an increase (+) or a decrease (-) in the effect upon the resource, not whether the effect is beneficial or adverse.

Projects involving long lengths of bank or shoreline, structural controls, substantial earth moving and/or fill, or sensitive waters may need to be evaluated in a site-specific EA or EIS.

[1] Additional information about potential protection measures and their impacts is available in the EIS for the Emergency Watershed Protection (EWP) Program.

[2] Conventional bank armoring (e.g., rip rap, gabions) may result in decreased (-) channel/flood plain dynamics, and associated impacts, while other less intrusive methods (e.g., stream barbs, stone toes with sloped, vegetated banks) may result in increased (+) channel/flood plain dynamics.

Figure 4.57. Network Effects Diagrams for Streambank and Shoreline Protection.

5.0 PERMITS

5.1 OVERVIEW

Information regarding the initial permitting and regulatory process for the proposed projects outlined in Chapter 4.0 of this report are contained in the following sections. The purpose of this preliminary analysis is to determine the known and probable reviews or assessments, permits and clearances, and other requirements or conditions that may be encountered in pursuing implementation of the proposed projects and watershed management recommendations within the watershed. These processes usually involve permit application and environmental evaluation; coordination with local, state, and federal agencies for review or approvals, and determination of potential impacts.

Some of proposed projects and future potential projects described in this study involving federal lands, funding, and programs would be subject to the National Environmental Policy Act (NEPA) and other federal regulations. The federal regulations are administered primarily by the BLM, USACE, EPA, NRCS, USFS, FSA, and USFWS. State agencies with regulatory oversight and permitting approval that would require coordination on some of the proposed or potential projects include, but are not limited to, the Wyoming SEO, WDEQ, SHPO, OSLI, and WGFD.

Additionally, various local zoning ordinances and permit requirements are associated with building, floodplain, and road or utility access that may be applicable within the city and county boundaries of the study area. Current zoning and permitting requirements are known to exist in Carbon, Converse, and Natrona Counties and within the municipal boundaries of the City of Casper and the towns of Alcova, Bar Nunn, Evansville and Mills that are applicable for constructing the proposed projects within the study area.

Permits or right-of-way access are required for the CAID, the WYDOT, and numerous utility and energy entities when project construction involves their properties. In the state of Wyoming, the state's "Wyoming Underground Facilities Notification Act" requires everyone who owns underground facilities in the state to be a member of One-Call of Wyoming. Before any excavation begins, the excavator is required to provide advance notice (at least 2 business days before intending to dig) to the One-Call of Wyoming Notification Center at 811 (or if calling from out-of-state, 1.800.849.2476) [W.S. §37 12-301].

5.2 NATIONAL ENVIRONMENTAL POLICY ACT COMPLIANCE AND DOCUMENTATION

Compliance with the NEPA applies whenever the proposed projects included in the watershed management plan would be located on federal lands, would need passage across federal lands, would be funded entirely or partially by federal agencies or programs, or would affect water quality that is regulated by federal law. The NEPA process is intended to help sponsors and agencies perform a review of the potential project effects and involve the public in making informed decisions about the environmental consequences of the proposed project.

For the proposed projects on federal lands or with federal cooperation, the BLM and the NRCS would likely be considered the lead agencies in the NEPA process because some of the proposed projects' involved actions would occur on BLM lands or would be in conjunction with NRCS Farmbill funding programs. Also, the COE would presumably have a role in reviewing proposed projects that involve wetland enhancement or where wetlands might be impacted. Typically, these federal agencies have a Memorandum of Understanding (MOU) to outline responsibilities and roles of the agencies when a proposed project involves multiple agencies. The NEPA process can also facilitate in meeting other environmental review requirements, such as the Endangered Species Act; the National Historic Preservation Act; the Environmental Justice Executive Order; and other federal, state, tribal, and local laws and regulations.

5.2.1 National Environmental Policy Act Process for Reservoir Storage Projects

NEPA compliance efforts associated with any reservoir alternative would likely require preparing an EIS and associated efforts. The BLM or the USFS would likely be the lead agency for any water storage alternative project specified in the Plan.

5.2.2 National Environmental Policy Act Process for Other Projects

To determine whether or not NEPA compliance is required for the proposed projects other than major (nonstock pond) reservoir storage, an individual, site-specific review is necessary to define factors, including the project's location, ownership, type, and funding. The majority of the proposed projects within the watershed management plan would involve coordinating with the NRCS and the BLM in completing the NEPA process and associated documentation. The NEPA process for the proposed projects is usually less rigorous and preparing an environmental assessment (EA) or EIS is probably unlikely because there is typically no significant impact to the environment and resources from the types of these proposed projects. However, the BLM and the NRCS have specific policies and procedures for completing and documenting the NEPA process for these other types of projects; these are explained in the following sections.

5.2.2.1 Bureau of Land Management

All of BLM's actions, approvals, or authorizations have to conform to an existing land use plan, which is typically a RMP. Three approved RMPs for the BLM's Field Offices cover portions of the watershed including the 2007 Casper RMP, the 1987 Lander RMP, and the 2008 Rawlins RMP. The Lander Field Office is revising their existing RMP.

A proposed project or action that was identified and provided for in the RMP and associated EIS or EA would be considered to be in compliance; however, if the plan did not include the project or action, the activity is then reviewed to determine whether or not it is in conformance with the plan. If the project or action conforms with the plan, no modification is necessary; however, if the proposed activity is not in conformance, the proposal could then be modified to conform with the plan, or an amendment of the plan could be completed if necessary, or the proposal could be rejected and is not considered through a plan amendment. Presently, the BLM would be the lead agency for the previously described environmental review process and proposal consideration. These reviews are performed by BLM personnel and/or cooperating state and federal agency specialists and qualified private expert contractors reporting to the BLM. An example of an environmental review would be a proposed new wildlife/livestock watering development, which includes a water tank and delivery pipeline system that crosses or provides water to a watering facility on the BLM land and, therefore, would need to be reviewed to determine whether or not it conforms with the appropriate BLM RMP and complete the identified NEPA requirements.

5.2.2.2 Natural Resource Conservation Service

An example of an environmental review for a project would be a proposed new wildlife/livestock watering development, which includes a water tank and delivery pipeline system that crosses or provides water to a watering facility on federal or state land and, thus, would need to follow and document an appropriate NEPA process. Another example would be a proposed wildlife/livestock water development, which includes NRCS EQIP funding, and engineering design assistance for a water well, solar pump, stock tank, and pipeline located entirely on private land. This would still require that the NRCS conduct an Environmental Evaluation and complete their Environmental Evaluation Worksheet (Form NRCS-CPA-52) to determine if an EA or EIS is required and to document the results of the evaluation and show compliance with NEPA.

5.3 PERMITS, CLEARANCES, AND APPROVALS

5.3.1 Dam and Reservoir Construction

In addition to the U.S. Army Corps of Engineers (COE) Section 404 Permit, there are numerous other permits and/or approvals required for new dam and reservoir construction. Presented below are the primary additional permits and/or approvals that would be required for any of the alternative projects under consideration.

Section 404 Permit. Like all water development projects, any dam and reservoir storage project in the study area will face environmental permitting issues. Typically the most significant environmental permit to be secured is a Section 404 Dredge and Fill permit from the COE, Omaha District. Even when impacts are anticipated to be modest, the process of obtaining a Section 404 permit for new storage projects may take several years from initiation of the NEPA process.

The primary guidance in embarking on the permitting process for a new dam and reservoir storage project is the development of a defensible Purpose and Need for the project. The NEPA process dictates that the least environmentally damaging practicable alternative that addresses the purpose and need be pursued. This is the alternative most likely to be successfully permitted.

Endangered Species Act (Section 7 Consultation). The lead agency would prepare a biological assessment to determine project effects on threatened and endangered plant and animal species listed or proposed for listing (candidate species) under the Endangered Species Act (16 U.S.C. § 1531 et seq.). U.S. Fish and Wildlife Service (FWS) would then issue an opinion on whether federal actions are likely to jeopardize the continued existence of a threatened or endangered species, or destroy or adversely modify critical habitat. FWS must approve the preparation of a biological assessment to comply with the Endangered Species Act in order to render its decision. If FWS determines that the preferred alternative would jeopardize the continued existence of a species, it may offer a reasonable and prudent alternative that would preclude jeopardy.

Fish and Wildlife Coordination Act. The Fish and Wildlife Coordination Act requires federal agencies involved in actions that will result in the control or structural modification of any natural stream or body of water for any purpose to take action to protect the fish and wildlife resources which may be affected by the action. It requires federal agencies or applicants to first consult with state and federal wildlife agencies to prevent, mitigate and compensate for project-caused losses of wildlife resources, as well as to enhance those resources.

Laws and Regulations Addressing Cultural Resources. Because federal approvals are likely involved with any of the identified alternatives, a consideration of effects on cultural resources must be undertaken (Section 106 consultation), as required under the following laws and regulations: the National Historic Preservation Act (NHPA) of 1966 (16 U.S.C. § 470 et seq.); the National Environmental Policy Act (NEPA) of 1969 (42 U.S.C., § 4321); the Archaeological Resources Protection Act (ARPA) of 1979 (16 U.S.C. § 470aa et seq.); the National Park Services (NPS) procedures concerning the National Register of Historic Places (NR) (36 CFR Part 60); the Advisory Council on Historic Preservation's Procedures for the Protection of Cultural Properties (36 CFR Part 800); the Treatment of Archaeological Properties of 1980: Determination of Eligibility for Inclusion in the NR (36 CFR 63); the Secretary of Interior's Standards and Guidelines for Archaeological Historical Preservation of 1983; Reservoir Salvage Act of 1960; and the l974 Amendment to the Reservoir Salvage Act of 1960. The State of Wyoming Historic Preservation Office (SHPO) coordinates with federal agencies in determining the significance of cultural resources potentially affected by ground disturbing activities.

In addition, consultation with relevant Native American groups concerning traditional cultural properties is required under the American Indian Religious Freedom Act of 1978 (AIRFA, P.L. 95-341.42 U.S.C. § 1996) and Section 4 of ARPA of 1979. Guidelines for evaluation of traditional cultural properties are contained in Bulletin 38 issued by the National Park Service.

Wyoming Board of Land Commissioners. The Wyoming Board of Land Commissioners through the State Lands and Investments Board (SLIB) is responsible for regulating all activities on state lands, including granting of rights-of-way. Any facility, utility, road, railroad, ditch or reservoir to be constructed on state or school lands must have a right-of-way, as required in the "Rules and Regulations Governing the Issuance of Rights Of Way" (W.S. 36-20 and W.S. 36-202).

Wyoming State Engineer's Office Surface Water Storage Permit. The State Engineer's Office administers the water rights system of appropriation within the state. The Applicant must obtain the necessary water rights permits from the State of Wyoming for the diversion and storage of the State's surface water.

Wyoming State Engineer's Office Permit to Construct/Dam Safety Review. The Wyoming Dam Safety Law [Wyoming State Legislature, 2013] requires that any persons, public company, government entity or private company who proposes to construct a dam which is greater than 20 feet high or which will impound more than 50 acre-feet of water, or a diversion system which will carry more than 50 cubic feet of water per second, must obtain approval for construction of the dam or ditch from the SEO. The approval by the SEO of a dam's construction is contingent upon the Office's review and approval of all dam plans and specifications, which must be prepared by a registered professional engineer licensed in Wyoming. Design, construction, and operation of jurisdictional dams must also comply with dam safety regulations promulgated pursuant to the Dam Safety Act.

Wyoming State Engineer's Office Ditch Enlargement Permit. In addition to the permits and clearances that will be required for reservoir construction, existing irrigation ditches may require to convey water to off-channel reservoirs. If so, this effort would require an enlargement filing with the SEO. Even if physical enlargement of the existing ditch was found to not be required, the enlargement filing would be a legal formality as a water right requirement.

Wyoming Department of Environmental Quality—National Pollution Discharge Elimination System (NPDES) Permit and SECTION 401 Certification. The federal Clean Water Act is administered in Wyoming by the WDEQ, Water Quality Division (WQD) consistent with the Wyoming Environmental Quality Act. The Section 401 Certification is the State's approval to ensure that the activities authorized under Section 404 meet state water quality standards and do not degrade water quality. Any discharge of pollutants into the broadly defined "waters of the state" requires application to and permit issuance by WQD in accord with WQD's Rules and Regulations. This body of regulations sets forth classification of surface and groundwater uses and establishes water quality standards. The WQD administers the NPDES permit system including storm water permits and construction-related, short-term discharge permits.

Implementation of any of the action alternatives would require application for and compliance with the provisions of the statewide general NPDES Construction Storm Water Discharge Permit

(WYR10-000). Construction activities associated with dam construction or enlargement often result in the requirement to temporarily discharge pumped water. These discharges are provided for in a general permit. Upon acceptance of the application by WDEQ, the temporary discharge must be in compliance with the terms of the general permit and any stipulations applied as a result of the application's review.

EPA has oversight responsibility for federal Clean Water Act programs delegated to and administered by the WDEQ WQD. EPA also may intervene to resolve interstate disputes where discharges of pollutants in an upstream state may affect water quality in a downstream state.

Mining Permit. A Wyoming mining permit is not required for development of an aggregate and/or borrow material source solely for use in construction of one of the various reservoir alternatives and whose product is not for commercial sale. Commercial sources of aggregate, rock, or other mined materials are responsible for obtaining and maintaining all required permits and clearances for their operations.

Special Use Permits/Rights-of-Way/Easements. Special use permits, rights-of-way (ROW) or easements will be required wherever access across the lands of others (private, state or federal) is needed for construction and/or operation of the project facilities. These may be temporary (e.g., access to a temporary borrow area or quarry site to be closed and reclaimed; construction of a new haul road; etc.) or permanent (e.g., construction of a wildlife/livestock pipeline alignment). Usually privately owned lands that will be rendered permanently unavailable (such as the dam and reservoir footprint of a storage project) would be purchased unless the owner desired (and the sponsoring entity agreed) to a permanent easement. Permanent use of BLM lands would most likely be administered under a grant with an appropriate term issued under their ROW process; the USFS would use their equivalent special use process. An easement or ROW from the Wyoming Department of Transportation (WYDOT) or Carbon, Converse, or Natrona Counties may also be required. The specific requirements for rights-of-way, special use permits and easements vary widely and should be determined as part of the early stages of planning for a specific proposed project. This will help to avoid the potential for significant project delay, higher costs, or required changes in location/alignment or design during project development and implementation.

Other. In addition to the above, there may be other permits and clearances required for a given dam and reservoir project. These might include permits typically required to be provided by the construction contractor (e.g., air quality permit and trash/slash burning permit).

5.3.2 Other Project Types

Permit and clearance approvals for the proposed projects would depend on the site-specific project and its location. The permits and clearances discussed in Sections 5.1 and 5.3.1 could also be applicable for proposed projects. Permitting and clearance requirements for a specific project should be identified in the initial planning to achieve regulatory compliance, lower project costs, and avoid construction interruptions or design modifications. The following list includes permits and entities that may need to be obtained or involved in some of the watershed development projects. The extent of involvement and the nature of coordination would be determined on a project-by-project basis.

- USCOE Section 404 permits
- WDEQ, City of Casper, and Natrona County NPDES Stormwater
- WDEQ Discharge Permits for Construction Activities and Section 401 Certification
- Endangered Species Act (Section 7 Consultation)
- Fish and Wildlife Coordination Act
- OSLI and Wyoming Board of Land Commissioners Permits and/or Clearances
- SHPO Reviews and Consultations
- SEO Water Well Permits
- BLM and USFS Special Use Permits
- Carbon, Converse, and Natrona County Building or Floodplain Permits
- Casper, Evansville, and Mills, and other towns' Building or Floodplain Permits.

5.4 ENVIRONMENTAL CONSIDERATIONS

5.4.1 Proposed, Threatened, and Endangered Species

The following species have the potential to occur within the proposed project areas within the watershed study area [Wyoming Natural Diversity Database, 2013]:

- **Endangered:** Black-footed ferret (*Mustela nigripes*)
- **Threatened:** Piping Plover (*Charadrius melodus*)
  Canada lynx (*Lynx Canadensis*)

5.4.2 Other Species of Concern

The WYNDD records and maintains a list of species in Wyoming that are thought to be rare or sensitive, as discussed in Section 3.4.8.2. Table 3.10 lists the tracked or watched status of other species of concern potentially occurring within the study area, including 2 amphibians, 77 birds, 3 crustaceans, 3 fish, 18 mammals, 5 mollusks, and 6 reptiles [Wyoming Natural Diversity Database, 2013]. While none of these other species receive federal or state protection, the sage grouse is listed as a "candidate species; warranted but precluded" because existing information supports a proposal to list them as endangered or threatened; however, developing a proposed listing is precluded by higher priority listing activities.

5.4.2.1 Sage Grouse

In March 2010, the USFWS published its listing decision for the Greater Sage-Grouse *(Centrocercus urophasianus)* as “warranted but precluded” and deficiencies in land use plan regulatory procedures was identified as a major threat in the USFWS’ decision. In 2011, the Governor of Wyoming issued an executive order that requires state agencies to focus management to the greatest extent possible to prevent the sage grouse from being listed as a threatened or endangered species. The core areas for sage grouse cover approximately 820,282 acres, or 55 percent of the study area, and are shown in Figure 3.17.

Also in response to the USFWS’ decision, the BLM and the USFS prepared draft amendments with conservation measures for sage grouse to their existing RMPs and Forest plans within the BLM’s Casper, Rawlins, and Lander Field Offices and the USFS’ Medicine Bow National Forest. These measures included restrictions on land uses and actions to reduce the impacts of BLM/Forest Service programs or authorized uses. These amendments addressed core/priority, general, and connectivity habitat types for the sage grouse in eastern, western, and southern Wyoming. In December 2013, the BLM and USFS released the following document and published a notice of availability in the Federal Register and opened a 90-day public comment period that will close March 24, 2014 [Sonneman, 2013]:

> *Wyoming Greater Sage-Grouse Draft Land Use Plan Amendment and Draft Environmental Impact Statement for the Casper, Kemmerer, Newcastle, Pinedale, Rawlins, and Rock Springs Field Offices and Bridger-Teton and Medicine Bow National Forests and Thunder Basin National Grassland for Public Lands Administered by the Bureau of Land Management Wyoming State Office and National Forest System Lands Administered by the Medicine Bow and Bridger-Teton National Forests and Thunder Basin National Grassland, December 2013.*

The BLM and the USFS is expected to issue separate records of decisions by September 30, 2014. Although the proposed and draft EIS for the Wyoming sage grouse plan have been released and reviewed as part of this watershed study, coordinating with the BLM and the WGFD is recommended for any proposed or future project that has potential to impact sage grouse habitat.

5.4.2.2 Rare Plant Species

The WYNDD, which was discussed in Section 3.5.4.2 and listed in Table 3.16, has 17 known rare plant species that are being watched and tracked along with wildlife species within the study area. Although some of these plant species could occur on a proposed project area, none of the plant species are currently protected by state or federal regulation but still deserve appropriate planning and implementation conservation efforts.

5.4.2.3 Big Game Species

The watershed contains portions of crucial big game habitat for antelope, mule deer, and elk managed by the WGFD and seasonal ranges for several big game species. Five terrestrial Crucial Habitat Priority Areas exist within the watershed that contains big game crucial winter ranges, big game parturition areas, and mule deer and antelope winter-yearlong ranges. Crucial habitats have biological important features that need protected or managed to maintain viable healthy wildlife populations and are areas where the WGFD concentrates their habitat protection and management activities. Proposed projects within this plan are typically implemented in a manner that improves or maintain these habitat features.

5.4.2.4 Fish Species

The study area contains waters with productive sport fisheries, including sections of the North Platte River, Alcova Reservoir, and Bates Creek. The alternatives presented for the Bates Creek Reservoir may have impacts to the streams and associated fishery resources, and initial review and coordinating with the WGFD is recommended before moving forward with any of the proposed alternatives. Other proposed projects such as livestock/wildlife water are expected to have no direct effect on fishery resources.

5.4.2.5 Wetlands

Site-specific wetland delineation and inventories were not part of the scope of the watershed study. Geospatial data for the mapped NWI areas are shown in Figure 3.27 and was included to identify where wetlands are located within the watershed. This mapping was used in preparing conceptual proposed projects areas that would avoid impacts to wetland resources. The alternatives for rehabilitating Bates Creek Reservoir, dam embankment, and the Inlet Ditch may affect wetland resources depending on the specific provisions of the plans, designs, and construction specifications. Wetland creation and water development proposals within the study area should consult the COE about any jurisdictional determinations and potential impacts on wetlands before implementing any proposed project. Additionally, proposed wetland projects should consider the concentration of selenium (Se) in the contributing water sources' soil and underlying geology.

5.5 MITIGATION

Mitigation requirements may be necessary for the alternative dam and reservoir sites presented in this plan to address impacts to wetlands, riparian vegetation, stream channel habitat, cultural resources, wildlife resources, and possibly threatened or endangered species. Preferably, an approach would include evaluating and considering these resources as part of any feasibility planning, which would adjust the designs accordingly and avoid the need for mitigation of significant impacts by potential designs and construction plans. Specific mitigation measures would need to be formulated to compensate for wetland losses determined by certified wetland delineations. Because of the relatively small number of wetland acres within the study area, the potential amount of wetland acres that would be impacted by proposed projects is also low. Avoiding potential impacts to species of concern and associated habitat could usually be accomplished by scheduling construction activities outside of the relevant species nesting, parturition, breeding, or migration seasons. Proposed projects and activities involving sage grouse and sage grouse habitat, as mentioned previously, should be coordinated with the BLM and the WGFD.

5.6 LAND OWNERSHIP AND PROPERTY OWNERS

Permission should be negotiated for easements, right-of-way, and right-of-access for all construction activities associated with the project. **Note that the WWDC has stated that lands will NOT be "taken" or condemned to construct projects recommended within the watershed management plan. Representatives of the WWDC have stated that the state is not interested in condemning lands for the purpose of constructing a reservoir built with an objective of benefitting those whose lands would be used. Participation must be voluntary.**

6.0 COST ESTIMATES

Costs were estimated for each of the conceptual proposed projects and alternatives described in Chapter 4.0. These estimated costs, representing 2013 dollars, are explained for each of the proposed project categories in the following subsections.

6.1 IRRIGATION SYSTEM COMPONENTS

The costs of irrigation system components of the watershed management plan were estimated by using current unit costs for individual projects. The NRCS EQIP cost docket data were used when possible for typical design concepts. The irrigation system cost estimates are itemized in Table 6.1.

6.2 UPLAND WILDLIFE/LIVESTOCK WATER COMPONENTS

The costs of upland wildlife/livestock water projects and components from the Watershed Management Plan were estimated by using recent unit costs for similar projects, the 2013 NRCS EQIP cost docket data, and manufacturers' and vendors' advertised product prices. An itemized list of accompanying costs for each upland wildlife/livestock water project component is provided in Table 6.2. A typical upland water project normally includes the following general cost assumptions:

- Water Wells – costs range from $9,000 to $22,000 each, depending on total depth.
- Water Tanks – costs range from $2,000 to $3,000 each, depending on stock and storage tank volume.
- Pipelines – costs range from $8,000 to $11,000 per mile of piping and trenching.
- Spring Developments – costs range from $1,000 to $2,000, depending on storage tank volume and infiltration design capacity.
- Solar Pump, Panels, and Controls – costs range from $6,000 to $10,000, depending on pumping depth and number of panels.
- Conventional Windmills – costs range from $5,000 to $10,000, depending on fan wheel and stroke size.

Table 6.1. Irrigation Cost Estimates

Rehabilitation Item Number	Priority	Pipeline	Structure for Water Control Small	Structure for Water Control Medium	Structure for Water Control Large	Streambank Protection	Irrigation Reservoir	Construction Costs	Engineering Costs (10%)	Construction and Engineering Subtotal	Contingency (15%)	Total Construction Costs	Final Plans and Specifications	Permits, Fees, Access	Total Project Costs	Total Project Costs
I-01	1	6,500			1			$95,297.49	$9,530	$104,827	$15,724	$120,551	$2,000	$2,000	$124,551	$124,600
I-02	1	300	1					$37,101.17	$3,710	$40,811	$6,122	$46,933	$2,000	$2,000	$50,933	$50,900
I-03	1		1	1	1	100		$47,778.47	$4,778	$52,556	$7,883	$60,440	$2,000	$2,000	$64,440	$64,400
I-04	1	10,200		1			1	$138,471.80	$13,847	$152,319	$22,848	$175,167	$2,000	$2,000	$179,167	$179,200
I-05	1	4,100	1					$53,415.84	$5,342	$58,757	$8,814	$67,571	$2,000	$2,000	$71,571	$71,600

Table 6.2. Estimated Costs Associated With Each of the Upland Livestock/Wildlife Water Source/Supply Proposed Projects and Components of the Watershed Management Plan (Page 1 of 2)

Item Number	Plan Component	Description	Priority	Construction Costs ($)	Engineering Costs (10%) ($)	Construction and Engineering Subtotal ($)	Contingency (15%) ($)	Total Construction Costs ($)	Final Plans and Specs ($)	Permits, Fees, Access ($)	Total Project Costs ($)
1	L/W-01	Stinking Water 1 Well and Pipeline	1	52,600	5,260	57,860	8,679	66,539	2,000	2,000	70,500
2	L/W-01A	Stinking Water Stock Reservoir/Wetland Rehabilitation	1	45,600	4,560	50,160	7,524	57,684	3,000	3,000	63,700
3	L/W-02	Middle Fork 2 Well and Pipeline	2	50,620	5,062	55,682	8,352	64,034	2,000	2,000	68,000
4	L/W-03	Middle Fork 3 Well and Pipeline	2	79,720	7,972	87,692	13,154	100,846	2,000	2,000	104,800
5	L/W-03A	Middle Fork 3A Spring Development	2	11,630	1,163	12,793	1,919	14,712	2,000	2,000	18,700
6	L/W-03B	Middle Fork 3B Spring Development	2	11,630	1,163	12,793	1,919	14,712	2,000	2,000	18,700
7	L/W-04	Middle Fork 4 Well and Pipeline	2	69,490	6,949	76,439	11,466	87,905	2,000	2,000	91,900
8	L/W-04A	Middle Fork 4A Pipeline and Tank	2	21,180	2,118	23,298	3,495	26,793	2,000	2,000	30,800
9	L/W-05	Middle Fork 5 Well and Pipeline	2	49,240	4,924	54,164	8,125	62,289	2,000	2,000	66,300
10	L/W-06	Shirley Ridge 1 Well and Pipeline	1	60,700	6,070	66,770	10,016	76,786	2,000	2,000	80,800
11	L/W-07	Shirley Ridge 2 Well and Pipeline	2	51,610	5,161	56,771	8,516	65,287	2,000	2,000	69,300
12	L/W-08	Shirley Ridge 3 Well and Pipeline	2	47,920	4,792	52,712	7,907	60,619	2,000	2,000	64,600
13	L/W-09	Shirley Ridge 4 Well and Pipeline	2	46,600	4,660	51,260	7,689	58,949	2,000	2,000	62,900
14	L/W-09A	Childers Well and Pipeline	2	101,830	10,183	112,013	16,802	128,815	2,000	2,000	132,800
15	L/W-10	McClanahan Well and Pipeline	1	76,900	7,690	84,590	12,689	97,279	2,000	2,000	101,300
16	L/W-11	Davidson 3 South Well and Pipeline	2	58,910	5,891	64,801	9,720	74,521	2,000	2,000	78,500
17	L/W-12	Davidson 3 North Well and Pipeline	2	47,260	4,726	51,986	7,798	59,784	2,000	2,000	63,800
18	L/W-13	Coyote Creek Well and Pipeline	2	52,210	5,221	57,431	8,615	66,046	2,000	2,000	70,000
19	L/W-14	Davidson 2 Well and Pipeline	2	58,810	5,881	64,691	9,704	74,395	2,000	2,000	78,400
20	L/W-15	Davidson South Well and Pipeline	2	32,020	3,202	35,222	5,283	40,505	2,000	2,000	44,500
21	L/W-15A	Forgey East Well and Pipeline	2	86,260	8,626	94,886	14,233	109,119	2,000	2,000	113,100
22	L/W-16	Strohecker 1 Well and Pipeline	1	42,200	4,220	46,420	6,963	53,383	2,000	2,000	57,400
23	L/W-17	Strohecker 2 Well and Pipeline	2	79,100	7,910	87,010	13,052	100,062	2,000	2,000	104,100
24	L/W-18	Pine Mountain Pipeline and Tank	2	26,520	2,652	29,172	4,376	33,548	2,000	2,000	37,500
25	L/W-19	Strohecker 3 Well and Pipeline	1	107,220	10,722	117,942	17,691	135,633	3,000	3,000	141,600
26	L/W-20	South Fork Casper Well and Pipeline	2	104,850	10,485	115,335	17,300	132,635	3,000	3,000	138,600
27	L/W-21	Strohecker 4 Well and Pipeline	2	46,930	4,693	51,623	7,743	59,366	2,000	2,000	63,400
28	L/W-22	West Pine Mountain Spring Development	2	3,320	332	3,652	548	4,200	2,000	2,000	8,200
29	L/W-23	Strohecker 5 Well and Pipeline	2	54,520	5,452	59,972	8,996	68,968	2,000	2,000	73,000
30	L/W-24	Eagle Ridge 1 Well and Pipeline	2	94,290	9,429	103,719	15,558	119,277	3,000	3,000	125,300
31	L/W-25	Eagle Ridge 2 Spring Development	2	6,020	602	6,622	993	7,615	2,000	2,000	11,600
32	L/W-26	Gotheberg Draw Well and Pipeline	2	50,560	5,056	55,616	8,342	63,958	2,000	2,000	68,000
33	L/W-27	Eagle Ridge 3 Well and Pipeline	2	57,880	5,788	63,668	9,550	73,218	2,000	2,000	77,200

Table 6.2. Estimated Costs Associated With Each of the Upland Livestock/Wildlife Water Source/Supply Proposed Projects and Components of the Watershed Management Plan (Page 2 of 2)

Item Number	Plan Component	Description	Priority	Construction Costs ($)	Engineering Costs (10%) ($)	Construction and Engineering Subtotal ($)	Contingency (15%) ($)	Total Construction Costs ($)	Final Plans and Specs ($)	Permits, Fees, Access ($)	Total Project Costs ($)
34	L/W-28	Little Red Well and Pipeline	2	67,780	6,778	74,558	11,184	85,742	2,000	2,000	89,700
35	L/W-29	Eagle Ridge 4 Well and Pipeline	2	64,150	6,415	70,565	10,585	81,150	2,000	2,000	85,100
36	L/W-30	Casper Mountain Well and Pipeline	2	64,480	6,448	70,928	10,639	81,567	2,000	2,000	85,600
37	L/W-31	Stinking Creek 1 Spring Development	2	9,650	965	10,615	1,592	12,207	2,000	2,000	16,200
38	L/W-32	Stinking Creek 2 Well and Pipeline	2	46,270	4,627	50,897	7,635	58,532	2,000	2,000	62,500
39	L/W-33	Stinking Creek 3 Well and Pipeline	2	100,230	10,023	110,253	16,538	126,791	3,000	3,000	132,800
40	L/W-34	Hunt Creek Well and Pipeline	2	55,840	5,584	61,424	9,214	70,638	2,000	2,000	74,600
41	L/W-35	Lone Tree Well and Pipeline	2	36,040	3,604	39,644	5,947	45,591	2,000	2,000	49,600
42	L/W-36	Bates Creek 1 Well and Pipeline	2	107,870	10,787	118,657	17,799	136,456	2,000	2,000	140,500
43	L/W-37	Bates Creek 2 Spring Development	2	10,970	1,097	12,067	1,810	13,877	2,000	2,000	17,900
44	L/W-38	Bolton Creek 1 Well and Pipeline	2	31,360	3,136	34,496	5,174	39,670	2,000	2,000	43,700
45	L/W-39	Bolton Creek 1A Stock Pond	2	50,000	5,000	55,000	8,250	63,250	3,000	3,000	69,300
46	L/W-40	Bolton Creek 2 Well and Tank	2	31,360	3,136	34,496	5,174	39,670	2,000	2,000	43,700
47	L/W-41	Bates Creek 3 Well and Tank	2	31,360	3,136	34,496	5,174	39,670	2,000	2,000	43,700
48	L/W-42	Bates Creek 4 Well and Tank	2	31,360	3,136	34,496	5,174	39,670	2,000	2,000	43,700
49	L/W-43	Chalk Creek 1 Well and Pipeline	2	45,610	4,561	50,171	7,526	57,697	2,000	2,000	61,700
50	L/W-44	Chalk Creek 2 Well and Pipeline	2	45,940	4,594	50,534	7,580	58,114	2,000	2,000	62,100
51	L/W-45	Stinking Creek 4 Well and Tank	2	31,360	3,136	34,496	5,174	39,670	2,000	2,000	43,700
52	L/W-46	Stinking Creek 5 Well and Pipeline	2	51,550	5,155	56,705	8,506	65,211	2,000	2,000	69,200
53	L/W-47	Bolton Creek 3 Well and Tank	2	31,360	3,136	34,496	5,174	39,670	2,000	2,000	43,700
54	L/W-48	Stinking Creek 6 Well and Tank	2	31,360	3,136	34,496	5,174	39,670	2,000	2,000	43,700
55	L/W-49	Stinking Creek 7 Well and Tank	2	31,360	3,136	34,496	5,174	39,670	2,000	2,000	43,700
56	L/W-50	Stinking Creek 8 Well and Tank	2	31,360	3,136	34,496	5,174	39,670	2,000	2,000	43,700
57	L/W-51	Soap Creek 1 Well and Tank	2	31,360	3,136	34,496	5,174	39,670	2,000	2,000	43,700
58	L/W-52	Cabin Creek 1 Well and Tank	2	31,360	3,136	34,496	5,174	39,670	2,000	2,000	43,700
59	L/W-53	Cabin Creek 2 Well and Tank	2	31,360	3,136	34,496	5,174	39,670	2,000	2,000	43,700
60	L/W-54	Horse Heaven 1 Spring Development	2	11,030	1,103	12,133	1,820	13,953	2,000	2,000	18,000
61	L/W-55	Cabin Creek 3 Spring Development	2	12,020	1,202	13,222	1,983	15,205	2,000	2,000	19,200
62	L/W-56	Soap Creek 2 Well and Tank	2	31,360	3,136	34,496	5,174	39,670	2,000	2,000	43,700
63	L/W-57	Sand Spring Creek 1 Well and Tank	2	31,360	3,136	34,496	5,174	39,670	2,000	2,000	43,700
64	L/W-58	Sand Spring Creek 2 Well and Tank	2	31,360	3,136	34,496	5,174	39,670	2,000	2,000	43,700
65	L/W-59	Sand Spring Creek 3 Well and Tank	2	31,360	3,136	34,496	5,174	39,670	2,000	2,000	43,700

6.3 OTHER MANAGEMENT PRACTICES AND IMPROVEMENTS

The costs of other potential practices and improvements from the watershed management plan, such as stream channel restoration, rangeland and grazing management, noxious weed control, prescribed burning, and wetland enhancement, were not estimated because these types of projects and associated components are highly variable and depend on site location and accessibility, available material sources, hauling and mileage, specialized equipment and operator availability, and permitting and design requirements. Staff with local organizations listed in Chapter 7.0 should be consulted regarding the estimated costs for these types of practices and improvement projects.

6.4 SURFACE WATER STORAGE

6.4.1 Surface Water Storage Conceptual Cost Estimates

Conceptual level estimates for each of the Bates Creek Reservoir alternatives identified in Chapter 3.0 were prepared by using data presented in previous reports and from previous cost estimation experience. The Bates Creek Reservoir alternatives included the following:

- **Alternative 1:** Bates Creek Reservoir and Inlet Ditch Rehabilitation
- **Alternative 2:** Bates Creek Reservoir Relocation to Downstream Location on Bates Creek
- **Alternative 3:** Bates Creek Reservoir Relocation to East Fork Bates Creek.

For Alternatives 2 and 3, a review of cost estimates associated with storage projects of similar magnitude was conducted. Based upon this review, relationships between costs of various reservoir project components and the size of the embankment were determined, as described below.

For each site, a conceptual layout of the embankment and reservoir pool was first prepared. USGS topographic mapping was used within the GIS environment coupled with a spreadsheet analysis to complete this task.

Based upon the review of cost estimation information discussed previously, it was concluded that $8.00 per installed cubic yard of embankment provided an approximate cost for a dam for this Level I investigation. This value includes cost of the dam shell, core, riprap, drain, and appurtenances.

Costs of dam spillways, outlets, and preparation of final plans and specifications were directly proportional to the size of the embankment and corresponding reservoir pool. Consequently, each site was categorized by the size of its embankment: small embankments (< 500,000 cubic yards), medium embankments (500,000 cubic yards to 1,500,000 cubic yards), and large embankments (> 1,500,000 cubic yards).

Table 6.3 presents the results of this analysis. Note that all improvements related to Bates Creek Reservoir Alternatives 2 and 3 reflect a reservoir with a small embankment. It is important to understand that these opinions of cost are very preliminary, and that a number of potentially significant factors must be further investigated to support refinement of these costs. Among these factors (probably the most significant), involve storage capacity/potential (seepage and evaporation are included in this factor), site topographic mapping, foundation design/improvement requirements, location and availability of suitable construction materials, spillway sizing/locations, acquisition of private lands/access/ROWs, and permitting.

Table 6.3. Summary of Cost Estimation Approach Used for Bates Creek Reservoir Alternatives 2 and 3

Cost Item	**Embankment Size**		
	Small (<.5MCY)	**Medium (.5MCY to 1.5MCY)**	**Large (>1.5MCY)**
Dam Cost	$8 per cubic yard		
Mobilization	9% Dam Cost		
Spillway	$1.5M	$1.75M	$2.0M
Outlet	12% Dam Cost	10% Dam Cost	9% Dam Cost
Component Cost	**Sum of the Above**		
Property	Rangeland $450/ac/Irrigated Land $1,400/ac		
Residences	Assessed Value		
Appurtenances			
Pipelines	Varies		
Construction Cost Subtotal	**Sum of the Above**		
Engineering	Construction Cost Subtotal × 10%		
Subtotal	**Construction Cost Subtotal plus Engineering**		
Contingency	Subtotal 1 x 15%		
Construction Cost Total	**Subtotal 1 Plus Contingency**		
Preparation of Final Designs and Specifications	10% Component Cost	7.5% Component Cost	5% Component Cost
Mitigation	0.5% × Dam Cost		
Legal Fees	0.8% × Dam Cost		
Rights of Way	3.8% × Dam Cost		
Permitting	Private ($0.5M), State ($1.0M), Federal ($1.5M)		
Total Project Costs	**Sum of the Above**		

Using these methodologies, conceptual level costs were estimated for each of the three alternatives to the rehabilitation/relocation of Bates Creek Reservoir. Tables 6.4 through 6.6 present the conceptual cost estimates generated for each alternative.

Table 6.4. Summary of Costs for Bates Creek Reservoir Alternative 1

Alt 1: Bates Creek Reservoir		**Size Category: Small**	
Cost Item		**Cost Estimate ($)**	
Project Components			
Dam Embankment	cy	50,000	
Slope Protection	cy	7,400	
Dam Rehab Cost		300,000	
Slope Protection		555,000	
Concrete Removal		50,000	
Outlet Works		150,000	
Mobilization		27,000	
Appurtenances			
Inlet Pipeline (48-inch PVC)	LF	12,000	
Inlet Pipeline		2,040,000	
Pipe Inlet/Outlet		50,000	
Miscellaneous		25,000	
Component Cost		3,197,000	
Property		–	
Residences		–	
Infrastructure		–	
Nonconstruction Cost Subtotal		–	
Construction Cost Subtotal			3,197,000
Engineering Costs = Construction Cost Subtotal × 10%			319,700
Subtotal			3,516,700
Contingency = Subtotal x 15%			527,505
Construction Cost Total			**4,044,205**
Preparation of Final Designs and Specifications		125,000	
Mitigation		–	
Legal Fees		1,000	
Acquisition of Access and Rights of Way		5,000	
Permitting		5,000	
Total Project Costs			**4,180,205**

Table 6.5. Summary of Costs for Bates Creek Reservoir Alternative 2

Alt 2: Bates Creek Reservoir		**Size Category:Small**	
Cost Item		**Cost Estimate**	
Project Components			
Dam Volume (cubic yards)		100,000	
Dam Cost		800,000	
Mobilization		72,000	
Spillway		1,500,000	
Outlet Works		96,000	
Appurtenances			
Diversion Structure		–	
Miscellaneous		50,000	
Component Cost		2,518,000	
Property		217,000	
Residences		–	
Infrastructure		40,000	
Nonconstruction Cost Subtotal		257,000	
Construction Cost Subtotal			2,775,000
Engineering Costs = Component Cost Subtotal × 10%			251,800
Subtotal			3,026,800
Contingency = Subtotal × 15%			454,020
Construction Cost Total			**3,480,820**
Preparation of Final Designs and Specifications		251,800	
Mitigation		4,000	
Legal Fees		6,400	
Acquisition of Access and Rights of Way		30,400	
Permitting		1,000,000	
Total Project Costs			**4,773,420**

Table 6.6. Summary of Costs for Bates Creek Reservoir Alternative 3

Alt 3: Bates Creek Reservoir		**Size Category: Small**	
Cost Item		**Cost Estimate**	
Project Components			
Dam Volume (cubic yards)		350,000	
Dam Cost		2,800,000	
Mobilization		252,000	
Spillway		1,500,000	
Outlet Works		336,000	
Appurtenances			
Diversion structure		–	
Miscellaneous		75,000	
Component Cost		4,963,000	
Property		–	
Residences		–	
Infrastructure		–	
Nonconstruction Cost Subtotal		–	
Construction Cost Subtotal			4,963,000
Engineering Costs = Construction Cost Subtotal × 10%			496,300
Subtotal			5,459,300
Contingency = Subtotal × 15%			818,895
Construction Cost Total			**6,278,195**
Preparation of Final Designs and Specifications		496,300	
Mitigation		14,000	
Legal Fees		22,400	
Acquisition of Access and Rights of Way		106,400	
Permitting		1,000,000	
Total Project Costs			**7,917,295**

7.0 FUNDING OPPORTUNITIES

7.1 OVERVIEW

Sources of funding and financing for proposed projects within the watershed and the associated technical support and assistance are available from various local, private, state, and federal entities. The widespread opportunities described in this Level I watershed study, watershed management plan, and resulting proposed projects and alternatives make identifying and obtaining potential project funding dependent on local coordination and voluntary cooperation.

Local coordination is crucial in developing viable financing approaches that could be developed in implementing proposed projects and realizing beneficial watershed improvements. Voluntary cooperation between landowners, managers, irrigators, residents, organizations, and agencies is essential in addressing the identified land and water resource concerns within the Middle North Platte Watershed. Land and water users and managers interested in voluntarily implementing conservation projects and programs should be aware of the partnership opportunities and program incentives available in successfully achieving their watershed improvement goals and objectives.

Local, state, and federal agencies, along with private organizations, provide technical assistance for watershed and conservation projects with a smaller amount of these entities also providing financial assistance. Private contributions, such as in-kind provisions, are vital in developing and accomplishing a successful watershed or conservation project. Agencies and organizations with technical and financial assistance programs, which could potentially assist with proposed projects and alternatives, are provided in the subsequent sections. Funding and program information for potential conservation and watershed project and program assistance was obtained primarily from the following three sources:

- **Water Management and Conservation Assistance Programs Directory**, Fourth Edition, is an overview of local, state, and federal programs; a description of respective programs with associated contact information [Wyoming Water Development Commission, 2009] (*http://wwdc.state.wy.us/wconsprog/WtrMgntConsDirectory.html*)
- **Catalog of Federal Funding Sources for Watershed Protection** is a searchable database of financial assistance sources (grants, loans, and cost-sharing) available to fund a variety of watershed projects (*http://www.epa.gov/watershedfunding*)
- **Fisheries and Wildlife Habitat Cost-Share Programs and Grants**, Habitat Extension Bulletin No. 50 [Wyoming Game and Fish Department, 2013] available on the web (*http://wgfd.wyo.gov/web2011/Departments/Wildlife/pdfs/BULLETIN_NO500001792.pdf).*

Additional information about potential funding sources were reviewed and incorporated from previous watershed studies completed on behalf of the WWDC and specifically included excerpts from the Sweetwater River Watershed Study Basinwide Watershed Management Plan [Anderson Consulting Engineers, 2012] and the Thunder Basin Watershed Management Plan, Level I Watershed Study [Olsson Associates, 2009]. These potential sources described in this chapter are certainly not an all-inclusive listing of the available opportunities for water management and conservation projects. Also, the available funding levels for these programs vary annually because they are subject to budget appropriations; spending authorizations; and in some instances, donation amounts for private organizations. Additionally, the contact information for these sources can and does change occasionally. Important local contact information for local conservation and civic organizations include, but are certainly not limited to, the following contacts:

- Natrona County Conservation District (307.261.5436, extension 103)
- Converse County Conservation District (307.358.3050, extension 4)
- Medicine Bow Conservation District (307.379.2221)
- NRCS Casper Office (307.261.5436)
- NRCS Douglas Office (307.358.3050)
- NRCS Medicine Bow Office (307.379.2542)
- BLM Casper Office (307.261.7600)
- BLM Lander Office (307.332.8400)
- BLM Rawlins Office (307.328.4200)
- City of Casper Manager's Office (307.235.8332)
- WGFD Casper Office (307.473.3400)

7.2 LOCAL AGENCIES

7.2.1 Conservation Districts

Three conservation districts cover portions of the watershed, including the Medicine Bow Conservation District (3.3 percent), Converse County Conservation District (2.0 percent), and Natrona County Conservation District (94.7 percent).

Local conservation districts are locally lead, governmental subdivisions of the state of Wyoming. Conservation districts are governed by a board of supervisors elected locally as representatives for local landowners and residents on natural resource conservation issues. Conservation district boards also act as liaisons between their constituents and agencies of the state and/or federal government. Primarily, conservation district supervisors obtain and coordinate available technical, financial, and educational resources to address the resource concerns of landowners and water users within their district. Also, conservation district supervisors and staff provide technical and funding assistance, in-kind match contributions, program administration and oversight, and facilitate partnerships programs and projects.

7.2.2 County Weed and Pest Districts

County Weed and Pest Districts in Carbon, Converse, and Natrona Counties also provide technical and financial assistance to landowners within the study area. These special-purpose districts deliver a wide range of support including weed information, treatment education, field mapping, infestation control and eradication, early detection and response, and cost-share or discounted product incentives. Local contact information for the Weed and Pest Control Districts within the study area include the following:

- Carbon County Weed and Pest (307.324.6584)
- Converse County Weed and Pest (307.358.2775)
- Natrona County Weed and Pest (307.472.5559).

7.3 STATE PROGRAMS

7.3.1 Wyoming Department of Environmental Quality

The WDEQ Water Quality Division administers the Nonpoint Source Program, which solicits funding proposals under Section 319(h) of the Clean Water Act that address nonpoint sources of pollution within the state of Wyoming. Funded proposals usually address multiple program objectives such as BMP installation, agriculture and urban, information and education, and BMP effectiveness or water-quality monitoring. Program funding depends upon federal budget appropriations and the annual fund allocation from EPA to the state of Wyoming. Section 319 grant funds are available to local, state, and federal agencies, nongovernmental organizations, and private individuals who implement projects that reduce nonpoint source pollution and improve the quality of surface water and groundwater. Information regarding program eligibility, priorities, and applications is available at the Wyoming NPS Program Website (*http://deq.state.wy.us/wqd/watershed/nps/NPS.htm*).

7.3.2 Wyoming Game and Fish Department

The Wyoming Game and Fish Department offers a funding program to help landowners, conservation groups, institutions, land managers, government agencies, industry and nonprofit organizations develop and/or maintain water sources for fish and wildlife [Wyoming Water Development Commission, 2009]. The WGFD's grant program descriptions are found below and were extracted from the Water Management and Conservation Assistance Program

Directory [Wyoming Water Development Commission, 2009]. Grant program applications are normally accepted by WGFD all year long but are only approved in January and August during the year.

- **Riparian Habitat Improvement Grant –** The purpose of this program is to improve or maintain riparian and wetland resources. Fencing, herding, stock water development, streambank stabilization, small damming projects and beaver transplanting are a few examples of efforts that qualify under this program. Permits, NEPA compliance, construction, maintenance, access, and management planning are all grantee responsibilities. An amount of $10,000 maximum per project is available with 50 percent cash or in-kind required from the grantee.
- **Water Development/Maintenance Habitat Project Grant –** The purpose of this program is to develop or maintain water for fish and wildlife. Spring development, windmills, guzzlers, water protection, and pumping payments are examples of the extent of this program. Permits, NEPA compliance, maintenance, access and water righting are responsibilities of the grantee. An amount of $7,500 maximum per project and 50 percent cash or in- kind contribution is required from the grantee.
- **Industrial Water Habitat Project Fund –** The purpose of this program is to develop water sources beneficial to fish and wildlife that are located by industrial drilling, mining or excavation operations. Examples of projects are tapped artesian wells, springs, or groundwater that could be used for wildlife watering or creation of wetlands or ponds. Industry must meet set criteria, obtain permitting and access, clean up and restore the site, and provide NEPA compliance. Funding is unlimited and matching contribution is not required for these projects.
- **Upland Development Grant –** The purpose of this program is to develop upland wildlife habitat. Examples of projects in this program are shrub management; grazing systems; prescribed burning; wildlife food plots such as oat, millet, or corn plantings; range pitting; and range seeding. Permits, NEPA compliance, maintenance, access, and management planning are responsibilities of the grantee. An amount of $10,000 maximum per project and 50 percent cash or in-kind contribution is required from the grantee.
- **Fish Wyoming –** The purpose of this program is to develop public fishing opportunities. Examples of projects within this effort are boat ramps and fishing access. This program provides a 50 percent match of funding that is channeled through a private organization or municipality.
- **WGFD/USFWS Landowner Incentive Program –** This program provides federal funds to enhance habitats for sensitive fish and wildlife species on private lands. Priorities in Wyoming are grassland, sagebrush, and prairie watersheds. Matching funds, goods, or services are required (*http://gf.state.wy.us*).

- **Wyoming Sage-Grouse Conservation Fund –** Funding is approved by the legislature via the Governor's budget request designed to implement projects identified in local Sage-Grouse Conservation Plans.

7.3.3 Wyoming Office of State Lands and Investments

The OSLI administer programs for the Board of Land Commissioners and the State Loan and Investment Board to serve the trust beneficiaries: Wyoming's school children and state institutions; agriculture, mineral, timber, transportation, communication, public utility, recreation, tourism and other Wyoming industries; local government entities; state and federal agencies; and the resident and nonresident general public [Wyoming Water Development Commission, 2009]. The OSLI has prepared packets of information that contains the procedure for filing loan applications and the documents required.

- **Farm Loans –** The original Farm Loan program was established by the Legislature in 1921 to provide long-term real-estate loans to Wyoming's agricultural operators. Currently, the Legislature has allocated $275 million to be used by the Farm Loan program. In 2003, the Legislature authorized a new program: the Beginning Agricultural Producers Loan Program. Of the $275 million allocated to the Farm Loan program, $7 million is to be used for Beginning Agricultural Producer loans.
- **Small Water Development Project Loans –** The Small Water Development Project Loan program was established by the Legislature in 1955. This program is authorized to finance projects for development and use of water upon agricultural lands for agricultural purposes. These loans can be granted to individuals or corporations as well as water districts and agencies of state and local government. The loan term can be up to 20 years, and the interest rate is normally 2.5 percent. Loan repayment must begin within 1 year after the substantial completion date of the project. At times, some SRF loans may be at even lower interest rates and/or include forgiveness of a portion of the principal, when congressional appropriation bills contain special requirements.

7.3.4 Wyoming Water Development Commission

The WWDC is responsible for coordinating, developing, and planning Wyoming's water and related land resources. The Commission, which consists of ten members who are appointed by the Governor with approval of the Senate, represents the four-state water divisions and the Wind River Reservation. Appointments are for a term of 4 years and a political split on the commission is required. Clients served by the Commission include irrigation districts, conservancy districts, municipalities, water and sewer districts, joint powers boards, improvement and service districts, counties, and state agencies.

The WWDC administers and develops financing recommendations for the Wyoming Water Development Program, which was defined as the following by W.S. 41-2-112(a).

Established to foster, promote and encourage the optimal development of the state's human, industrial, mineral, agricultural, water and recreational resources. The program shall provide, through the commission, procedures and policies for the planning, selection, financing, construction, acquisition and operation of projects and facilities for the conservation, storage, distribution and use of water, necessary in the public interest to develop and preserve Wyoming's water and related land resources. The program shall encourage development of water facilities for irrigation, for reduction of flood damage, for abatement of pollution, for preservation and development of fish and wildlife resources and for protection and improvement of public lands and shall help make available the waters of this state for all beneficial uses, including but not limited to municipal, domestic, agricultural, industrial, instream flows, hydroelectric power and recreational purposes, conservation of land resources and protection of the health, safety and general welfare of the people of the state of Wyoming.

7.3.5 Wyoming Water Development Program

The main Wyoming Water Development Program encompasses new development, dams and reservoirs, rehabilitation, water resources planning and master planning. Information described below was abstracted from the Operating Criteria of the Wyoming Water Development Program (*http://wwdc.state.wy.us/opcrit/final_opcrit.pdf*) and from a form titled *Information for New Applicants* (*http://wwdc.state.wy.us/projappl/New_Ap_Info.pdf*).

The most current information on funding is important to review before submitting an application because WWDC's policies and procedures can and do change over time in response to legislative direction and/or Commission action. Review of information available at the above websites and contact with the staff of the WWDC is recommended before beginning the application process.

- **New Development Program** – The New Development Program develops presently unused and/or unappropriated waters of Wyoming.
- **Rehabilitation Program** – The Rehabilitation Program provides funding assistance for the improvement of water projects completed and in use for at least 15 years.
- **Dam and Reservoir Program** – Proposed new dams with storage capacity of 2,000 acre-feet or more and proposed expansions of existing dams of 1,000 acre-feet or more qualify for the Dam and Reservoir Program.
- **Water Resource Planning** – The Wyoming Water Development Commission serves as the water development planning agency for the State of Wyoming. In this capacity, the WWDC can provide the following assistance to project sponsors:
  - **Basinwide Plans** – The program serves to develop basin-wide plans for each of the state's major drainage basins.

- **Master Plans** – The program provides a service to municipalities, districts, and other entities to assist in preparing planning documents that serve as master plans for future water supply systems and improvements. The plans are a framework for the entities to establish project priorities and to perform the financial planning necessary to meet those priorities. These plans can assist entities in preparing the reports necessary to achieve federal funding assistance for water development and other water-related projects.

- **Groundwater Grant Program** – The primary purpose of the program is to inventory the available groundwater resources in the state. The program also serves to assist communities in developing efficient water supplies. Municipalities and special districts that purvey drinking water are eligible to receive up to $400,000 in grant funds if 25 percent of the total project costs will be paid by local matching funds.

New Development Program. This program provides technical assistance and funding to develop waters of the state that are unused and/or unappropriated at present. The program encompasses a wide range of projects, including the following types:

- Multiple Purpose (including among other uses two or more of the following: agriculture, recreation, environmental, and erosion control)
- New Storage (dams and reservoirs less than 2,000 acre-feet)
- New Supply (e.g., deep wells, alluvial wells, diversion dams)
- Watershed Improvement (for components whose primary function or benefit is water development)
- Recreation.

These project types are listed above in the order of preference assigned by WWDC when determining what projects to pursue among all of the applications received for funding.

Rehabilitation Program. The Rehabilitation Program addresses the improvement of water projects completed and in use for at least 15 years to assist in keeping existing water supplies effective and viable for the future. The Rehabilitation Program can improve existing agricultural storage facilities or conveyance systems to ensure safety, decrease operation and maintenance costs, and increase the efficiency of agricultural water use. The types of projects supported relevant to this watershed are essentially the same as listed above for the New Development Program.

Note that on-farm improvements (e.g., gated pipe, side rolls, center pivots and related facilities and/or equipment such as pumps, power lines) are excluded from WWDC funding under both the New Development and Rehabilitation Programs.

Dam and Reservoir Program. Proposed new dams with storage capacity of 2,000 acre-feet or more and proposed expansions of existing dams of 1,000 acre-feet or more qualify for the Dam and Reservoir Program. The source of revenue for the program is Water Development Account No. Ill [W.S. 41-2-124(a)(iii)], which has received Water Development Account No. I appropriations and budget reserve account appropriations on occasion, as approved by the legislature; the interest earnings that have accrued to the Water Development Account No. Ill; and a percentage (0.5 percent) of the revenues which accrue to the state's severance tax distribution account. Legislative approval must be granted prior to allocating funds to a particular purpose or project.

Dams and reservoirs typically provide opportunities for many potential uses. While water supply shall be emphasized in the development of reservoir operating plans, recreation, environmental enhancement, flood control, erosion control and hydropower uses should be explored as secondary purposes.

Key Criteria and Procedures. An application for funding under the New Development and Rehabilitation Programs must meet the following key criteria most applicable to potential projects as identified in Chapter 3.0 above:

- *The project sponsor shall be a public entity that can legally receive state funds, incur debt, generate revenues to repay a state loan, hold title and grant a minimum of a parity position mortgage on the existing water system and improvements or provide other adequate security for the anticipated state construction loan.*
- *The proposed project must serve... 2,000 or more acres of irrigated cropland, or must rehabilitate watershed infrastructure, which will develop or preserve the beneficial use of water in a watershed. The watershed rehabilitation projects must possess an estimated minimum useful life span of twenty-five (25) years and demonstrate that sufficient public benefits will accrue to justify construction of the anticipated improvements...*

Important procedures, deadlines and requirements for applications to the New Development and Rehabilitation Programs include, but are not necessarily limited to, the following:

- A fee of $1,000 must be submitted with the initial project applications; the fee does not apply to projects advanced to the next level of study or to construction.
- A certified resolution passed by the governing body of the sponsoring entity must accompany an application for a Level II study or Level III construction. This requirement may be deferred if the applicant is in the process of forming a public entity.
- A public entity must be in place before a Level II study or Level III construction can commence, with certain exceptions discussed below.

- The due date for new project applications is August 15 of each year; the due date for applications for advancing to the next study level or construction funding is October 1 of each year.

Two important criteria that apply specifically to dam and reservoir projects include the following:

- *For projects that enlarge existing storage projects by 1,000 acre-feet or greater or for proposed new dam and reservoirs with a capacity of 2,000 acre-feet or greater, expenses associated with final engineering design and required National Environmental Policy Act reviews, including but not limited to environmental assessments and environmental Impact statements, are eligible components of a Water Development Program Level II, Phase III Study Project.*
- *For dam and reservoir projects, the Commission may waive sponsor eligibility requirements through Level II, Phase II. However, the eligible entity requirements shall be met prior to initiation of Level II, Phase III activities described herein.*

Financial Plan. The current standard terms of the Wyoming Water Development Program financial plan are summarized as follows:

- Sixty-seven percent grant to 33 percent loan mix.
- Minimum 4 percent loan interest rate (current rate is 4 percent, but legislature may increase the rate).
- Maximum 50-year term of loans; term shall not exceed economic life of project.
- Payment of loan interest and principal may be deferred up to 5 years after substantial completion at WWDC's discretion under special circumstances.

In the document titled *Information for New Applicants*, the following additional relevant information is provided regarding financial terms:

- *The best available project financial terms include a grant for Level I and Level II expenses, a grand of 75% of the Level III costs, a loan of 25% of the Level III costs with an interest rate of four percent (4%) and a term equal to the economic life of the project/improvements or fifty (50) years, whichever is less. Principal and interest payments may be deferred for five (5) years after project completion. However, these favorable terms will be granted when a project is essential and the project sponsor has a very limited ability to pay.*
- *Those sponsors who feel more favorable terms are warranted due to a limited ability to pay must make a formal presentation to the Commission documenting their case. Sponsors electing to pursue this option should be*

aware that the Commission is reluctant to deviate from this standard and such requests will be denied unless they are clearly documented and justified.

The Commission will evaluate whether or not a project will be funded for Level III construction following review of the results of Level II studies. If the Commission determines that the project should not advance because of high repayment costs (as determined by an analysis of the sponsor's ability-to-pay and after other funding sources have been considered), the sponsor has the option of making a formal presentation to WWDC relative to the sponsor's ability and willingness to pay. This presentation must address the need for the project, the direct and indirect benefits of the project, and any other information the sponsor believes is relevant to the Commission's final decision.

The project sponsor shall be a public entity that can legally receive state funds, incur debt, generate revenues to repay a state loan, hold title, and grant a minimum of a parity position mortgage on the existing water system and improvements appurtenant to the project or provide other adequate security for the anticipated state construction loan. The WWDC may waive the requirement that the project sponsor be a public entity under the following exceptions:

1. The WWDC may accept applications for Level I studies from applicants that are not public entities. Applicant may then know if there is a viable project before becoming a public entity. However, the applicant must be a public entity before applying for a Level II study. Under these circumstances, the Level I process will have a 2-year duration with the study being completed the first year and the sponsor forming the public entity the second year.
2. The WWDC may accept applications related to the construction of dams and reservoirs from applicants that are not public entities. As the evaluations of the feasibility of new dams are complex, this will allow the applicant to know if the proposed reservoir is feasible before becoming a public entity. However, the applicant must be a public entity before applying for Level II, Phase III funding.

7.3.6 Small Water Project Program

The SWPP is intended to be compatible with the conventional WWDC program described above. Small water projects are defined as providing multiple benefits where the total estimated project costs (including construction, permitting, construction engineering, and land procurement) are less than $100,000 or where WWDC's maximum financial contribution is 50 percent of project costs or $25,000, whichever is less. SWPP funding is a "one-time" grant so that ongoing operation and maintenance costs are not included. Loans are not available under SWPP.

Eligibility. The kinds of projects eligible for SWPP funding include, but are not necessarily limited to, the following:

- Small reservoirs and stock watering ponds (up to 20 feet high and 20 acre-feet capacity)
- Wells
- Pipelines and conveyance facilities
- Spring developments
- Windmills
- Wetland developments.

Irrigation works/projects may be eligible if they are already documented in a conservation district's existing watershed plan or a resource management plan or environmental evaluation prepared by a state or federal agency. These types of projects are only eligible if they cannot be addressed by the Water Development Program. Benefits associated with SWPP projects may include, but are not necessarily limited to, the following:

- Improved water quality
- Habitat and water for fish and wildlife
- Improved riparian habitat
- Increased recreational opportunities.

These projects may address environmental concerns by providing water supplies to support plant and animal species and serve as instruments to improve rangeland conditions.

Funding can only be provided to eligible public entities including but not necessarily limited to conservation districts, watershed improvement districts, water conservancy districts, and irrigation districts.

Application, Evaluation and Administration. Details of the application and evaluation process and program administrative procedures are provided in the Small Water Project Program Operating Criteria available online as noted previously. Some key aspects of the process and procedures applicable to the potential projects identified in Chapter 4.0 include the following:

1. Planning for small water projects will be generated by a WWDC watershed study or equivalent as determined by the WWDO. A watershed study will incorporate, at a minimum, available technical information that describes conditions and assessments of the watershed including hydrology, geology, geomorphology, geography, soils, vegetation, water conveyance, infrastructure, and stream system data. A plan outlining the site-specific activities that may remediate existing impairments or address opportunities beneficial to the watershed shall also be included. A watershed study may identify one or more projects that may qualify for SWPP funding. A professional engineer and/or

geologist (as appropriate) shall certify any analysis submitted unless generated by a federal agency.

2. Applications shall be received by January 1 of each calendar year. Applications meeting criteria requirements will be considered during the regularly scheduled WWDC meeting in March. Applications shall include a project application, sponsor project referral, project location map, project cost estimates, and any letters of authorization or commitment of participation that may be available from other funding sources.
3. Project that improve watershed condition and function, provide multiple benefits, and meet the funding criteria specified in W.S. 99-3-703(j)(vii) or W.S. 99-3-704(g)(vii), as described in B.4 herein, are eligible for consideration.
4. The sponsoring entity will be required to address the WWDC and provide testimony and other additional supporting evidence that justifies SWPP funding whenever the public benefit documentation, submitted with the application, is deemed to be insufficient by the WWDC.

7.3.7 Wyoming Wildlife and Natural Resource Trust

The WWNRT was formed to preserve and enhance Wyoming's wildlife and natural resources by the state legislature in 2005. Projects funded by the WWNRT must provide a public benefit such as continued agricultural production to maintain open space and healthy ecosystems, enhancements to water quality, and maintenance or enhancement of wildlife habitat.

Wildlife and Natural Resource Trust funding is available for a wide variety of projects throughout the state, including natural resource programs of other agencies. Some examples include the following:

- Projects that improve or maintain existing terrestrial habitat necessary to maintain optimum wildlife populations may include grassland restoration, changes in management, prescribed fire, or treatment of invasive plants.
- Preservation of open space by purchase or acquisition of development rights contractual obligations, or other means of maintaining open space.
- Improvement and maintenance of aquatic habitats, including wetland creation or enhancement, stream restoration, water management or other methods.
- Acquisition of terrestrial or aquatic habitat when existing habitat is determined crucial/critical, or is present in minimum amounts, and acquisition presents the necessary factor in attaining or preserving desired wildlife or fish population levels.
- Mitigation of impacts detrimental to wildlife habitat, the environment and the multiple use of renewable natural resources, or mitigation of conflicts and reduction of potential for disease transmission between wildlife and domestic livestock.

Allowable projects under this program that are potentially relevant to this watershed management plan study include the following:

- Improvement and maintenance of existing aquatic habitat necessary to maintain optimum fish populations.
- Conservation, maintenance, protection and development of wildlife resources, the environment, and Wyoming's natural resource heritage.
- Participation in water enhancement projects to benefit aquatic habitat for fish populations and allow for other watershed enhancements that benefit wildlife.

Funding is by grant with no matching funds required. Nonprofit and governmental organizations (including watershed improvement districts and conservation districts) are eligible for funding by the WWNRT. Projects will be funded in July and January. Applications may be filed any time but must be filed within 90 days of the next funding cycle to receive consideration in that cycle.

7.4 FEDERAL AGENCIES

7.4.1 Bureau of Land Management

- **The BLM's Riparian Habitat Management Program** offers the opportunity to coordinate with outside interests on riparian improvement projects. The goal of the BLM's riparian-wetland management is to maintain, restore, improve, protect, and expand these areas so they are in proper functioning condition for their productivity, biological diversity, and sustainability. The overall objective is to achieve an advanced ecological status, except where resource management objectives, including proper functioning condition, would require an earlier successional stage. The goal includes aggressive riparian-wetland information, inventory, training and research programs as well as improving the partnerships and cooperative management processes.

  Partnerships have been available for riparian improvement projects and for research into riparian issues. Funding is available on an annual basis subject to budget allocations from Congress. All submitted cooperative projects complete for the funds available in the riparian program.

- **Range Improvement Planning and Development** is a cooperative effort not only with the livestock operator but also with other outside interests, including the various environmental/conservation groups. Water development, whether it be for better livestock distribution or improved wetland habitats for wildlife, is key to healthy rangelands and biodiversity. Before actual range improvement development occurs, an approved management plan must be in place. These plans outline a management strategy for an area and identify the type of range improvements needed to accommodate that management. Examples of these plans are Coordinated Resource Plans, Allotment Management Plans, and Wildlife Habitat Management Plans.

All rangeland improvement projects on lands administered by the BLM require the execution of a Permit. Although there are a couple of methods for authorizing range improvements on public lands, Cooperative Agreement for Range Improvements form 4120-6 is the method most commonly used. This applies equally to range improvement projects involving water such as reservoirs, pits, springs, and wells including any associated pipelines for distribution. The major funding source for the BLM's share comes from the range improvement fund which is generated from the grazing fees collected. A limited amount of funding is from the general rangeland management appropriations. If the cooperator is a livestock operator, their contributions come generally in the form of labor; at times, they may also provide some of the material costs as well. Contributions from the conservation/environmental interest is monetary and often come in the form of grants. They also contribute labor on occasion.

BLM's Watershed and Water Quality Improvement efforts are undertaken in a cooperative approach with the state of Wyoming, Conservation Districts, livestock operators and various conservation groups. Wyoming's BLM is partnering in the implementation of several Section 319 watershed plans state-wide.

- It is anticipated that as the WDEQ continues the inventory of waters of the state and the identification of impaired and/or threatened waterbodies, the BLM will be partnering with the WDEQ to improve water quality in waterbodies on public lands. In the course of developing watershed plans or TMDLs for these watersheds, the BLM will be routinely involved in watershed health assessments, planning, project implementation and BMP monitoring.

Now, and in the future, the goals of cooperative watershed projects will typically be the restoration and maintenance of healthy watershed function. These goals will typically be accomplished through approved BMPs; e.g., prescribed burns, vegetation treatments, instream structures to enhance vegetation cover, controlled accelerated soil erosion, increased water infiltration, and enhance stream flows and water quality.

Currently, in response to the Clean Water and Watershed Restoration initiative and associated funding increases, the BLM is expanding its efforts to address water-quality and environmental concerns associated with abandoned mines. This work will also be accomplished, in cooperation with the State Abandoned Mine Lands Division, on a priority watershed basis and will employ appropriate BMPs to address identified acid mine drainage and runoff problems from mine tailings and waste rock piles.

7.4.2 Bureau of Reclamation

The USBR administers the Water 2025 Challenge Grant Program. This program provides funding on a competitive basis for projects focused on water conservation, efficiency and water marketing. Preference is given to projects that can be completed within 24 months that will help to prevent crises over water in areas identified as “hot spots” where potential for conflict is judged to be moderate to highly likely by 2025.

7.4.3 Environmental Protection Agency

The Targeted Watershed Grants Program administered by the EPA “encourages watershed practitioners to examine local water related problems in the context of the larger watershed in which they exist, to develop solutions to those problems by creatively applying the full array of available tools, including general, state and local programs, to restore and preserve water resources through strategic planning and coordinated project management that draw in public and private sector partners...” as described in the program website (*http://www.epa.gov/twg/2006/2006faq.html#intro*). Organizations eligible for funding include nonprofits, tribes, and local governments. The assistance provided consists of grants for up to 75 percent of the total project costs. A match of at least 25 percent is required. The typical median amount awarded is $700,000 with a typical range of $300,000 to $900,000. The application must be made by the governor and the competition for these grants is keen.

7.4.4 Farm Service Agency

The Farm Service Agency (FSA) administers three different programs that may be applicable to some of the alternative projects identified in Chapter 4.0. Technical assistance for the FSA programs is provided by NRCS. Each of these three programs is briefly discussed below. .

- **Conservation Reserve Program (CRP).** This is a voluntary program under which eligible highly erodible cropland is removed from production in return for annual rental payments and cost-share assistance by ESA over a 10- to 15-year period. The producer is required to establish long-term conservation practices on the erodible, environmentally sensitive lands taken out of production. Continuous Sign-Up for High Priority Conservation Practices. Under this program, farmers and ranchers implement certain high-priority conservation practices on their eligible CRP lands. These practices may include: riparian buffers, filter strips, grass waterways, shelter belts, field windbreaks, living snow fences, contour grass strips, salt tolerant vegetation, and shallow water areas for wildlife.

  This cost-share program offers rental rates for the CRP lands based on the average value of dryland cash rent with an additional financial incentive of up to 20 percent of the soil rental rate for selected practices. Establishing permanent cover merits up to a 50 percent cost share.

- **Emergency Conservation Program (ECP).** This program provides emergency funding and technical assistance for implementing emergency livestock watering conservation measures during periods of severe drought and rehabilitating farmland damaged during natural disasters. Cost-share assistance up to 75 percent of the cost to implement the emergency measure(s) is available.

- **Continuous Sign-Up for High Priority Conservation Practices.** Continuous sign-up provides management flexibility to farmers and ranchers to implement certain high-priority conservation practices on eligible land. Land must meet the requirements of CRP and be determined by the NRCS to be eligible and suitable for riparian buffers, filter strips, grass waterways, shelter belts, living snow fences, contour grass strips, salt tolerant vegetation, shallow water areas for wildlife Field windbreaks.

  This is a cost-share program that offers rental rates based on the average value of dryland cash rent with an additional financial incentive of up to 20 percent of the soil rental rate for filed windbreaks, grass waterways, filter strips and riparian buffers. An additional 10 percent may be added if the land is located in a EPA-designated wellhead protection area. There is also a provision for cost share of up to 50 percent of the cost of establishing permanent cover.

7.4.5 Fish and Wildlife Service

Technical and financial assistance are available to private landowners, profit or nonprofit entities, public agencies, and public-private partnerships under several programs addressing the management, conservation, restoration or enhancement of wildlife and aquatic habitat (including riparian areas, streams, wetlands and grasslands). These programs include, but are not necessarily limited to, the following:

- **Partners for Wildlife Habitat.** This program provides technical and financial assistance directly to private landowners through voluntary cooperative agreements called wildlife extension agreements. The program targets habitats that are in need of management, restoration or enhancement such as riparian areas, streams, wetlands and grasslands. Under these wildlife extension agreements, private landowners agree to maintain the restoration projects as specified in the agreement but otherwise retain full control of the land. Depending on the number of partners, the cost share may vary somewhat but is typically 75 percent partners and 25 percent landowner.
- N**orth American Wetlands Conservation Act Grant Program.** This grant program promotes long-term conservation of wetlands ecosystems and the waterfowl, migratory birds, fish and wildlife that depend upon such habitat. Conservation actions supported are acquisition, enhancement and restoration of wetlands and wetlands associated habitat. This program encourages voluntary, public-private partnerships. Public or private, profit or nonprofit entities or individuals establishing public-private sector partnerships are eligible. Cost-share partners must at least match grant funds with nonfederal monies. Small Grants are typically for $50,000.
- **Wildlife Conservation and Appreciation Program.** This program provides grants to state fish and wildlife agencies to fund projects that bring together USFWWS, state

agencies, private organizations, and individuals. Projects include identifying significant problems that can adversely affect fish and wildlife and their habitats, actions to conserve species and their habitats, actions that will provide opportunities for the public to use and enjoy fish and wildlife through nonconsumptive activities, monitoring of species, and identification of significant habitats.

- **Cooperative Endangered Species Conservation Fund.** This program is available to states that have a cooperative agreement with the Secretary of Interior. The intent is to provide federal assistance to any state to assist in developing programs for the conservation of endangered and threatened species. Potential programs include animal, plant and habitat surveys, research, planning, management, land acquisition, protection and public education. Single states may receive up to 75 percent of program costs.
- **Landowner Incentive Program (Nontribal).** This program provides funding directly to the lead state wildlife service agency (WGFD in Wyoming) for programs addressing the issues noted previously.

7.4.6 Natural Resources Conservation Service

The NRCS administers a number of funding and technical assistance programs applicable to many of the alternative projects. These programs are briefly described below:

- **Environmental Quality Incentives Program.** The EQIP is a voluntary program available to agricultural producers that provides technical assistance and cost-sharing and incentive payments for projects and practices that improve water quality, enhance grazing lands, and/or increase water conservation. Projects funded by EQIP often include those that reduce nonpoint-source pollution of surface waters, reduce soil erosion and sedimentation from agricultural lands, and promote of at-risk species habitat conservation.
- Nonfederal landowners (including American Indian tribes) that engage in livestock operations or agricultural production are eligible for funding. Eligible land includes cropland, rangeland, pasture, forestland, and other farm and ranch lands. Eligibility also requires that the applicant develop an EQIP plan of operations that becomes the basis of the cost-sharing agreement between NRCS and the participant.
- EQIP provides payments up to 75 percent of the incurred costs and income foregone of certain conservation practices and activities. However, certain historically underserved producers (limited resource farmers/ranchers, beginning farmers/ranchers, socially disadvantaged producers) may be eligible for payments up to 90 percent of the estimated incurred costs and income foregone. Farmers and ranchers may elect to use a certified technical service provider for technical assistance needed for certain eligible activities and services. The new Farm Bill established a new payment limitation for individuals or legal entity participants who may not receive, directly or indirectly, payments that in the aggregate, exceed $300,000 for all program contracts entered during any 6-year period.

Projects determined as having special environmental significance may, with approval of the NRCS Chief, have the payment limitation raised to a maximum of $450,000.

- Detailed information about the EQIP program is available (*http://www.nrcs.usda.gov/PROGRAMS/EQIP/*).
- **Watershed Protection and Flood Prevention Program.** Also known as the "Small Watershed Program or the "PL 566 Program," this program provides technical and financial assistance to address resource and related economic problems on a watershed basis. Projects related to watershed protection, flood prevention, water supply, water quality, erosion and sediment control, wetland creation and restoration, fish and wildlife habitat enhancement, and public recreation are eligible for assistance. Technical and financial assistance is also available for planning and installation of works of improvement to protect, develop, and use land and water resources in small watersheds.
- Applicants eligible for funding through this program include local or state agencies, counties, conservation districts, or other subunits of state government (e.g., watershed improvement, water conservancy and irrigation districts) with the authority and capacity to carry out, operate, and maintain installed works of improvement. Projects are limited to watersheds containing less than 250,000 acres.
- The assistance provided consists of technical assistance and cost sharing (amount varies) for implementation of NRCS-authorized watershed plans. Technical assistance is provided on watershed surveys and planning. Although projects vary significantly in scope and complexity, projects receiving $3.5 million to $5 million in federal financial assistance are not uncommon.
- **Other NRCS Programs.** Other programs administered through NRCS that may be relevant to certain of the alternative projects discussed in Chapter 4 include, but are not necessarily limited to the following:
  - **Wildlife Habitat Incentives Program** – Through the wildlife habitat incentives program, technical and financial assistance is provided to landowners and others to develop and improve wildlife habitat on private lands.
  - **Wetlands Reserve Program** – Eligible landowners may receive technical and financial assistance through the wetlands reserve program to address wetland, wildlife habitat, soil, water and related natural resource concerns on private lands.
  - **Grassland Reserve Program** – This program emphasizes support for grazing operations, plant and animal biodiversity, and grassland and land containing shrubs and forbs under the greatest threat of conversion.
  - **Farm and Ranch Lands Protection Program** – This program is designed to help farmers and ranchers keep their land in agriculture. The program provides matching funds to state, tribal or local governments and nongovernmental organizations with

existing farm and ranch land protection programs to purchase conservation easements.

- **Resource Conservation and Development–** Wyoming's five resource conservation and development areas assist communities by promoting conservation, developing and use of natural resources; improving the general level of economic activity; and enhancing the environment and standard of living for residents of those communities.
  - Emergency Watershed Protection
  - Small Watershed Rehabilitation Program
  - Sage Grouse Restoration Project
  - Grazing Lands Conservation Initiative grants
  - Cooperative Conservation Partnership Initiative

7.4.7 U.S. Army Corps of Engineers

The Army Corps of Engineers has civil responsibilities for flood damage reduction, hydroelectric power generation and navigational improvement as well as other water and land resource problems and needs including environmental preservation and enhancement, ecosystem management and comprehensive flood plain management.

The Corps is responsible for a worldwide military construction program, an extensive environmental program, and a broad national civil works program. The Corps is authorized to provide technical assistance to local communities, states and federally recognized Indian Tribes in support of their efforts to alleviate flooding impacts, reduce erosion and otherwise plan for the wise and prudent use of the nation's water and related land resources. They also have authority to construct certain water resources related projects and respond to water resource needs.

- **Planning Assistance to States.** This program provides for assistance in preparing plans for developing, using, and conserving water and related land resources. The Corps provide technical planning assistance in all areas related to water resources development such as bank stabilization, sedimentation, water conservation, ecosystem and watershed planning, and water quality. Assistance is limited to $500,000 per state and studies are cost-shared on a 50-50 basis with a nonfederal sponsor such as a state, public entity, or an Indian Tribe.
- **Flood Plain Management Services.** This program provides technical services and planning guidance for support and promotion of effective flood plain management. Flood and flood plain data are developed and interpreted with assistance and guidance provided in the form of "Special Studies" on all aspects of flood plain management planning. All services are provided free of charge to local, regional, state, or nonfederal public agencies. Federal agencies and private entities have to cover 100 percent of costs.
- **Flood Damage Reduction Projects.** This program provides structural and nonstructural projects to reduce damages caused by flooding and focuses on solving local

flood problems in urban areas, towns, and villages. The Corps works with the project sponsor to define the flood problem, evaluate solutions, select a plan, develop the design and construct a project. A feasibility study is conducted to identify potential projects with the first $100,000 of the cost funded by federal sources. Any cost above this amount is cost-shared 50-50 with the sponsor in the form of cash and in-kind services. Construction lands, easements, rights-of-way, relocations, and disposal and 5 percent of the projects costs are the sponsor's responsibility. Operation and maintenance and a maximum of 50 percent of total project cost are the sponsor's responsibility.

- P**roject Modification For Improvement of Environment.** The purpose of this program is to modify structures or operation of previously constructed water resources projects to improve environmental quality, especially fish and wildlife values. A study, at federal expense, is initiated followed by a feasibility plan that is cost-shared 25 percent by the sponsor.
- **Aquatic Ecosystem Restoration.** This effort is for restoring historic habitat conditions to benefit fish and wildlife resources primarily to provide structural or operational changes to improve the environment such river channel reconnection, wetland creation, or improving water quality. The conditions are similar to the Project Modification program with sponsor cost-share being 35 percent.
- **Water Resources Projects.** The purpose of this program is to construct larger projects for flood damage reduction and to provide technical assistance in resolving more complex water resource problems. The program is used to evaluate projects costing more than $10 million that include purposes of flood control, water supplies, water quality, environmental protection and restoration, sedimentation, or recreation. Reservoirs, diversions, levees, channels, or flood plain parks are examples. The Corps works with a nonfederal sponsor to define the flood- or water resource-related problem or opportunity, evaluate flood control or solutions, select a plan, develop a design, and construct a project. Special authorization and funding from Congress is required with a reconnaissance study being federal cost. A feasibility study to establish solutions is cost-shared 50 percent by the nonfederal sponsor with 35–50 percent of the construction cost the responsibility of the sponsor.
- **Support for Others Program.** This program provides for environmental protection and restoration or facilities and infrastructure and includes Environmental Planning and Compliance, Economic and Financial Analyses, Flood Plain Management, Cultural Resources and General Planning. All costs for these programs are provided by the customer agency.
- **Regulatory Authority/Responsibility.** The USACE has regulatory authority under the Clean Water Act and the River and Harbor Act. The purpose of these laws is to restore and maintain the chemical, physical and biological integrity of waters of the United States. Section 404 of the Clean Water Act authorizes the Corps to regulate the discharge of dredged or fill material into waters, which would include dams and dikes,

levees, riprap, bank stabilization, and development fill. Three kinds of permits are issued by the Corps: Individual, Nationwide and Regional General.

7.4.8 Rural Utilities Service

The U.S. Department of Agriculture, Rural Development's utilities program is authorized to provide financial assistance for water and waste disposal facilities in rural areas in towns of up to 10,000 people. This program is intended for nonprofit corporation and public bodies such as municipalities, counties, and special purpose districts and authorities.

Funding may be obtained through Rural Development only when the applicant is unable to secure funding from other sources at reasonable rates and terms. The applicant must have legal capacity to borrow and repay loans, to pledge security for loans, and to operate and maintain the facilities. The applicant must be financially sound and able to manage the facility effectively as well as have a financially sound facility based upon taxes, assessments, revenues, fees, or other satisfactory sources of income to pay costs of operating, debt service, and reserve. Grants are also available and are used to supplement loans to reduce debt service where necessary to achieve reasonable user rates. Assistance is also available on how to assemble information concerning engineering, financing, and management of proposed improvements.

Loans and grants may be used to construct, repair, improve, expand, or modify rural water supplies and distribution facilities such as reservoirs, pipelines, wells and pumping stations, waste collection, pumping, treatment, or other disposal facilities. This assistance may also be used to acquire a water supply or water right or finance facilities in conjunction with funds from other agencies or those provided by the applicant. These funds can be used to pay legal and engineering fees connected with the development of a facility or pay other costs related to development including rights-of-way or easements and relocation of roads or utilities. Loan terms are a maximum of 40 years, State Statute, or the useful life, whichever is less with interest rates based on current market yields for municipal obligations.

USDA Rural Development also guarantees loans to eligible commercial lenders to improve, develop, or finance water or waste disposal facilities in rural areas. This guarantee is a warrant to protect the lender and may cover up to 90 percent of the principal advanced. The guarantee fee is 1 percent of the loan amount multiplied by the percent of the guarantee. Interest rates will be negotiated between the lender and the borrower.

7.5 NONPROFIT AND OTHER ORGANIZATIONS

7.5.1 Ducks Unlimited

Ducks Unlimited, Inc. is a potential funding source for wetlands and waterfowl restoration projects. Although direct grant funding is limited (to the extent that there is generally approximately $20,000 to $30,000 available annually statewide), in-kind assistance may be available from the local chapter of Ducks Unlimited. Additional information on funding programs and opportunities of Ducks Unlimited is available in the Water Management & Conservation Assistance Program Directory referenced previously.

7.5.2 National Fish and Wildlife Foundation

The National Fish and Wildlife Foundation (NFWF) is a private, nonprofit, tax exempt organization chartered by Congress in 1984 to sustain, restore, and enhance the nation's fish, wildlife, plants, and habitats. The NFWF provides grant funding on a competitive basis through their Keystone Initiative Grants and Special Grant Program. Some of the grants/programs available include, but are not limited to, the following:

- **Pulling Together Initiative** – provides support on a competitive basis for the formation of local weed management area partnerships that engage federal resource agencies, state and local governments, private landowners, and other interested parties in developing long-term weed management projects within the scope of an integrated pest management strategy; minimum 1:1 nonfederal match is required.
- **Native Plant Conservation Initiative** – funding preference for "on-the-ground" projects that involve local communities and citizen volunteers in the restoration of native plant communities.
- **Bring Back the Natives Grant Program** – funds to restore damaged or degraded riverine habitats and their native aquatic species provided by the BLM, USBR, USFWS, USFS, and NFWF; minimum 2:1 nonfederal match required.
- **Five-Star Restoration Program** – provides modest financial assistance on a competitive basis to support community-based wetland, riparian, and coastal habitat restoration projects that build diverse partnerships and foster local natural resource stewardship through education, outreach, and training activities; average grant is $13,000.

Information about these and other NFWF grants/programs is available at their website (*http://nfwf.org/*).

7.5.3 Trout Unlimited

The Wyoming Council of Trout Unlimited provides funding and volunteer labor for a variety of stream and watershed projects such as erosion control and fish habitat structures, willow and other riparian plantings, and stream protection fencing. Embrace-A-Stream grants are available for up to $10,000 per project. Partnerships are encouraged and can include local conservation districts and state and federal agencies.

8.0 CONCLUSIONS AND RECOMMENDATIONS

A comprehensive, interdisciplinary study including inventory and description of the Middle North Platte Watershed was completed to identify and evaluate land and water resource issues and concerns in the study area. An extensive geographic information system (GIS) and digital library were also incorporated as part of this Level I watershed study. The GIS includes information collected and generated during the study from many sources. This information serves as a valuable reference for potential projects and future study efforts within the watershed.

8.1 CONCLUSIONS

Following the information gathering and watershed inventory efforts of the study, several proposed projects and associated components along with identified opportunities, initial recommendations, and potential resource effects were developed as part of the watershed management plan. The plan's projects, opportunities, and recommendations were formulated based upon field inventory findings, GIS mapping and analysis, landowner feedback during scoping meetings and field visits, and planning conceptual projects with participants, partners, and sponsors during the study. Resource issues and concerns within the watershed were identified and evaluated to outline proposed improvements and alternatives associated with the following study areas:

- Irrigation System Conservation and Rehabilitation
- Livestock/Wildlife Upland Watering Opportunities
- Grazing Management Opportunities
- Surface Water Storage Opportunities
- Stream Channel Condition and Stability
- Wetlands Enhancement Opportunities
- Other Watershed Management Opportunities

8.1.1 Irrigation System Components

- Proposed projects and associated components for issues identified during field inventories for irrigation system infrastructure were completed for five irrigation systems.
- Estimated costs were calculated for the conceptual design components and recommended improvements.

- Most of the structures inventoried and evaluated require rehabilitation efforts to reduce seepage and conserve water.
- Recommended improvements to existing irrigation systems mainly involve replacement and/or rehabilitation of existing but weakened diversion structures and headgates along with replacement of ditches with pipelines to reduce water conveyance losses.
- Irrigation system improvements could be implemented individually or entirely at once depending on the goals of the landowner or manager.
- The proposed irrigation system projects would require minor involvement or permitting from regulatory agencies to be completed. However, work involving stream channels would require consultation with theUSACE.

8.1.2 Livestock/Wildlife Upland Watering Opportunities

- Grazing on federal lands within the watershed encompasses a major portion of the watershed and is administered by the BLM.
- There are approximately 146 BLM grazing allotments within the study area with about 79 percent of the allotments managed by the BLM Casper Field Office.
- Coordination with BLM regarding grazing allotment management is necessary and would require more involvement in developing proposed upland livestock/wildlife water supply projects beyond the conceptual level projects included within the study.
- Because of the existing regulatory environment and involvement of third-party interests, the proposed projects with portions of federal lands could be difficult and require additional review and planning efforts.
- Several proposed projects and pipeline components could be rerouted or redesigned to involve only private or state lands but might result in increased materials and construction costs. However, these modifications might also avoid project delays and permitting problems compensating potential increased construction costs. Otherwise, projects could be modified to be constructed on deeded or state lands initially, and then constructed on federal lands in future projects.
- Opportunities to improve range and riparian conditions require the installation and operation of well-distributed, reliable upland water sources and watering facilities for wildlife and livestock. Installing pipelines and stock tanks is the foundation of effective grazing management and can be an economical way to improve rangeland conditions.
- There were 64 potential livestock/wildlife water projects identified for development resulting from an effort that evaluated available water sources in coordination with participating landowners and allotment permittees.
- Conceptual project plans and component designs along with associated cost estimates were calculated for each of the proposed projects. The primary components included

water wells, solar pumps, buried pipelines, and stock tanks, which would require additional final planning, design, and permitting completed before construction.

- The proposed projects and components would need to be installed, operated, and maintained by the landowner or manager in accordance with current standards and specifications realize the expected benefits to the project area and watershed.

8.1.3 Surface Water Storage Opportunities

- Institutional issues and constraints related to the North Platte Decree or the Platte River Recovery and Implementation Program limit the opportunity to create new reservoirs or increase existing reservoirs through enlargement within the watershed.
- Although not a priority task within the scope of this study, storage evaluations focused on existing facilities and potential upland water storage facilities less than 20 acre-feet.
- During this study, water users identified problems with Bates Creek Reservoir that severely limit the potential to store water in this permitted facility.
- Consequently, an initial investigation of Bates Creek Reservoir was completed and alternatives are presented in this report.

8.1.4 Stream Channel Condition and Stability

- Several impaired channel reaches were identified during the geomorphic assessment and classification within the study area.
- Categories of impairments were identified and included, but not limited to, degradation of riparian vegetation and degradation of riparian condition in the form of stream bank erosion and channel degradation.
- Site-specific improvements should be developed to alleviate the channel impairments and restore riparian/wetland function as part of the watershed management plan.
- Locally-led stream channel and habitat improvement projects, such as the North Platte River Master Plan and others, could provide significant benefits to the watershed.

8.1.5 Grazing Management Opportunities

- Construction and operation of reliable water supply projects must be developed and implemented in areas with inadequate water sources before adjustments or alternatives in grazing management could be made on a particular area or allotment.
- Development of reliable water sources and associated watering facilities can aid in distribution, timing, and frequency of grazing animals. However, additional measures such as cross-fencing, low-stress herding, mineral/salting, and grazing density should be evaluated as part of the site-specific, grazing management inventory and plan.

- Available tools such as the ESD and the STM can be used by landowners and managers to become aware of the growth potential of desirable vegetation and predicted responses on a particular range site.
- These tools could be used in developing appropriate rangeland treatments and grazing practices to begin the transition from an undesirable to a desirable plant community.

8.1.6 Other Upland Management Opportunities

- Coordination with the weed and pest control districts should continue especially regarding beneficial projects such as noxious weed control, planting of desirable vegetation, cheatgrass control areas in conjunction with upland water development, and weed infestations on canals or laterals.

8.2 RECOMMENDATIONS

Several proposed conceptual projects, identified opportunities, suggested alternatives, and initial conclusions have been presented and discussed within this report and watershed management plan. Summary recommendations listed below are included for consideration:

- Several irrigation system rehabilitation projects and livestock/wildlife upland water projects could be eligible to apply for funding through the WWDC SWPP.
- Priority projects should be reviewed, selected, and components implemented once the necessary technical and financial requirements are determined.
- Landowners or managers seeking to participate in the SWPP should consult and coordinate with their local conservation districts, which are eligible sponsors of SWPP applications and project agreements.
- The study's GIS and digital library should be used as a tool in planning and developing potential projects and should be updated as necessary from available information sources.
- Potential funding opportunities exist for proposed and future improvement projects within the watershed including ranch and farm improvements, irrigation system rehabilitation, riparian/wetland enhancements, river corridor and stream channel restoration, and urban drainage and flood control projects.
- Innovative strategies for coordinated project funding and financing should be investigated and focus on local, collaborative endeavors that integrate more than one watershed issue or concern that could potentially result in achievement of multiple benefits.

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