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FINAL REPORT

BELLE FOURCHE RIVER WATERSHED STUDY

SUBBASIN BELOW KEYHOLE RESERVOIR

WATERSHED MANAGEMENT PLAN

Topical Report RSI-2513

prepared for

Wyoming Water Development Commission
6920 Yellowtail Road
Cheyenne, Wyoming 82002

March 2015

RESPEC

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BELLE FOURCHE RIVER WATERSHED STUDY

SUBBASIN BELOW KEYHOLE RESERVOIR

WATERSHED MANAGEMENT PLAN

Topical Report RSI-2513

by

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Cheyenne, Wyoming 82002

March 2015

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1.0 INTRODUCTION

In 2012, the Crook County Natural Resources District (CCNRD), Campbell County Conservation District (CCCD), and Crook County Irrigation District (CCID) requested that the Wyoming Water Development Commission (WWDC) conduct a comprehensive study of the Belle Fourche River Watershed and its water resources. The local sponsors 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. The WWDC approved funding for the watershed study and then contracted with RESPEC and Anderson Consulting Engineers, Inc. (ACE), to provide technical or professional services for the watershed study.

The Belle Fourche River Watershed Study, Level I 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 CCNRD, CCCD, and CCID—the study's local sponsors, 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 study includes descriptions about needed water development projects that could provide economic, ecological, and social benefits to the state of Wyoming and its citizens.

Because of the size and variability of the study area for the Belle Fourche River Watershed, as shown in Figure 1.1, the final reports for the watershed were separated into this basin wide summary report and a final report was completed for each of the three subareas or subbasins. The terms "watershed" and "study area" are used interchangeably throughout this study and associated reports. The "subarea" and "subbasin" terms are also used interchangeably in these reports. This basin wide summary report was completed for the study area and includes data and information regarding the overall study area along with inclusion of all three of the subbasin reports and watershed management plan and rehabilitation components. Throughout these reports, mention will be made where more specific information can be found within the subbasin reports or the basin wide summary report where appropriate.

This "Subbasin below Keyhole Reservoir Report" was completed for the Belle Fourche River Watershed that occurs below Keyhole Reservoir within the study area. The intent of these reports, accompanied by the "digital library" and Geographic Information System (GIS) geodatabase, is to provide the results of the Belle Fourche River Watershed Study, Level I. The subbasins were identified based on the U.S. Geological Survey (USGS) 10th order "hydrologic units" classification which has an assigned Hydrologic Unit Code (HUC). Six watersheds (HUC-10) are located within the Subbasin below Keyhole Reservoir and are listed in Table 1.1 and shown in Figure 1.2.

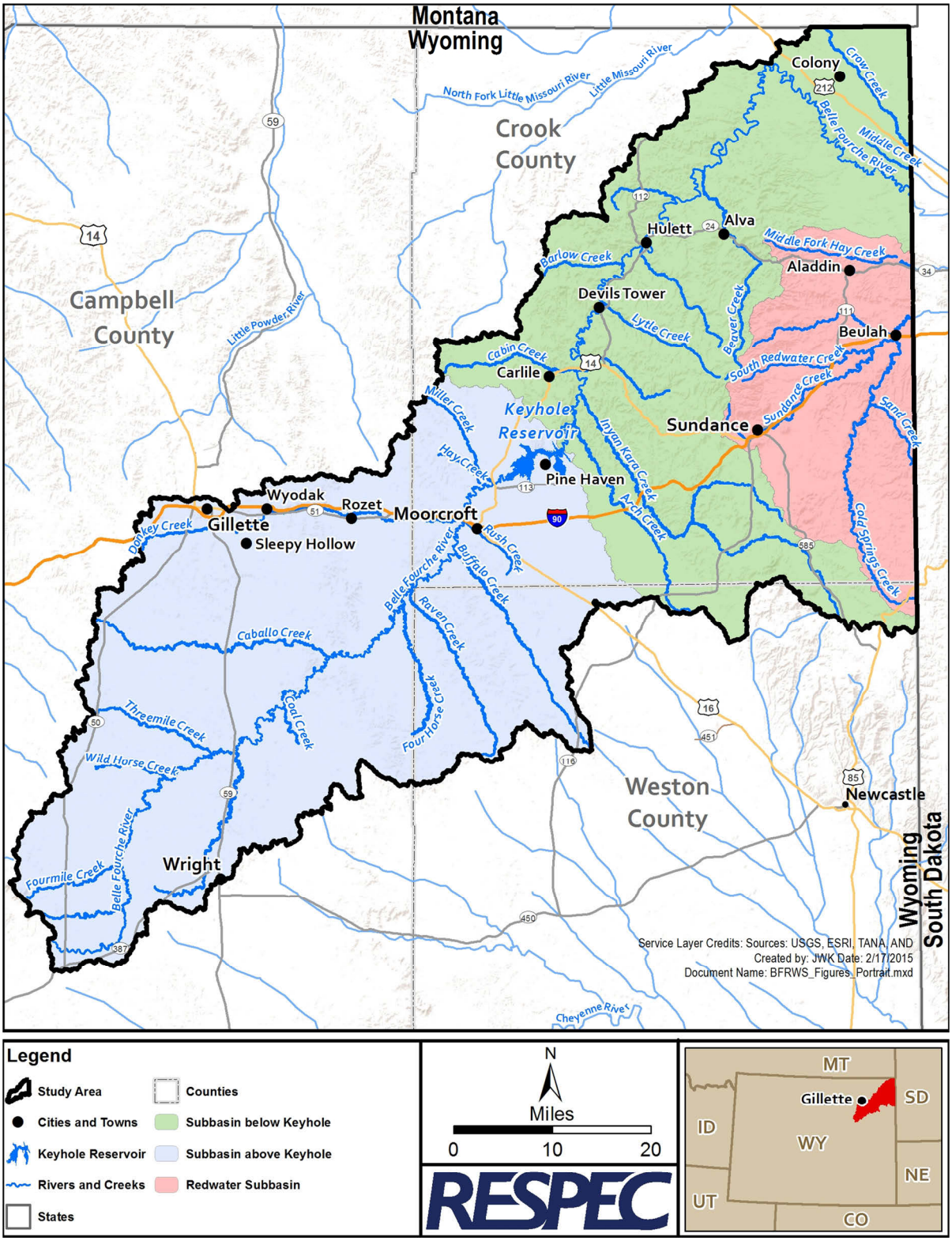

Figure 1.1. Belle Fourche River Watershed and Distinct Subbasins Within the Study Area.

Table 1.1. Watersheds (10th Order Hydrologic Unit Codes) Within the Subbasin Below Keyhole Reservoir

Hydrologic Unit Code	Watershed (HUC-10) Name	Study Subbasin	Acres	Square Miles
1012020203	Owl Creek	Below Keyhole Reservoir	22,910	36
1012020201	Upper Belle Fourche River	Below Keyhole Reservoir	202,650	317
1012020202	Middle Belle Fourche River	Below Keyhole Reservoir	43,470	68
1012020107	Arch Creek-Belle Fourche River	Below Keyhole Reservoir	216,390	338
1012020108	Inyan Kara Creek	Below Keyhole Reservoir	215,330	336
1012020109	Blacktail Creek-Belle Fourche River	Below Keyhole Reservoir	199,300	311
Subtotal			**900,050**	**1,406**
Total			**2,485,020**	**3,883**

1.1 SUBBASIN BELOW KEYHOLE RESERVOIR

The Belle Fourche River Watershed – Subbasin below Keyhole Reservoir encompasses the drainage area for the Belle Fourche River beginning at the outlet of Keyhole Reservoir where it flows generally northeast to the Wyoming–South Dakota state line approximately 10 miles northeast of Aladdin, Wyoming. The Subbasin below Keyhole Reservoir includes all of the land draining to the Belle Fourche River and tributaries covering approximately 1,406 square miles or 900,050 acres in northeast Wyoming and encompasses approximately 36 percent of the study area. The subbasin is situated in Crook County with a portion in Weston County, including the cities, towns, and communities of Alva, Carlile, Colony, Devils Tower, and Hulett, Wyoming.

1.2 STUDY ISSUES AND UNDERSTANDING

This Level I study provides a comprehensive evaluation of the Belle Fourche River Watershed and concludes with the Watershed Management and Rehabilitation Plan, which is included in Chapter 4.0 of the basin wide summary report. This report includes the proposed alternatives that address water and land resource issues identified by landowners. During this study, the consultant worked with the local sponsors, the Wyoming Water Development Office (WWDO), and participants to address the following issues within the subbasin including: surface water availability; irrigation system improvements; and rangeland and grazing improvements.

1.3 PURPOSE AND SCOPE

The purpose of this Level I study was to combine the available and relevant data and information with the study-generated inventory data into a GIS geodatabase and digital library. And to develop a Watershed Management and Rehabilitation Plan outlining proposed and potential water development opportunities and improvement alternatives. To accomplish this effort, several objectives were completed and are discussed in the basin wide summary report.

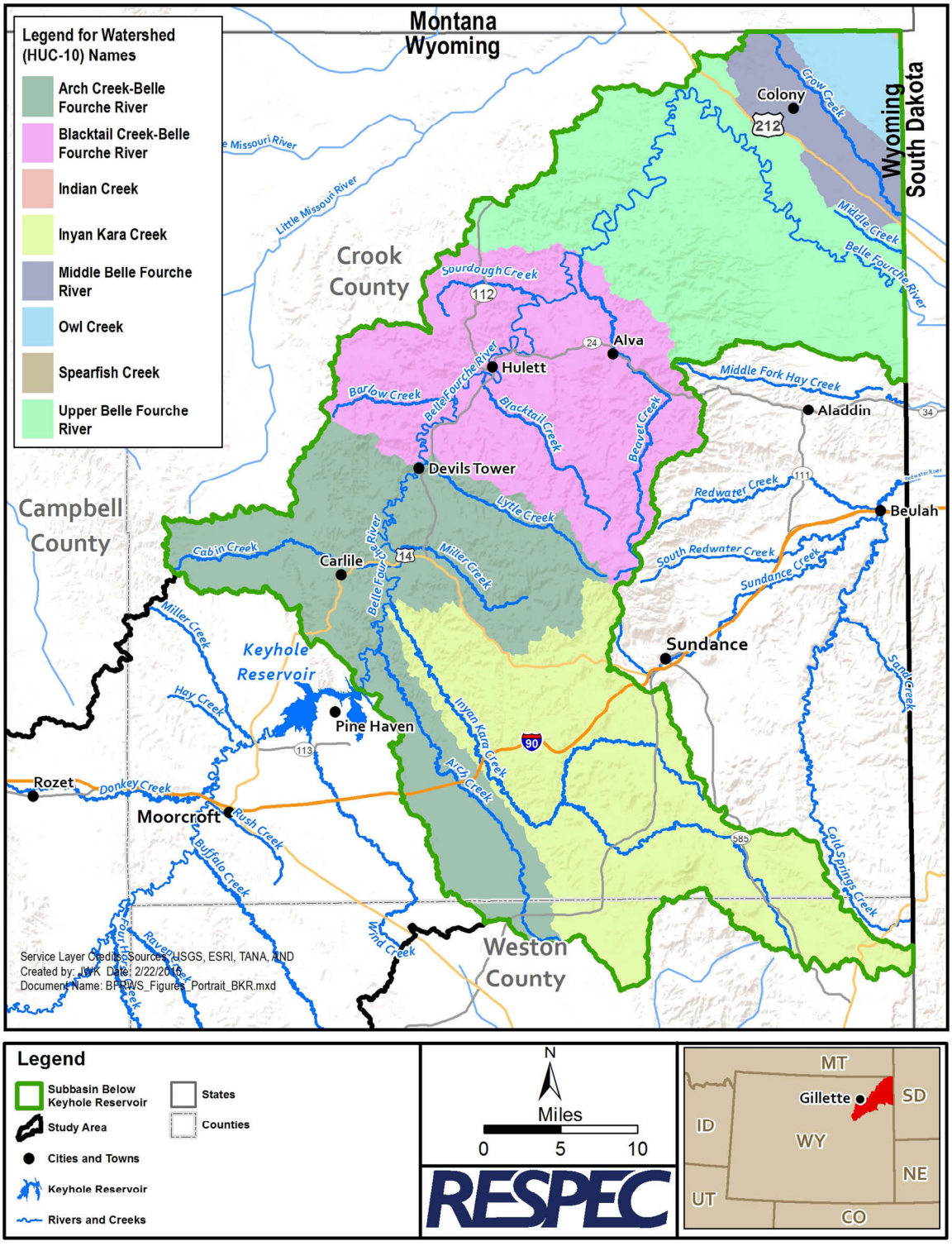

Figure 1.2. Watersheds (HUC-10) Within the Subbasin Below Keyhole Reservoir.

2.0 PROJECT MEETINGS

2.1 SCOPING MEETINGS, OPEN HOUSES, AND LANDOWNER MEETINGS

Public involvement and landowner participation were an important element of the Belle Fourche River 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. Scoping meetings, open houses, landowner meetings, and on-site field visits were conducted by RESPEC and ACE staff in cooperation with CCNRD, CCCD, CCID, WWDO, and Natural Resources Conservation Service (NRCS). Scoping meetings, open houses, landowner meetings, and field visits were coordinated by RESPEC with assistance from the CCNRD, CCCD, CCID, WWDO, and NRCS. A detailed description of the scoping meetings, open houses, and project meetings is included in the basin wide summary report.

Within the Subbasin below Keyhole Reservoir, a scoping meeting was held in Hulett, Wyoming on September 18, 2013, where RESPEC representatives made presentations, summarized work, and outlined tasks. Draft maps generated with available GIS data were presented to inform attendees. Questions were answered during the meetings but most discussions occurred between the attendees, local sponsors, and consultants after the scoping meeting. Landowner open houses were held in Moorcroft, Gillette, and Sundance where landowners discussed their concerns and potential projects with the consultant and representatives from CCNRD, CCCD, CCID, WWDO, or NRCS. Table 2.1 lists the meetings conducted within the subbasin during the study.

2.2 LANDOWNER MEETINGS AND FIELD VISITS

Following the scoping meetings and open houses, landowners interested in the study contacted the consultant, CCNRD, CCCD, or NRCS staff. Meetings with landowners were then scheduled at their 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 CCNRD, CCCD, or NRCS. During these visits, conceptual projects were discussed for potential water development projects.

Field inventory efforts were often conducted in coordination with planned scoping meetings, landowner open houses, CCNRD and CCCD board meetings, and landowner visits. Field activities focused on irrigation, upland livestock/wildlife water opportunities, riparian and stream channel conditions, dam and reservoir assessment, and hydrologic investigations. Ranchers, irrigators, and residents who visited with the study team to discuss issues and concerns demonstrated extensive knowledge and valuable insight about the watershed.

Table 2.1. Scoping, Landowner, Study, and Coordination Meetings in the Subbasin Below Keyhole Reservoir

Number	Date	Type	Location
9	09/18/13	Scoping Meeting	Hulett Civic Center
11	10/16/13	Landowner Meeting	Canfield Ranch
12	01/09/14	Project Update/Status	Hulett Community Center
19	03/10/14	Local Sponsor Meeting	CCID Hulett Community Center
23	04/18/14	Landowner Meeting	Keyhole Ranch
29	04/23/14	Landowner Meeting	Erland Ranch
33	04/25/14	Landowner Meeting	Driskill Ranch
38	07/10/14	Landowner Meeting	Williams Ranch
39	07/10/14	Landowner Meeting	Nieman 77 Ranch
41	07/22/14	Landowner Meeting	Keyhole Ranch
46	08/29/14	Landowner Meeting	Pearson Ranch
51	09/22/14	Landowner Meeting	Schlabach Ranch
53	10/03/14	Landowner Meeting	Keyhole Ranch
57	10/10/14	Landowner Meeting	Graham Ranch
58	10/13/14	Landowner Meeting	Ondriezek Ranch
61	10/23/14	Landowner Meeting	Jensen Ranch
62	10/24/14	Landowner Meeting	Downey Ranch
63	10/24/14	Landowner Meeting	Altaffer Ranch
65	10/25/14	Landowner Meeting	Driskill Ranch
66	10/31/14	Landowner Meeting	Mule Shoe Ranch

3.0 WATERSHED DESCRIPTION AND INVENTORY

3.1 LAND USES AND ACTIVITIES

3.1.1 Land Ownership

The area of the Subbasin below Keyhole Reservoir within the Belle Fourche River Watershed Study covers approximately 1,406 square miles or 900,050 acres. Land management within the subbasin consists of 81.5 percent of parcels or approximately 733,500 acres under private ownership, 93,380 acres (10.4 percent) managed by federal agencies, and 8.1 percent of parcels or 73,170 acres managed by the state of Wyoming. Almost 95 percent of the subbasin is located within Crook County, while the remaining 5 percent is located in Weston County. Table 3.1 lists the generalized categories of surface land ownership within the subbasin and Figure 3.1 displays the land ownership categories.

Table 3.1. Land Ownership Within the Subbasin

Ownership	Area (acres)	Area (square miles)	Area (Percent)
Private	733,500	1,146	81.5
Federal	93,380	146	10.4
Wyoming State Lands	73,170	114	8.1
Total	**900,050**	**1,406**	**100.0**

3.1.2 Irrigated Lands

Irrigation within the Subbasin below Keyhole Reservoir is primarily agricultural use. Based upon evaluation of the irrigated acreage provided by the WWDO, approximately 12,161 acres of irrigated lands comprises approximately 1.4 percent of the subbasin as listed by watershed (HUC-10) in Table 3.2 and shown in Figure 3.2. There are 153 points of diversion associated with these irrigated acres. Several individual ditches convey water to these irrigated acres. The crops primarily grown on irrigated lands within the subbasin include alfalfa, hay, small grains such as oats and barley, and corn [HKM Engineering Inc. et al., 2002].

3.1.3 Grazing

3.1.3.1 Range and Forest Lands

Approximately 879,730 acres of rangeland and forest lands occur within the subbasin and cover more than 97 percent of the subbasin. Approximately 624,080 acres of rangelands are located within the subbasin and covers approximately 69.3 percent of the subbasin. Private land

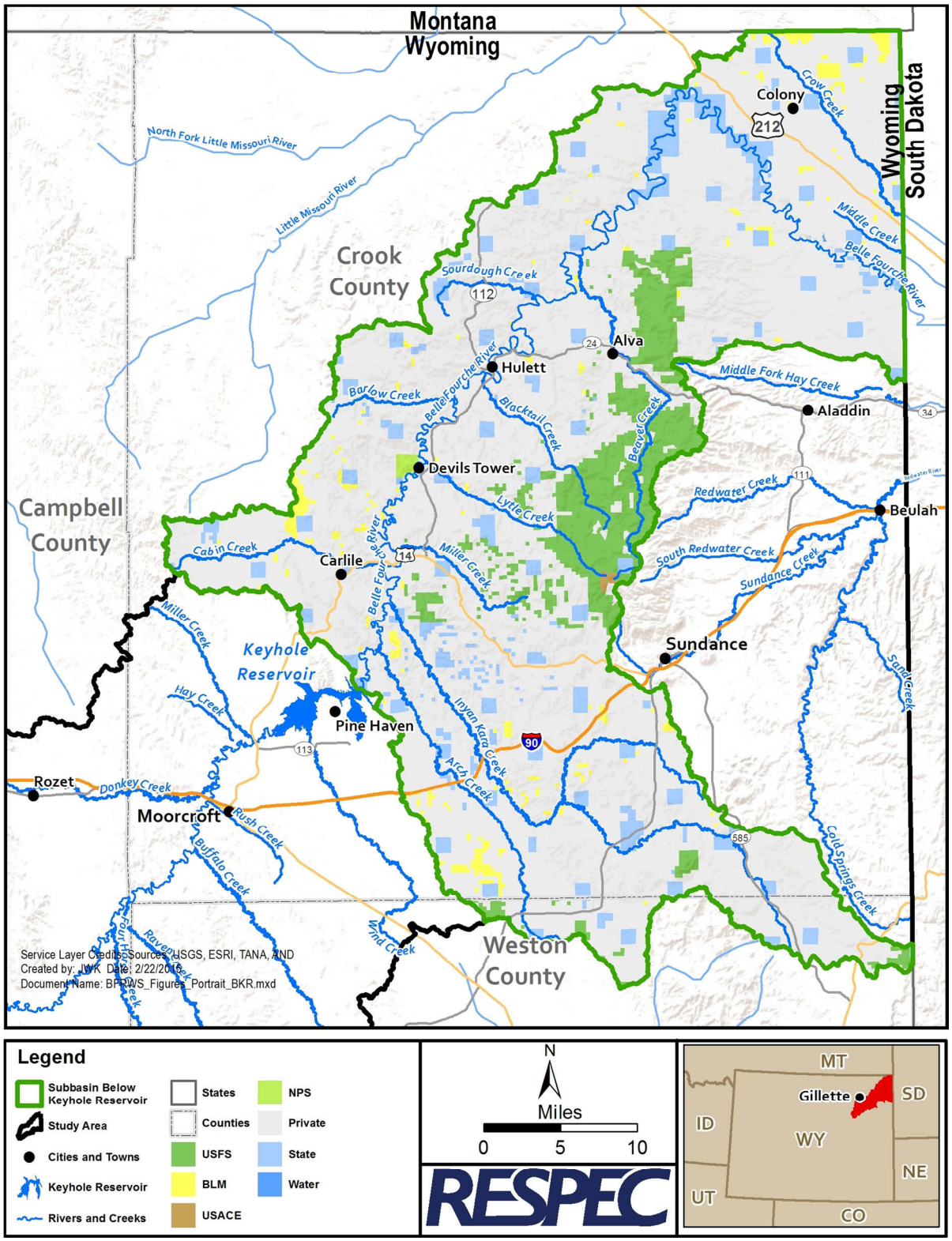

Figure 3.1. Categories of Land Ownership Within the Subbasin.

encompasses approximately 544,680 acres (87.3 percent) of the rangelands in the subbasin. The state of Wyoming manages 51,800 acres (8.3 percent), the Bureau of Land Management (BLM) manages approximately 14,430 acres (2.3 percent) and the United States Forest Service (USFS) manages approximately 10,590 acres (1.7 percent) of the rangelands within the subbasin as shown in Table 3.3. The remaining 2,580 acres (0.4 percent) of rangelands within the subbasin are owned by other parcel owners.

Table 3.2. Irrigated Lands by Subwatershed (HUC10) Within the Subbasin

Watershed (HUC10)	Estimated Area (acres)	Percent of Subbasin (%)
Arch Creek-Belle Fourche River	1,189	0.13
Inyan Kara Creek	2,494	0.28
Blacktail Creek-Belle Fourche River	2,592	0.29
Upper Belle Fourche River	2,631	0.29
Middle Belle Fourche River	3,021	0.34
Owl Creek	234	0.03
Total Estimated Acres	**12,161**	**1.35**

In addition to the rangelands, forest lands cover approximately 28.4 percent of the subbasin or 255,650 acres within the subbasin. Private land encompasses approximately 172,620 acres (67.5 percent) of the forest lands within the subbasin. The USFS manages approximately 62,260 acres (24.4 percent) and the state of Wyoming manages 6.3 percent or 16,010 acres of the forest lands within the subbasin. The BLM manages approximately 3,700 acres (1.4 percent) of the remaining forest lands within the subbasin as shown in Table 3.4

3.1.3.2 Federal Grazing Allotments

Grazing on an estimated 90,980 acres of federal rangelands and forest lands within the subbasin is administered by the USFS and BLM. The USFS Bearlodge Ranger District administers 22 grazing allotments encompassing 84,720 acres consisting of private, state, and federal lands within the subbasin. The USFS grazing allotments are listed in Table 3.5 and shown in Figure 3.3. The BLM manages 73 grazing allotments in the subbasin comprising of approximately 23,276 acres as shown in Figure 3.3 and listed in Table 3.6.

3.1.3.3 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 condition goals, objectives, and actions for the BLM managed allotments within the subbasin are detailed in the BLM's proposed and approved resource management

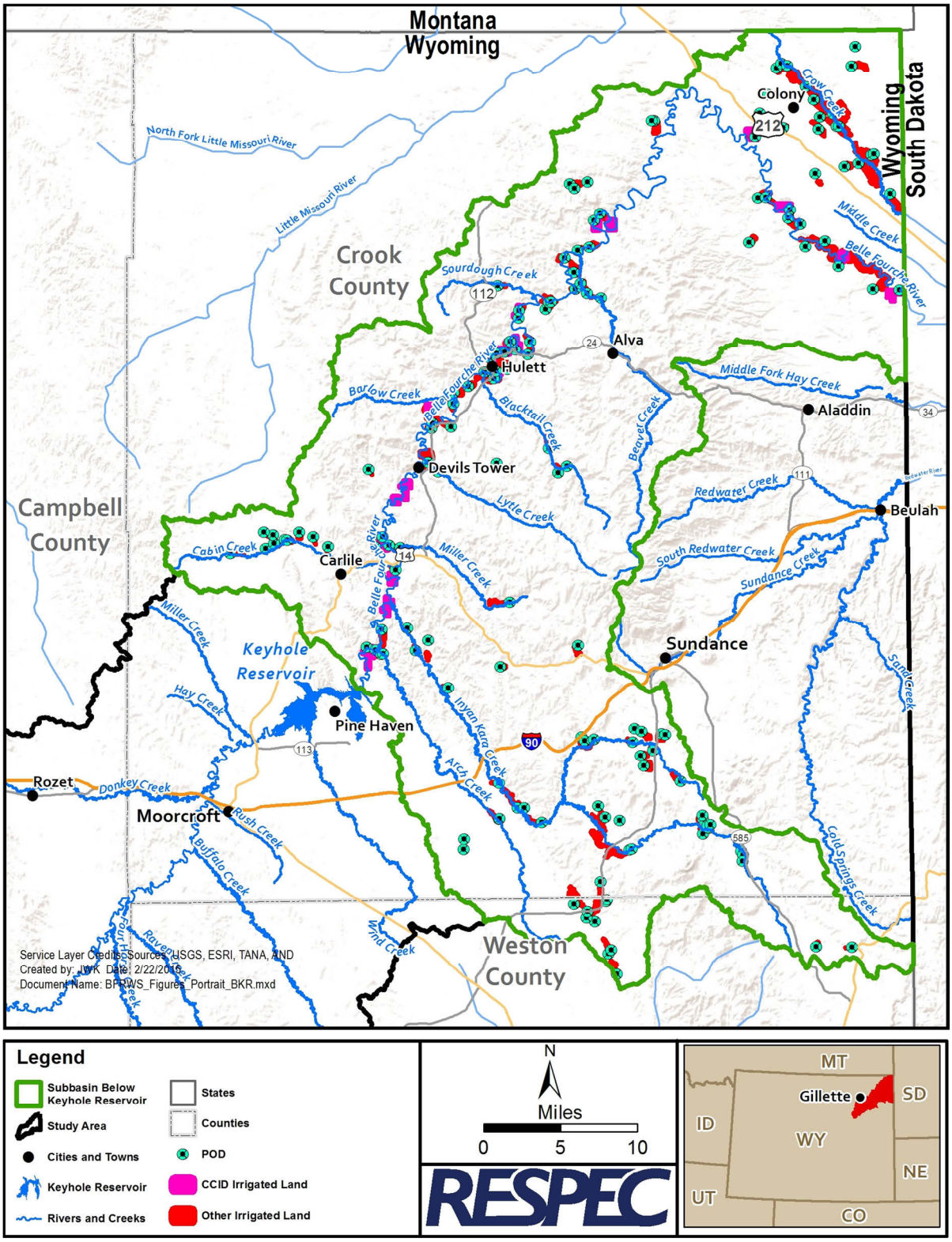

Figure 3.2. Irrigated Lands and Points of Diversions Within the Subbasin.

plans (RMPs) and associated environmental impact statement (EIS) documents for the BLM Buffalo, Newcastle, and South Dakota field offices. Range condition goals, objectives, and actions for the USFS grazing allotments are included in the USFS Forest Plan and amendments and associated EIS documents for the USFS ranger districts.

Table 3.3. Rangelands by Ownership/Management Within the Subbasin

Land Ownership or Management	Rangeland Acres	Percent of Total Rangeland Acres
Private	544,680	87.3
State of Wyoming	51,800	8.3
BLM	14,430	2.3
USFS	10,590	1.7
Other	2,580	0.4
Total	**624,080**	**100.0**

Table 3.4. Forest Lands by Ownership/Management Within the Subbasin

Land Ownership or Management	Forest Land Acres	Percent of Total Forest Land Acres
Private	172,620	67.5
USFS	62,260	24.4
State of Wyoming	16,010	6.3
BLM	3,700	1.4
Other	1,060	0.4
Total	**255,650**	**100.0**

Grazing permits or leases for a particular allotment, however, are not included within the RMP, Forest Plan, or EIS. Grazing permits or leases for a particular allotment, however, are not included within the RMP, Forest Plan, or EIS. 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.

Table 3.5. U.S. Forest Service Allotment Summary for the Subbasin

Ranger District	Allotment Number	Allotment Name	Area (acres)
Bearlodge	110	Addition	5,798.4
	103	Beaver Creek	12,785.4
	107	Blacktail	10,240.2
	117	Divide	3,366.8
	111	Huett Springs	2,131.5
	116	Inyan Kara	1,547.8
	121	Lame Jones	395.6
	118	Lytle Creek	3,107.0
	102	North Bearlodge	8,403.7
	109	Oak Creek	1,099.9
	120	Pheasant Draw	393.4
	101	Stoney Point	9,085.1
	106	Togus	5,519.5
	119	Warren Peak	8,058.7
Hell Canyon	406	Dry Beaver	48.5
	416	Soldier Creek	2,926.1
Douglas	9356	Arledge	4,825.6
	9345	Hagerman	753.9
	9333	May	1,349.1
	9375	Murray	2,565.0
	9335	Sweet	179.0
	9324	Sweet Ranch	140.5

Public land management policies directly affect the management of the private rangelands because public grazing leases and federal grazing allotments are integral components of a typical private grazing operation within the study area. Whether grazing occurs on private or public lands, a system of well-distributed, reliable water sources is a vital component to maintain or improve range conditions. A considerable amount of information regarding soils, hydrology, ecology, production, and vegetation within the study area is available. The ecological site description, which helps landowners and managers evaluate the condition of a range or forest site by comparing the current growth to what the site is capable of growing, can also be a valuable tool for landowners to use in their decision making.

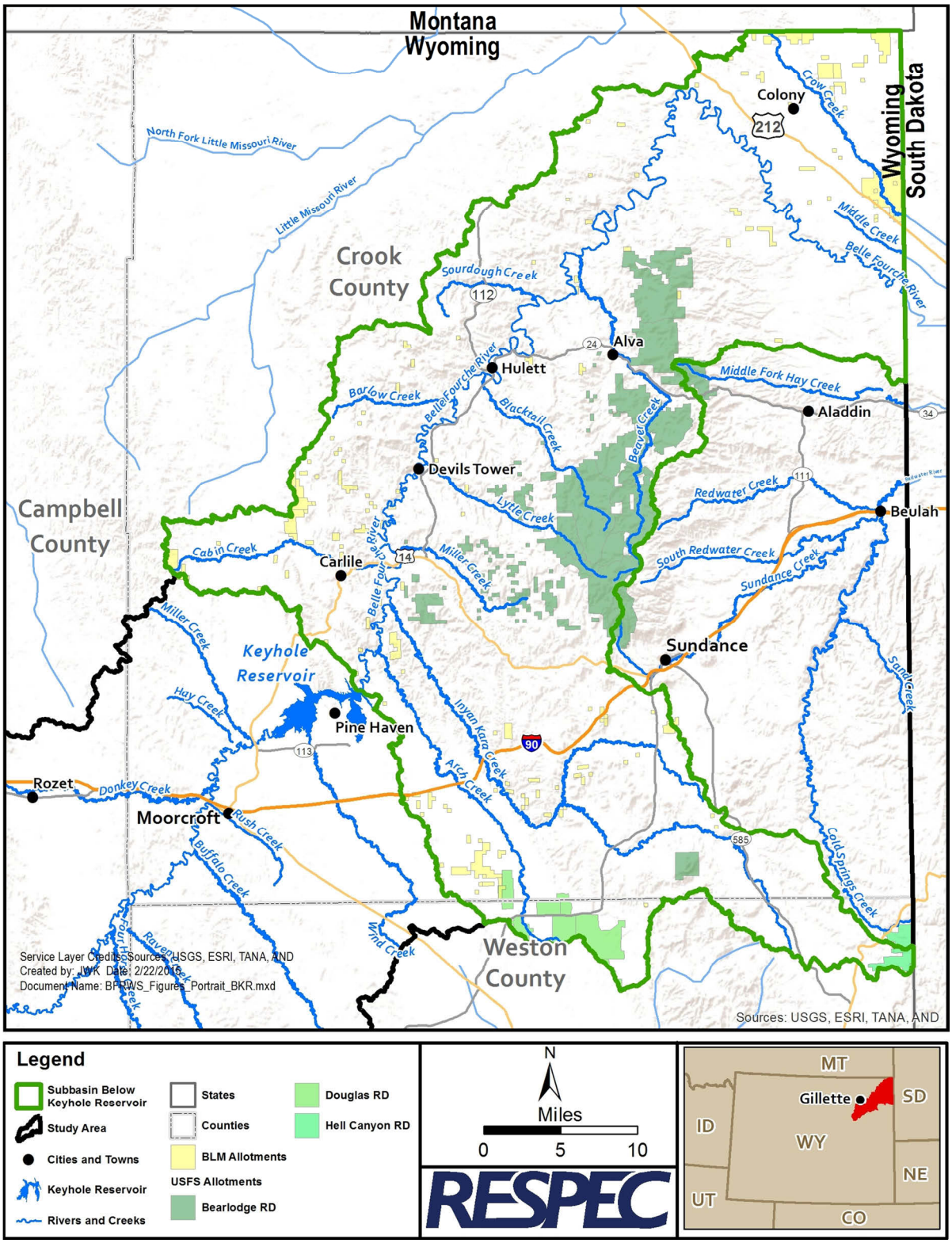

Figure 3.3. Federal Grazing Allotments Within the Subbasin and Study Area.

Table 3.6. Bureau of Land Management Allotment Summary for the Subbasin (Page 1 of 2)

Allotment Number	Allotment Name	Area (acres)	Allotment Number	Allotment Name	Area (acres)
Buffalo Field Office			**Newcastle Field Office**		
22106	Wagonhammer	997	4211	Branaman Mountain	85
Newcastle Field Office			4214	Gumbo Creek III	239
745	Cabin Creek II	87	4218	Crow Creek I	2,172
753	Right Creek II	40	4220	Red Canyon II	147
4045	Rifle Pit Road	40	4224	Barlow Creek	77
4058	Pipeline	1,214	4226	Kaiser Divide	83
4060	Little Creek	118	4228	Deep Draw II	1,342
4065	Buck Creek S13	164	4230	Terhune	76
4078	Left Creek	686	4251	Barnard Creek	194
4083	Brush Creek II	40	4252	Lipe Canyon II	40
4100	Cabin Creek I	114	4256	Stockade Beaver Creek	22
4106	Inyan Kara Creek	282	4259	Hoffman Creek	41
4108	Keyhole Lake	78	4265	Cedar Hill I	779
4110	Black Gulch	194	4270	Well	42
4113	Deep Draw I	244	4285	Cundy Creek	40
4117	Sage Creek II	41	4298	Rocky Ford Creek	248
4125	Right Creek I	283	4299	Lime Buttes	412
4139	Storm Hill	117	4304	Trail Creek	3,215
4142	Gladson Creek	26	4306	Ronning Draw	1,151
4144	Beaver/Inyan Kara	41	4308	Mcque Draw	38
4149	Jack	351	4315	Humboldt Creek	232
4154	Strawberry Hill	6	4317	Pine Creek Spring	76
4164	Pine Ridge II	1,138	4320	Arnold Creek	80
4166	Schoolhouse	153	4332	Cabin Creek III	39
4169	The Basin	156	4335	Ponderosa	39
4173	Deep Creek	340	4344	Newman Divide	40
4178	Cedar Ridge	81	4349	Benton Creek	39
4184	Rock Hill	124	4358	Eggie Creek	44
4186	Four Corners	86	4366	Moore Canyon	39
4194	Soap Creek	202	4367	Chicago Creek	158
4196	Horse Creek	84	4375	Basin Reservoir No. 1	42
4203	East Creek	82	4376	Cabin Creek IV	81
4208	Boggy Creek II	126	4377	Basin Reservoir	326

Table 3.6. Bureau of Land Management Allotment Summary for the Subbasin (Page 2 of 2)

Allotment Number	Allotment Name	Area (acres)	Allotment Number	Allotment Name	Area (acres)
Newcastle Field Office			**Newcastle Field Office**		
4378	Brosa Draw	718	14017	Houston Creek	327
4379	Cyclone Canyon	84	14018	Pine Ridge III	1,918
4395	Cedar Hill II	83	14025	Lipe Canyon I	230
4410	Dark Canyon	194	**South Dakota Field Office**		
4413	Red Canyon I	124	1801	Daley Creek	4,299

3.1.3.4 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 subbasin. Mapping viable water sources within the subbasin included the following items:

- Maps of springs were obtained from the BLM Field Offices, Forest Service Ranger Districts, and USGS topographic maps.
- Maps of stock wells were created by using data obtained from the Wyoming State Engineer's Office (SEO) and WWDO.
- Interviews with landowners were conducted during study meetings and field visits.
- Maps were developed and existing stock ponds and reservoirs were inventoried during field visits and assessed using imagery, topographic maps, and hydrography datasets.

This mapping effort indicated the existence of 167 stock reservoirs, ponds, lakes, and reservoirs. Digitized locations of springs were included using BLM, USFS, and USGS data. 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 data 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 structures showed visible evidence of dam and spillway breaches or 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 3.4. The results of this mapping effort are presented in Figure 3.5. Several livestock/wildlife water development projects, which typically include wells, spring developments, pipelines, and stock tanks, have been completed within the subbasin. A 1-mile buffer was delineated around the existing viable water source locations within the subbasin and is presented in Figure 3.6. This figure of mapping results does not include water sources such as perennial and intermittent streams, undeveloped springs, or breached ponds and reservoirs.

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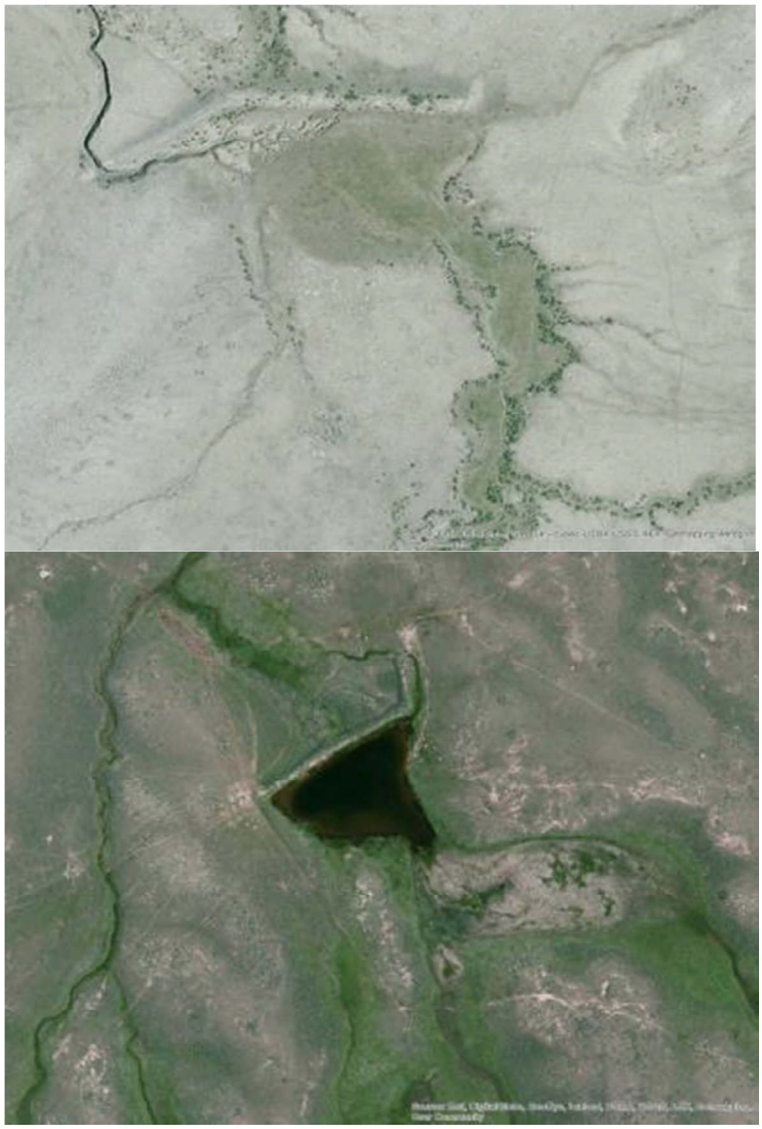

Figure 3.4. Geographic Information System Evaluation of Stock Ponds and Reservoirs Within the Subbasin.

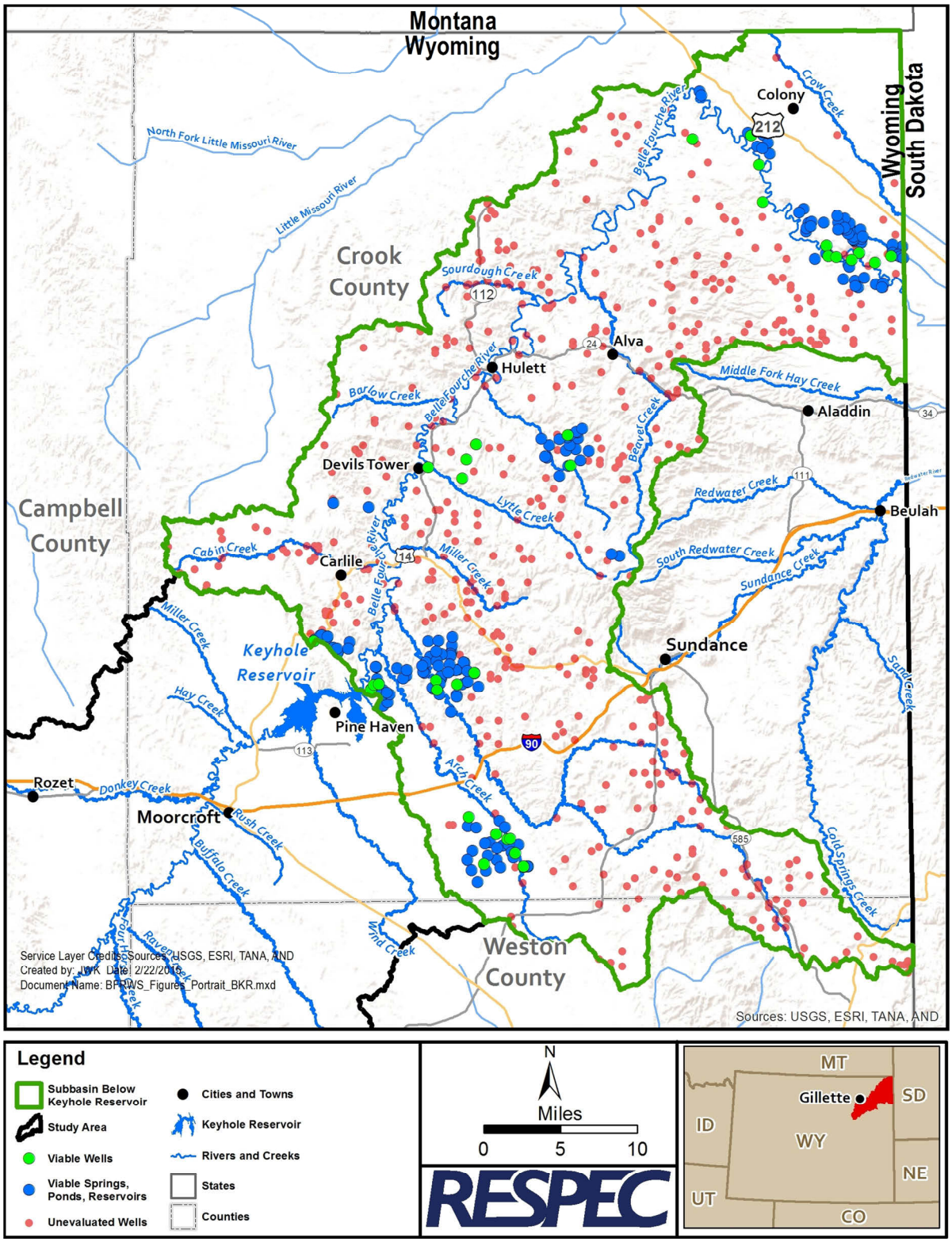

Figure 3.5. Viable Water Sources Within the Subbasin.

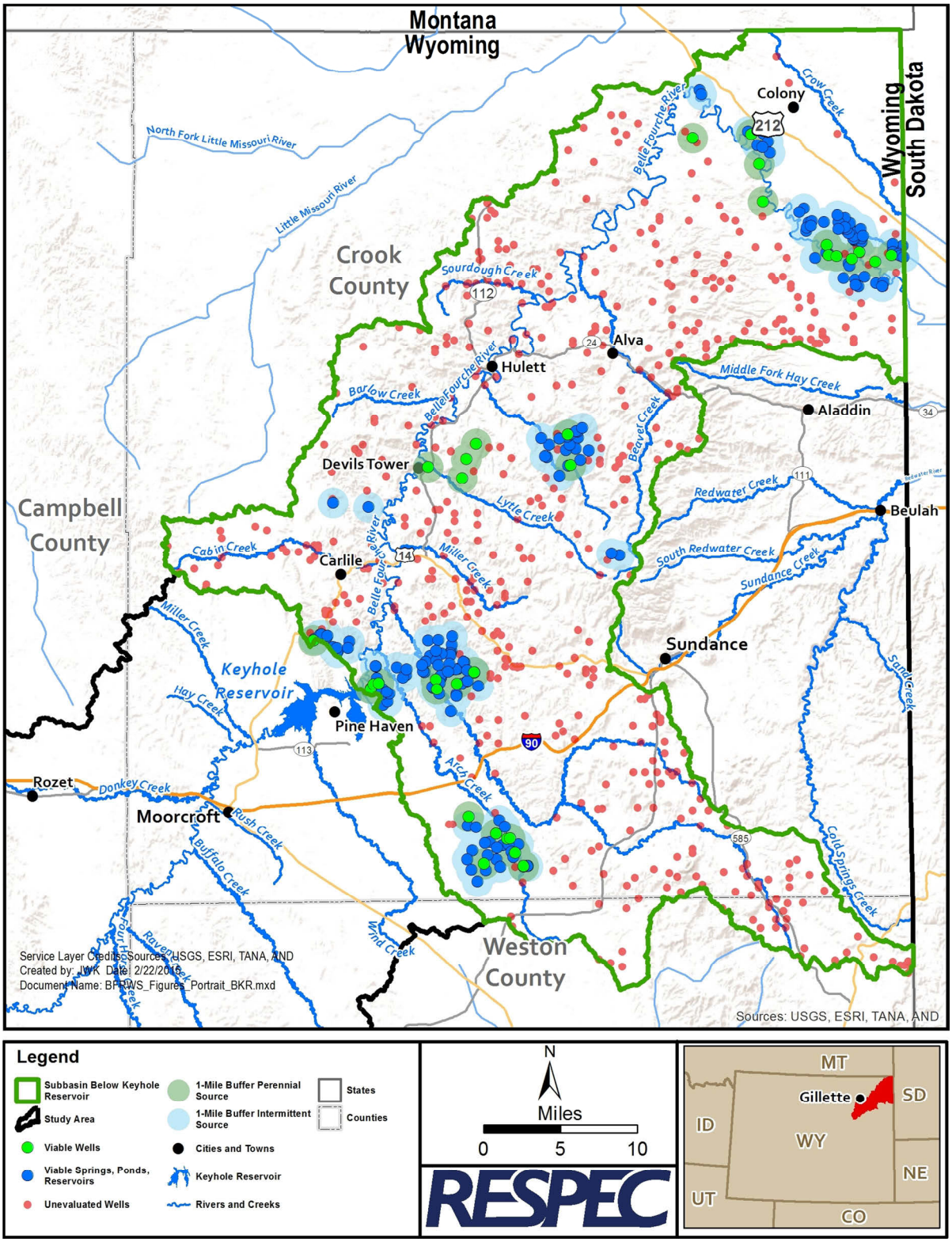

Figure 3.6. Viable Water Sources With a 1-Mile Buffer Within the Subbasin.

3.1.3.5 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 along with 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 and 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 96 percent of the subbasin. There are 54 mapped ESDs covering approximately 96 percent of the subbasin. Figure 3.7 shows the locations of the ecological sites covering more than 1 percent of the acres within the subbasin. Four predominant ESDs cover approximately 46 percent of the subbasin as listed in Table 3.7 and are described in Chapter 4.0. The most predominant

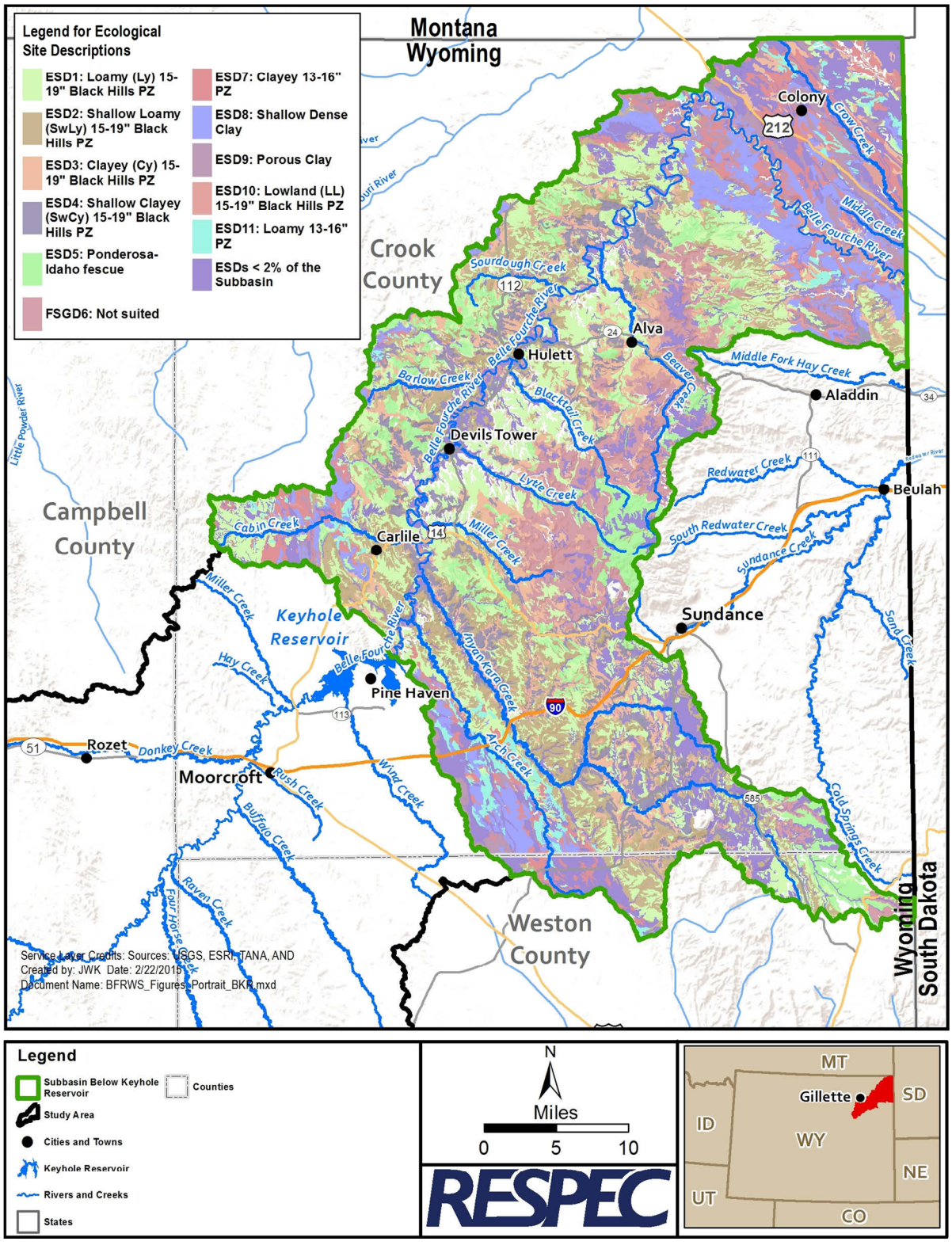

Figure 3.7. Ecological Site Descriptions Within the Subbasin.

ecological site, loamy (Ly) 15–19-inch Black Hills Precipitation Zone ESD (R061XY122WY) covers approximately 160,433 acres (17.8 percent) of the subbasin. The ESDs covering more than 1 percent of the subbasin are listed in Table 3.8.

Table 3.7. Predominant Ecological Sites, Descriptions, and Areas Within the Subbasin

Identifier	Ecological Site I.D.	Description	Area (acres)	Percent of Subbasin
1	R061XY122WY	Loamy (Ly) 15–19 inch Black Hills PZ	160,433	17.8
2	R061XY162WY	Shallow Loamy (SwLy) 15–19 inch Black Hills PZ	113,621	12.6
3	R061XY104WY	Clayey (Cy) 15–19 inch Black Hills PZ	83,066	9.2
4	R061XY158WY	Shallow Clayey (SwCy) 15–19 inch Black Hills PZ	58,277	6.5
Total			415,397	46.1

In addition to the ESDs, the NRCS soils data includes forage suitability group descriptions (FSGDs), which occur on approximately 75,243 acres within the subbasin. FSGDs describe one or more soil map units having similar potentials and limitations for forage production and can be linked or associated to one individual ecological site or to multiple ecological sites. Because ESDs are still being developed and approved for interpreting ecological conditions on forest soils within the watershed, FSGDs could be used as a basic interpretive tool but caution should be exercised when using these for specific pastures, grazing allotments, or management units.

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 an indicator of potential site productivity.

The descriptions of the HCPC associated with the predominant ESDs within the subbasin were obtained 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*) and are included in Chapter 4.0 of this report.

Table 3.8. Ecological Sites, Descriptions, and Areas for Subbasin

Identifier	Ecological Site I.D.	Description	Area (acres)	Percent of Subbasin
1	R061XY122WY	Loamy (Ly) 15–19 inch Black Hills PZ	160,433	17.8
2	R061XY162WY	Shallow Loamy (SwLy) 15–19 inch Black Hills PZ	113,621	12.6
3	R061XY104WY	Clayey (Cy) 15–19 inch Black Hills PZ	83,066	9.2
4	R061XY158WY	Shallow Clayey (SwCy) 15–19 inch Black Hills PZ	58,277	6.5
5	GFL_PIPO_FEID	Ponderosa-Idaho fescue	58,204	6.5
6	G062XY000SD	Not suited	57,885	6.4
7	R060AY011SD	Clayey 13–16 inch PZ	55,985	6.2
8	R060AY025SD	Shallow Dense Clay	54,564	6.1
9	R060AY030SD	Porous Clay	26,526	2.9
10	R061XY128WY	Lowland (LL) 15–19 inch Black Hills PZ	21,350	2.4
11	R060AY010SD	Loamy 13–16 inch PZ	18,146	2.0
12	R060AY017SD	Shallow Clay	14,356	1.6
13	G062XY210SD	Clayey Subsoil	14,186	1.6
14	R060AY043SD	Shallow Porous Clay	11,272	1.3
15	R061XY130WY	Overflow (Ov) 15–19 inch Black Hills PZ	10,916	1.2
16	R061XY168WY	Thin Upland	10,887	1.2
17	R060AY018SD	Dense Clay	9,988	1.1
18-54	Various ESDs	ESDs covering less than 1 percent of the Subbasin	85,248	9.5
Total			864,910	96.1

3.1.4 Mining and Mineral Resources

The subbasin contains eight operating non-coal mines. Information about the mines was obtained from the Wyoming Department of Environmental Quality (WDEQ) and summarized in Table 3.9 and Figure 3.8. Sand/gravel mines constitute the majority of permitted mine operations within the project area. Other minerals mined include bentonite and limestone. The largest mineral mining operation in the subbasin is the Belle Fourche River bentonite mine operated by American Colloid Company on a permitted acreage of approximately 39,093 acres. No active coal mines are located within the subbasin.

Table 3.9. Current Mineral Resource Mines Within the Subbasin

Permit I.D.	Permitted Mine	Permittee	Commodity	Mine Area (acres)
ET0888	Tenke	Dan Hart Patrol Service, LLC	Limestone	9.9
ET1255	Tenke	Tenke, Vince, Arelene & Leslie	Sand & Gravel	10.0
ET1429	Zimmerschied	Quality Agg & Construction Inc.	Sand and Gravel	10.0
ET1448	Schlautmann	Quality Agg & Construction Inc.	Sand and Gravel	9.6
PT0267	Colony	Bentonite Performance Minerals LLC	Bentonite	17,347.0
PT0620	Belle Fourche River	American Colloid Co.	Bentonite	39,092.6
PT0667	Habeck	Hills Material Co.	Limestone	140.5
PT0677	Neiman	Birdsall Sand & Gravel	Sand and Gravel	730.0
PT0789	Lake Ranch	Aggregate Solutions, LLC	Gravel	118.3

3.1.5 Oil and Gas Production and Resources

Information and data regarding the active and abandoned oil and gas wells within the subbasin was obtained from the Wyoming Oil and Gas Conservation Commission (WOGCC) by accessing their website (*http://wogccms.state.wy.us/*) and by communicating with WOGCC staff. Approximately 113 producing oil wells and 580 permanently abandoned wells are within the subbasin. No gas-producing wells are located in the subbasin. Locations of the active oil wells and permanently abandoned wells are displayed in Figure 3.9. According to the Wyoming State Geological Survey, 4,656 acres of oil field are within the subbasin. In 2013, oil fields within the subbasin produced approximately 49,231 barrels (bbls) of oil and 2,515,828 bbls of water [Wyoming Oil and Gas Conservation Commission, 2014]. Table 3.10 summarizes the 2013 oil and gas production by field for the oil and gas areas within the subbasin. Field locations and pipelines are also shown on Figure 3.9.

3.1.6 Wildlife and Habitat

3.1.6.1 Big Game

The Wyoming Game and Fish Department (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. No areas within the subbasin are considered as parturition area or crucial range for any big game species. Figures 3.10 through 3.13 display the herd units, seasonal range, and critical range for antelope, elk, mule deer, and white-tailed deer. These figures show that the entire subbasin is seasonal range for antelope, mule deer, and white-tailed deer. Approximately 25 percent of the subbasin is seasonal range for elk.

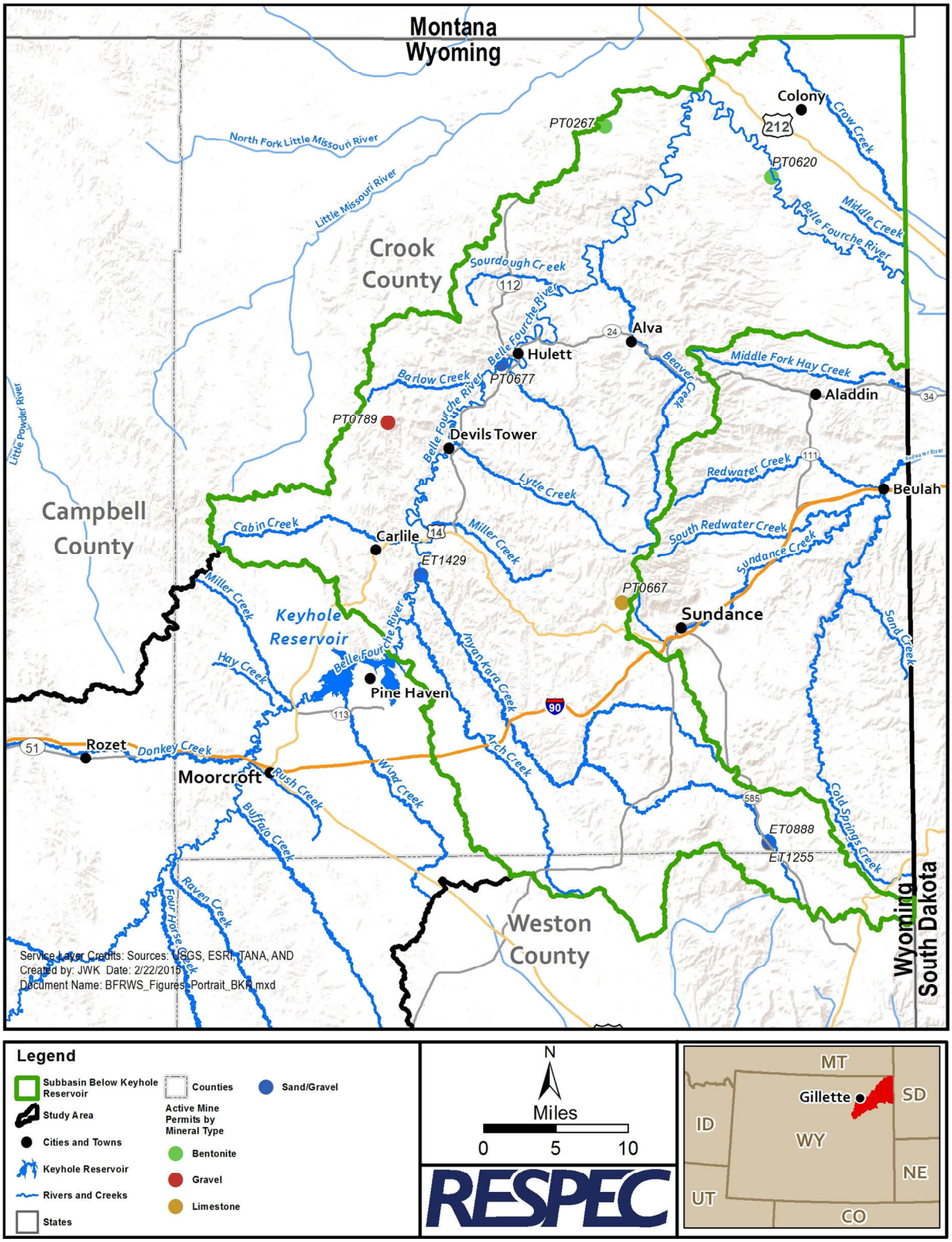

Figure 3.8. Permitted Mines Within the Subbasin.

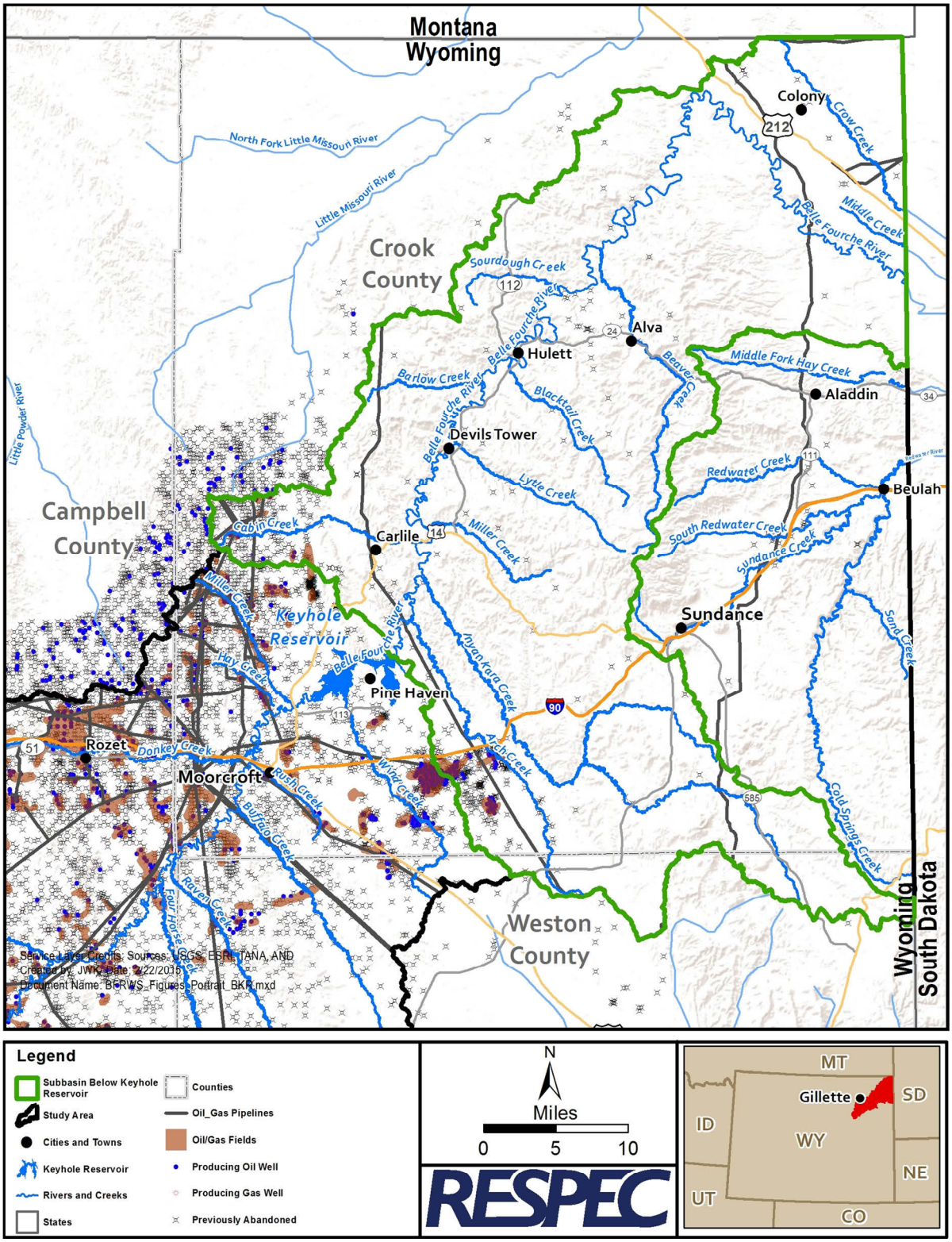

Figure 3.9. Active Oil and Gas Wells Within the Subbasin.

Table 3.10. 2013 Oil and Gas Production by Field Within the Subbasin

Oil or Gas Field	Oil (bbls)[(a)]	Gas (mcf)[(b)]	Water (bbls)[(a)]
Kiehl	33,548	0	898,045
Olds	5,072	0	575,401
Pine Ridge	3,999	0	311,772
Soap Hole	735	0	5,648
Tomcat Creek	5,270	0	607,172
Wind Creek	607	0	117,790

(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.

3.1.6.2 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. Table 3.11 lists the tracked or watched species of amphibians, birds, crustaceans, fern and fern ally, fish, insects, mammals, mollusks found within the subbasin [Wyoming Natural Diversity Database, 2014]. The list shows that there is one endangered species: the black-footed ferret (*Mustela nigripes*) and one threatened species: piping plover (*Charadrius melodus*) known to have occurred within the subbasin.

Table 3.11 shows that 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 to protect and enhance 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. No core areas for sage-grouse are located within the subbasin as shown in Figure 3.14.

3.1 SETTING AND ENVIRONMENT

3.1.1 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. Approximately 315,420 acres (35 percent) of land cover within the subbasin is comprised of grassland/herbaceous vegetative cover. Approximately 308,900 acres (34 percent) of the subbasin is classified as shrub/scrub land and approximately 251,470 acres (28 percent) are classified as evergreen forest. The remaining areas consist of pasture/hay, decidious forest, water, and other small cover classes.

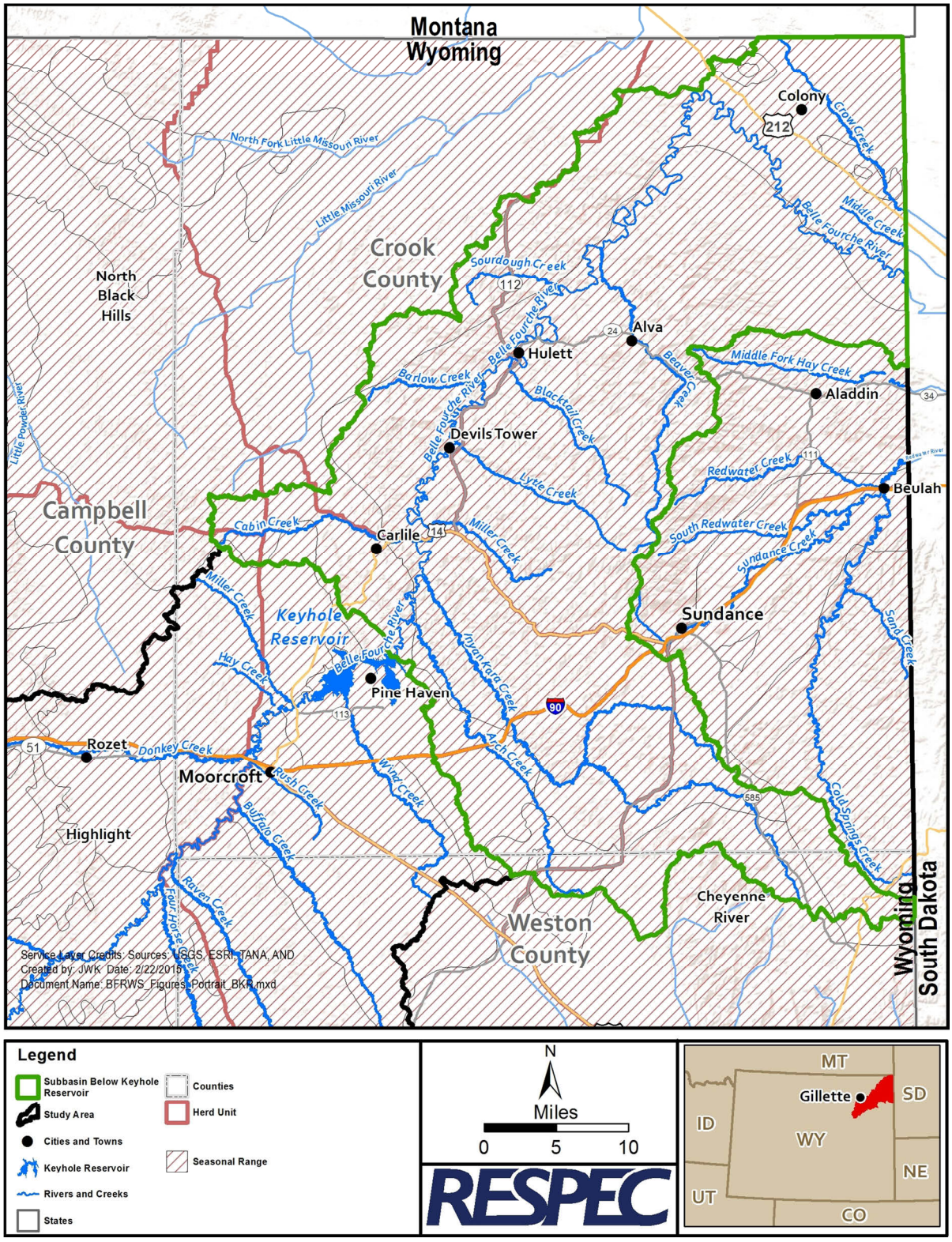

Figure 3.10. Antelope Habitat Within the Subbasin and Surrounding Area.

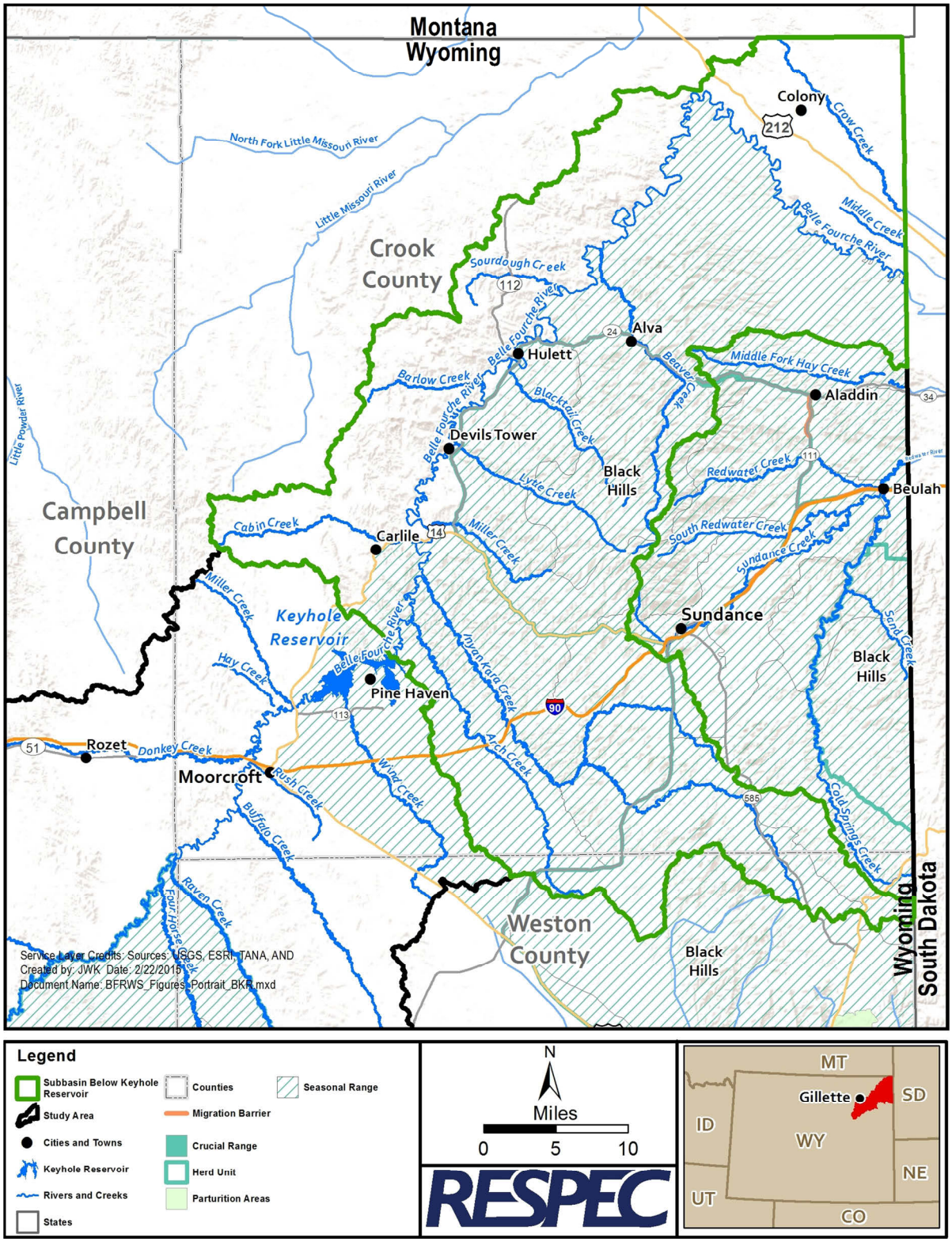

Figure 3.11. Elk Habitat Within the Subbasin and Surrounding Area.

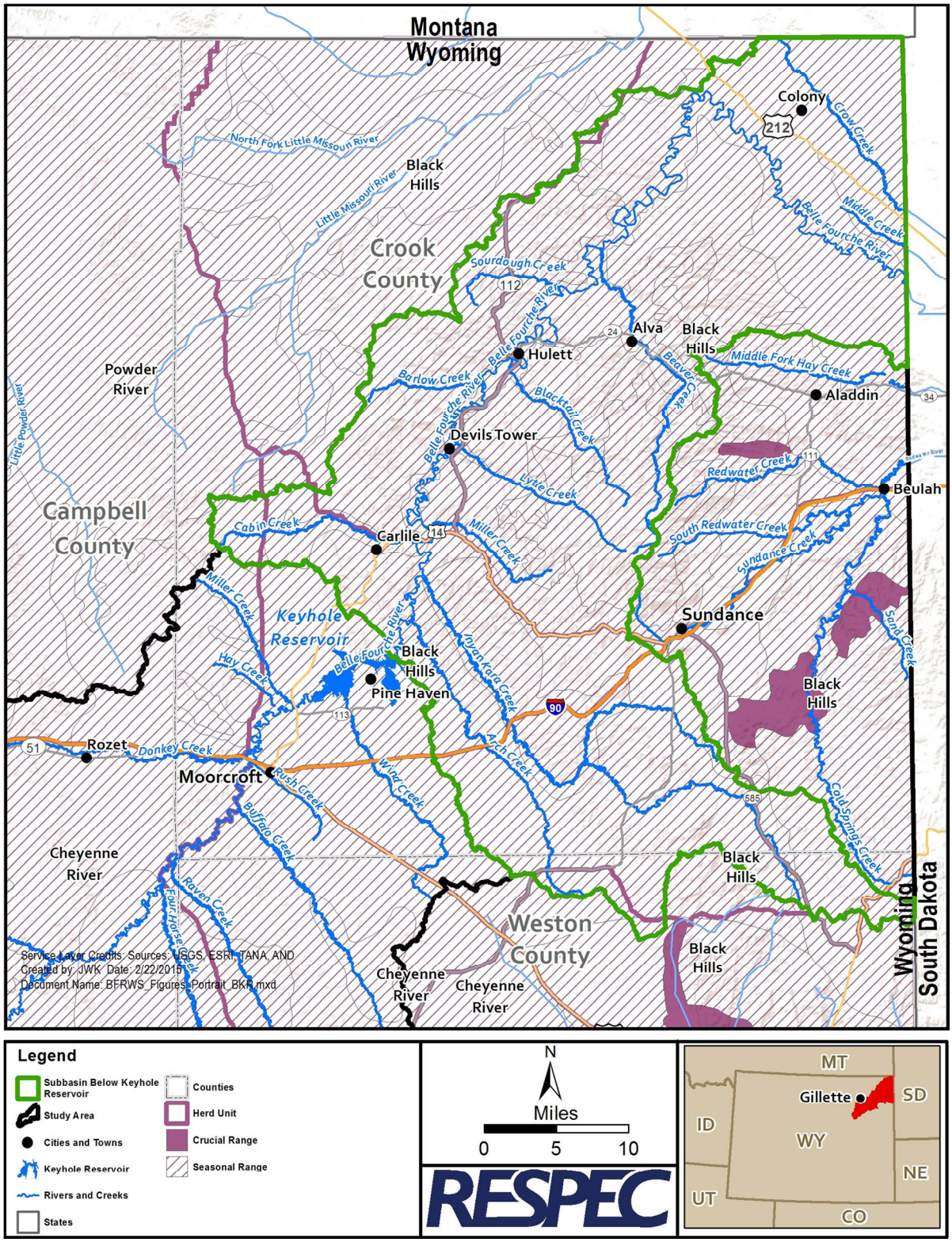

Figure 3.12. Mule Deer Habitat Within the Subbasin and Surrounding Area.

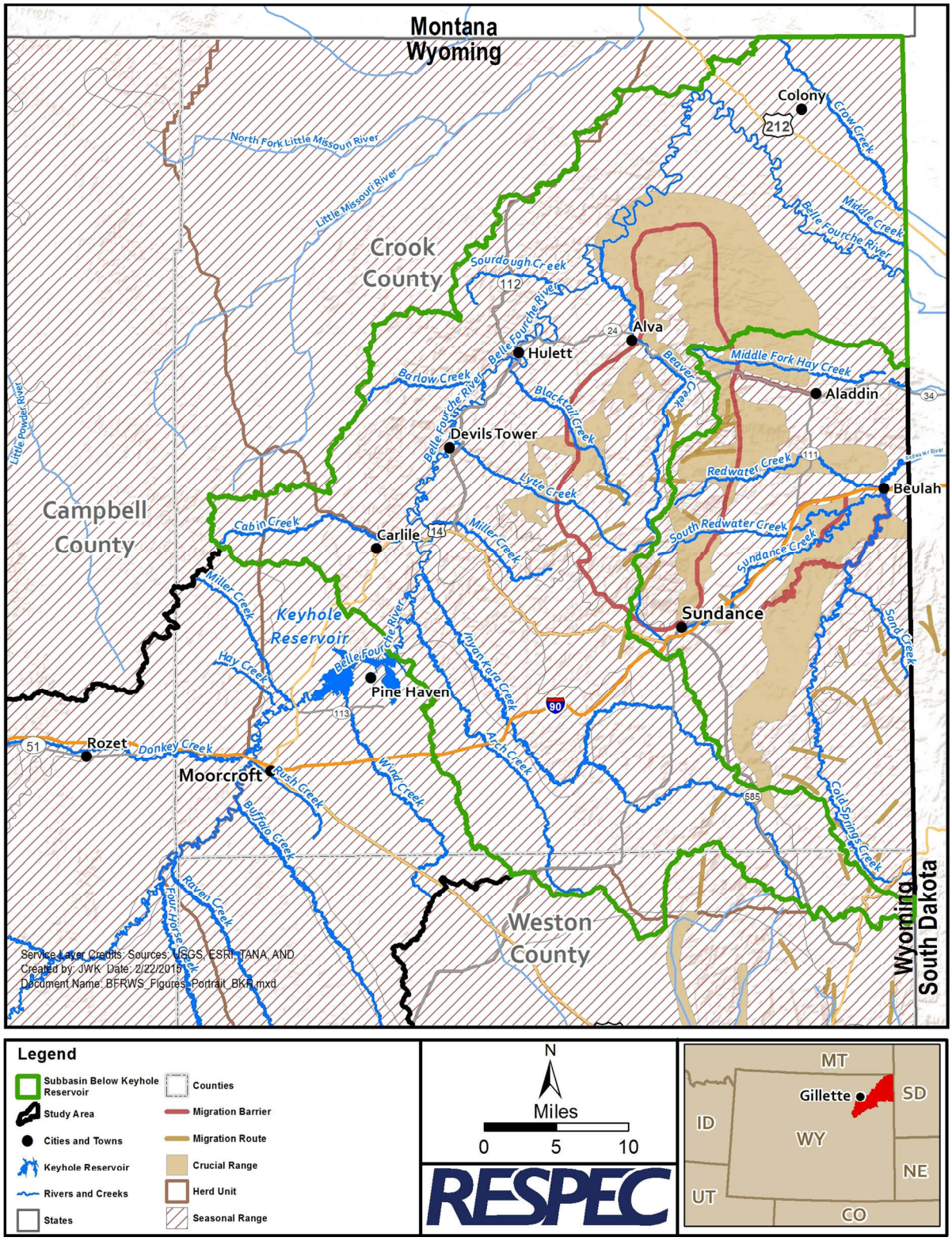

Figure 3.13. White-Tailed Deer Habitat Within the Subbasin and Surrounding Area.

Table 3.11. Wyoming Natural Diversity Database: Wildlife Species in the Subbasin (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			
Accipiter gentilis	Northern Goshawk	Not Warranted for Listing	Tracked
Ammodramus savannarum	Grasshopper Sparrow		Watched
Aquila chrysaetos	Golden Eagle		Watched
Asio flammeus	Short-eared Owl		Tracked
Athene cunicularia	Burrowing Owl		Tracked
Aythya collaris	Ring-necked Duck		Watched
Botaurus lentiginosus	American Bittern		Tracked
Bucephala albeola	Bufflehead		Watched
Buteo regalis	Ferruginous Hawk		Tracked
Catherpes mexicanus	Canyon Wren		Watched
Centrocercus urophasianus	Greater Sage-Grouse	Warranted but Precluded	Tracked
Charadrius melodus	Piping Plover	Listed Threatened	Watched
Charadrius montanus	Mountain Plover	Not Warranted for Listing	Tracked
Coccyzus americanus	Yellow-billed Cuckoo		Tracked
Coccyzus erythropthalmus	Black-billed Cuckoo		Tracked
Cygnus buccinator	Trumpeter Swan	Not Warranted for Listing	Tracked
Cygnus columbianus	Tundra Swan		Watched
Dolichonyx oryzivorus	Bobolink		Tracked
Empidonax hammondii	Hammond's Flycatcher		Watched
Falco columbarius	Merlin		Watched
Gavia immer	Common Loon		Tracked
Grus canadensis	Sandhill Crane		Watched
Haliaeetus leucocephalus	Bald Eagle	Delisted, formally monitored	Tracked
Himantopus mexicanus	Black-necked Stilt		Watched
Junco hyemalis	Dark-eyed Junco		Tracked
Junco hyemalis aikeni	White-winged Junco		Watched
Lanius ludovicianus	Loggerhead Shrike		Tracked
Larus argentatus	Herring Gull		Watched
Larus delawarensis	Ring-billed Gull		Watched
Melanerpes lewis	Lewis's Woodpecker		Tracked

Table 3.11. Wyoming Natural Diversity Database: Wildlife Species in the Subbasin (Page 2 of 4)

Scientific Name	Common Name	Listing Status	Tracking Status
Bird			
Numenius americanus	Long-billed Curlew		Tracked
Nycticorax nycticorax	Black-crowned Night-Heron		Watched
Oreoscoptes montanus	Sage Thrasher		Watched
Oreothlypis virginiae	Virginia's Warbler		Tracked
Pandion haliaetus	Osprey		Watched
Passerina cyanea	Indigo Bunting		Watched
Pelecanus erythrorhynchos	American White Pelican		Tracked
Picoides arcticus - Black Hills	Black Hills Black-backed Woodpecker	Petition Under Review	Tracked
Picoides dorsalis - Black Hills	Black Hills Three-toed Woodpecker		Tracked
Plegadis chihi	White-faced Ibis		Tracked
Rallus limicola	Virginia Rail		Watched
Recurvirostra americana	American Avocet		Watched
Regulus satrapa	Golden-crowned Kinglet		Watched
Rhynchophanes mccownii	McCown's Longspur		Tracked
Sialia sialis	Eastern Bluebird		Watched
Sitta pygmaea	Pygmy Nuthatch		Tracked
Spiza americana	Dickcissel		Watched
Spizella pallida	Clay-colored Sparrow		Watched
Sterna forsteri	Forster's Tern		
Strix nebulosa	Great Gray Owl		Watched
Vireo olivaceus	Red-eyed Vireo		Watched
Fern and Fern Ally			
Botrychium campestre	Prairie moonwort		Tracked
Botrychium pallidum	Pale moonwort		Tracked
Equisetum scirpoides	Dwarf scouring rush		Tracked
Equisetum sylvaticum	Woodland horsetail		Tracked
Gymnocarpium dryopteris	Oak fern		Tracked
Lycopodium dendroideum	Tree-like clubmoss		Tracked
Onoclea sensibilis	Sensitive fern		Tracked
Pellaea gastonyi	Gastony's cliff brake		Tracked
Selaginella rupestris	Ledge spike-moss		Tracked

Table 3.11. Wyoming Natural Diversity Database: Wildlife Species in the Subbasin (Page 3 of 4)

Scientific Name	Common Name	Listing Status	Tracking Status
Fish			
Couesius plumbeus	Lake Chub		Watched
Hybognathus argyritis	Western Silvery Minnow		Tracked
Platygobio gracilis	Flathead Chub		Watched
Insect			
Dichagyris (Mesembagrotis) reliqua	A Noctuid Moth		Tracked
Hesperia ottoe	Ottoe Skipper		Tracked
Phyciodes batesii	Tawny Crescent		Tracked
Speyeria idalia	Regal Fritillary		Tracked
Mammal			
Antrozous pallidus	Pallid Bat		Tracked
Canis lupus	Gray Wolf	Proposed for Delisting	Tracked
Corynorhinus townsendii	Townsend's Big-eared Bat		Tracked
Cynomys ludovicianus	Black-tailed Prairie Dog	Not Warranted for Listing	Tracked
Glaucomys sabrinus - Black Hills	Black Hills Flying Squirrel		Tracked
Lasionycteris noctivagans	Silver-haired Bat		Watched
Lasiurus cinereus	Hoary Bat		Watched
Mustela nigripes	Black-footed Ferret	Listed Endangered	Tracked
Myotis ciliolabrum	Western Small-footed Myotis		Watched
Myotis evotis	Long-eared Myotis		Watched
Myotis lucifugus	Little Brown Myotis	Petition Under Review	Watched
Myotis septentrionalis	Northern Myotis	Proposed Endangered	Tracked
Myotis thysanodes	Fringed Myotis		Tracked
Myotis volans	Long-legged Myotis		Watched
Myotis yumanensis	Yuma Myotis		Tracked
Ovis canadensis	Bighorn Sheep		Watched
Peromyscus leucopus	White-footed Deermouse		Watched
Sorex haydeni	Hayden's Shrew		Tracked
Sylvilagus floridanus	Eastern Cottontail		Watched
Tamiasciurus hudsonicus dakotensis	Black Hills Red Squirrel		Tracked
Urocyon cinereoargenteus ocythous	Prairie Gray Fox	Petition Under Review	Watched
Ursus arctos arctos	Grizzly Bear	Listed Threatened	Tracked
Vulpes velox	Swift Fox	Not Warranted for Listing	Tracked
Zapus hudsonius campestris	Bear Lodge Meadow Jumping Mouse		Tracked

Table 3.11. Wyoming Natural Diversity Database: Wildlife Species in the Subbasin (Page 4 of 4)

Scientific Name	Common Name	Listing Status	Tracking Status
Mollusk			
Catinella stretchiana	Sierra Ambersnail		Tracked
Lasmigona complanata	White Heelsplitter		Tracked
Oreohelix strigosa ssp. 1	Bear Lodge Mountainsnail		Tracked
Oreohelix subrudis	A Mountainsnail		Tracked
Pyganodon grandis	Giant Floater		Tracked
Vertigo arthuri	Callused Vertigo Snail		Tracked
Vertigo paradoxa	Mystery Vertigo		Tracked
Reptile			
Apalone spinifera spinifera	Eastern Spiny Softshell		Watched
Coluber constrictor flaviventris	Eastern Yellow-bellied Racer		Watched
Opheodrys vernalis	Smooth Greensnake		Tracked
Storeria occipitomaculata pahasapae	Black Hills Red-bellied Snake		Tracked
Thamnophis radix	Plains Gartersnake		Watched
Thamnophis sirtalis parietalis	Red-sided Gartersnake		Watched

3.1.2 Vegetation

The Wyoming Gap Analysis Program (GAP) data were obtained to evaluate existing vegetation in the subbasin, which are listed in Table 3.13 and shown in Figure 3.15. Additionally Table 3.14 lists the plant species of concern within the subbasin as supplied by WYNDD. Vegetative communities within the subbasin vary throughout the watershed because of the differing ecoregions. The western portion of the watershed, Great Plains Ecoregion, include mostly grass, forb, shrub, and sagebrush communities. In the eastern portion of the watershed, Northwestern Forested Mountains Ecoregion, plant communities include pine forests and woodlands, areas of deciduous forest, with an understory consisting of grasses, sedges, and shrubs. In general, the desirable grass species in the watershed include rhizomatous wheatgrass, needleandthread, green needlegrass, prairie sandreed, big bluestem, and blue grama. Twenty-five designated and prohibited noxious weeds are on the state of Wyoming Weed and Pest Control Act Designated List and detailed in the basin wide summary report.

3.1.3 Wetlands

Approximately 4,942 acres of National Wetlands Inventory (NWI) ae mapped wetland types, which cover approximately 0.54 percent of the subbasin. The predominant wetland type is a

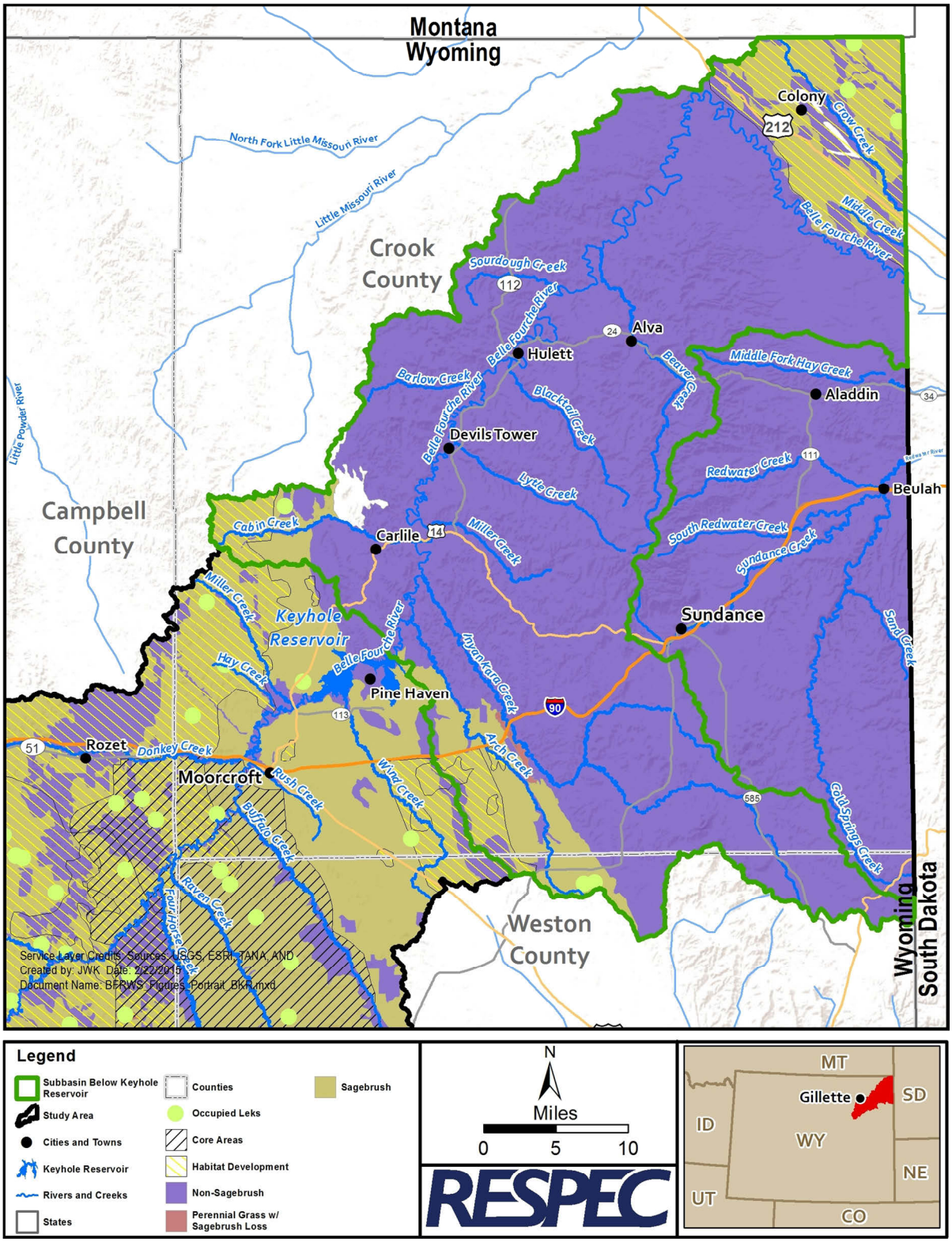

Figure 3.14. Sage-Grouse Distribution and Core Areas Within the Subbasin.

freshwater pond, which occurs on approximately 2,146 acres within the subbasin. The NWI wetlands within the subbasin are listed in Table 3.15. The NWI wetland areas are shown in Figure 3.16. However, because the NWI wetland areas are very small in size relative to the subbasin and are scarcely visible when presented at this 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 figure. Site-specific wetland delineation were not part of the inventory and it is recommended that wetland delineation and inventories should be completed before planning future wetland projects.

Table 3.12. National Land Cover Dataset Classifications Within the Subbasin

Classification	Description	Area (acres)	Percent of Subbasin
Grassland and Herbaceous	Gramanoid or herbaceous vegetation, generally greater than 80 percent of total vegetation. These areas are not subject to tilling, but are used for grazing.	315,423	35.0
Shrub and Scrub	Shrubs less than 16 feet tall with canopy typically greater than 20 percent of total vegetation. This class includes shrubs and trees in early successional stages or stunted from environmental conditions.	308,898	34.3
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.	251,467	27.9
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.	4,529	0.5
Deciduous Forest	Trees greater than 16 feet tall, and greater than 20 percent of vegetation cover. More than 75 percent of the tree species shed foliage in response to a seasonal change.	4,229	0.5
Woody Wetlands	Forests or shrublands accounts for greater than 20 percent and the soil is periodically covered with water.	3,856	0.4
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 aesthetics.	3,760	0.4
Emergent Herbaceous Wetlands	Perennial herbaceous vegetation accounts for greater than 80 percent of vegetative cover and the soil or substrate is periodically covered with water.	2,749	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 land being tilled.	2,714	0.3
Developed, Low Intensity	A mixture of constructed materials and vegetation. Impervious surfaces account for 20 to 49 percent of total cover. These areas commonly include single-family housing units.	927	0.1
Other	Areas with less than 0.1 percent of the study area.	1,498	0.3
Total		**900,050**	**100.0**

Table 3.13. National Vegetation Classifications Within the Subbasin

National Vegetation Classification	Area (acres)	Percent of Subbasin
Northwestern Great Plains Mixedgrass Prairie	329,964	36.7
Northwestern Great Plains - Black Hills Ponderosa Pine Woodland and Savanna	214,641	23.8
Inter-Mountain Basins Big Sagebrush Steppe	169,919	18.9
Western Great Plains Dry Bur Oak Forest and Woodland	67,487	7.5
Pasture/Hay	26,167	2.9
Northwestern Great Plains Riparian	21,026	2.3
Introduced Upland Vegetation - Annual Grassland	15,297	1.7
Rocky Mountain Aspen Forest and Woodland	10,771	1.2
All other classes, less than 0.1 percent each	44,778	5.0
Total	**900,050**	**100.0**

3.1.4 Geology

Geologic mapping information and data for the subbasin 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 subbasin. The subbasin includes parts of both the Black Hills uplift and the Powder River structural basin. The surficial geologic units within the subbasin consist of residuum mixed, slopewash and colluvium, alluvium, and landslide mixed covering approximately 89 percent of the subbasin as shown in Figure 3.17. The remaining prominent units include mined areas mixed, mesa, alluvial fan, terrace deposits mixed, and dissected terrace deposits. These geologic units influence the subbasin by providing the parent material and morphology for the soil formations and plant communities within the subbasin.

The bedrock geologic units that underlie the subbasin predominantly consist of the Cloverly and Morrison Formations, Sundance and Gypsum Spring Formation, Greenhorn Formation and Belle Fourche and Mowry Shale, and the Newcastle Sandstone and Skull Creek Shale covering approximately 77 percent of the subbasin as shown in Figure 3.18 and listed in Table 3.16. The remaining prominent bedrock features include alluvium and colluvium, Spearfish Formation, Minnekahta Limestone and Opeche Shale, and Niobrara Formation and Carlile Shale. Figure 3.19 displays the known faults and landslides in the subbasin. Landslide deposits were present on the surficial geology and indicate that landslide activity has occurred predominantly in the Bear Lodge Mountains and surrounding foothills.

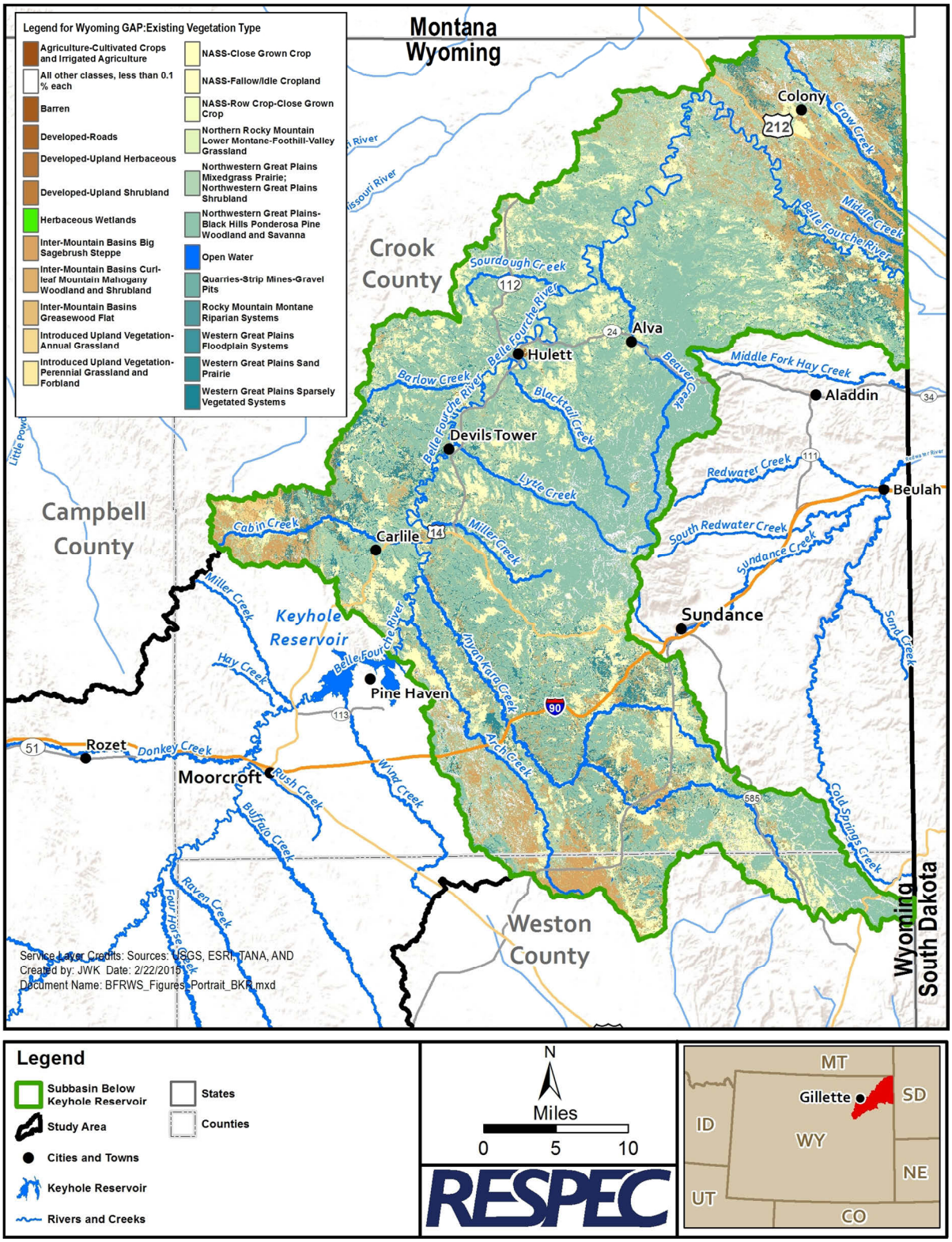

Figure 3.15. Wyoming Gap Analysis Program: Existing Vegetation Type Within the Subbasin.

Table 3.14. Wyoming Natural Diversity Database: Plants Within the Subbasin

Scientific Name	Common Name	Tracking Status
Calochortus apiculatus	Pointedtip mariposa-lily	Tracked
Campanula aparinoides	Marsh bellflower	Tracked
Carex alopecoidea	Foxtail sedge	Tracked
Carex emoryi	Emory's sedge	Tracked
Carex granularis var. haleana	Meadow sedge	Tracked
Carex richardsonii	Richardson's sedge	Tracked
Carex rosea	Rosy sedge	Tracked
Ceanothus herbaceus	Prairie redroot	Tracked
Centunculus minimus	Chaffweed	Tracked
Cyperus erythrorhizos	Red-root flatsedge	Tracked
Eleocharis ovata	Ovate spikerush	Tracked
Eleocharis tenuis var. borealis	Boreal spikerush	Tracked
Elymus villosus	Hairy wildrye	Tracked
Filago prolifera	Rabbit tobacco	Tracked
Glandularia bipinnatifida	Dakota vervain	Tracked
Helianthemum bicknellii	Plains frostweed	Tracked
Hymenopappus tenuifolius	Chalk-hill woollywhite	Tracked
Lechea intermedia	Narrowleaf pinweed	Tracked
Loeflingia squarrosa	Spreading loeflingia	Tracked
Lycopus uniflorus	Northern bugleweed	Tracked
Lythrum alatum var. alatum	Winged loosestrife	Tracked
Muhlenbergia glomerata	Marsh muhly	Tracked
Myosotis verna	*Spring forget-me-not*	*Tracked*
Oenothera laciniata	Cut-leaved Evening-primrose	Tracked
Platanthera orbiculata	Large roundleaf orchid	Tracked
Polygala verticillata	Whorled milkwort	Tracked
Potamogeton diversifolius	Water-thread pondweed	Tracked
Prosartes hookeri	Hooker's Fairy Bell	Tracked
Schoenoplectus heterochaetus	Slender bulrush	Tracked
Sparganium eurycarpum	Large bur-reed	Tracked
Sporobolus heterolepis	Northern dropseed	Tracked
Tradescantia bracteata	Long-bract spiderwort	Tracked
Triodanis leptocarpa	Slim-pod Venus' looking-glass	Tracked
Viola pedatifida	Prairie violet	Tracked

Table 3.15. Summary of Wetland Types Within the Subbasin

Wetland Type	Area (Acres)	Percent of Subbasin
Freshwater Pond	2,146	0.24
Freshwater Emergent Wetland	1,633	0.18
Lake	490	0.05
Riverine	480	0.05
Other	193	0.02
Total	**4,942**	**0.54**

3.1.5 Soils

Soils in the subbasin vary considerably but usually are loams, with over 54 percent of the subbasin categorized as loam soils with channery, cobbly, gravelly, sandy, and stony loam surface textures. Soils information and data were obtained from the NRCS and compiled for the portions of the subbasin within Crook and Weston counties. Two digitized soil surveys cover approximately 95 percent of the subbasin. NRCS published the soil surveys in Crook County and Weston County in 1983 and 1990, respectively. Detailed soils information, ratings, data, and maps can be accessed at the NRCS Web Soil Survey website (*http://websoilsurvey.sc.egov.usda.gov/App/HomePage.htm*).

Over 290 soil map units are within the subbasin. The Lakoa-Butche complex, 10 to 60 percent slopes is the largest single map unit and covers 84,232 acres (9.4 percent) of the subbasin. Other major soil units include the Larkson-Lakoa loams, Samsil-Gaynor complex, and Louviers clay. Figure 3.20 displays a general soils map of the subbasin. Thirteen hydric soil map units covering approximately 4,928 acres within the subbasin were mapped as “partially hydric” to identify areas where soils were formed under saturated, flooded, or ponded conditions during the growing season creating anaerobic conditions in the soil. Table 3.17 lists the three soil map units rated as hydric by NRCS that cover more 0.1 percent of the area within the subbasin. A detailed description of hydric soils is included in the basin wide summary report.

3.2 HYDROLOGY

3.2.1 Groundwater

Groundwater availability within the subbasin is variable because of the diverse aquifer characteristics and hydrogeological properties. Depending on the specific area, groundwater can occurs at various depths; areas near streams and along alluvial valleys have shallower groundwater with depths of 25 feet or less. Other locations in the subbasin have deep groundwater aquifers with depths of more than 1,000 feet below the ground surface. Groundwater and water well databases were obtained from the SEO.

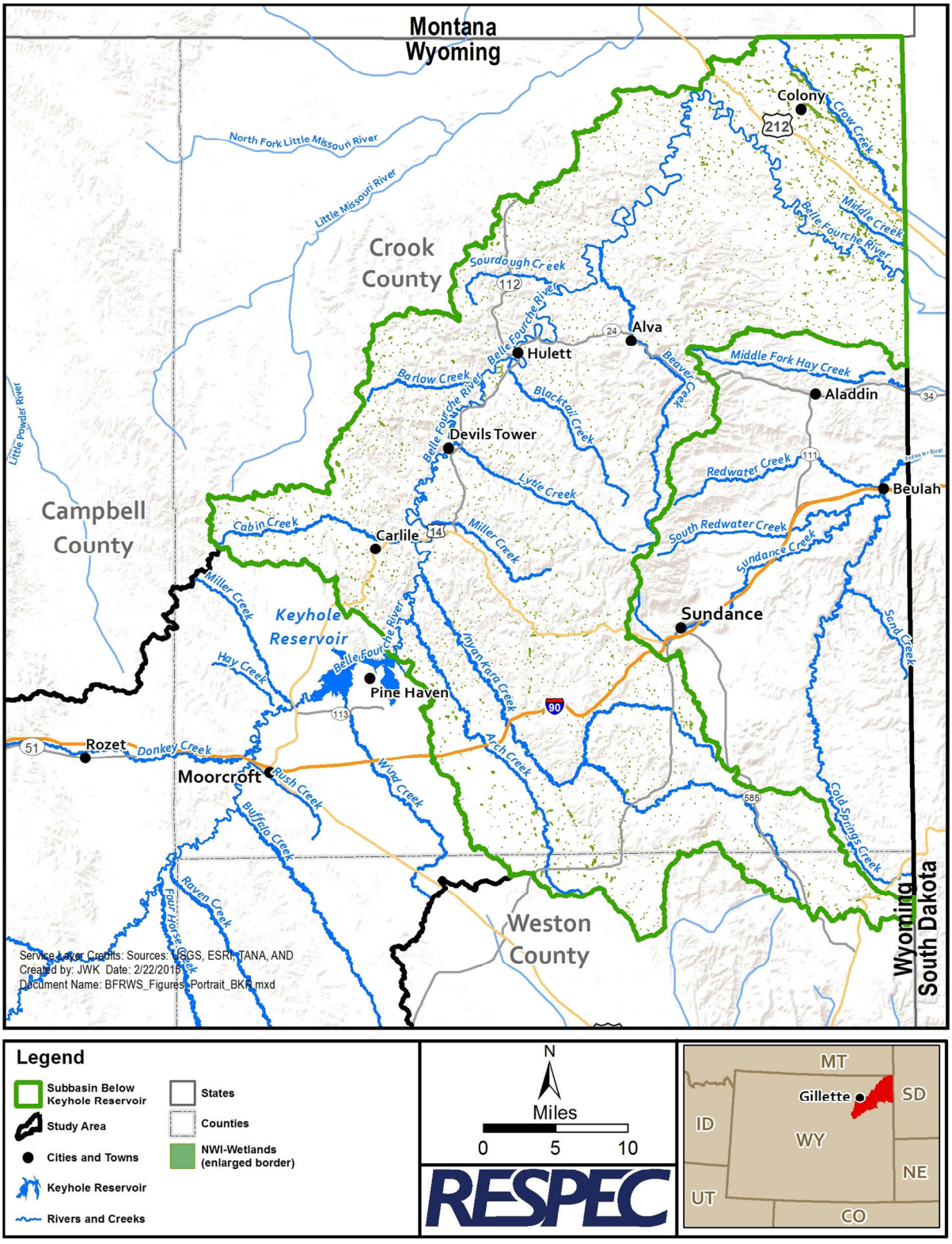

Figure 3.16. National Wetlands Inventory Wetlands Located Within the Subbasin.

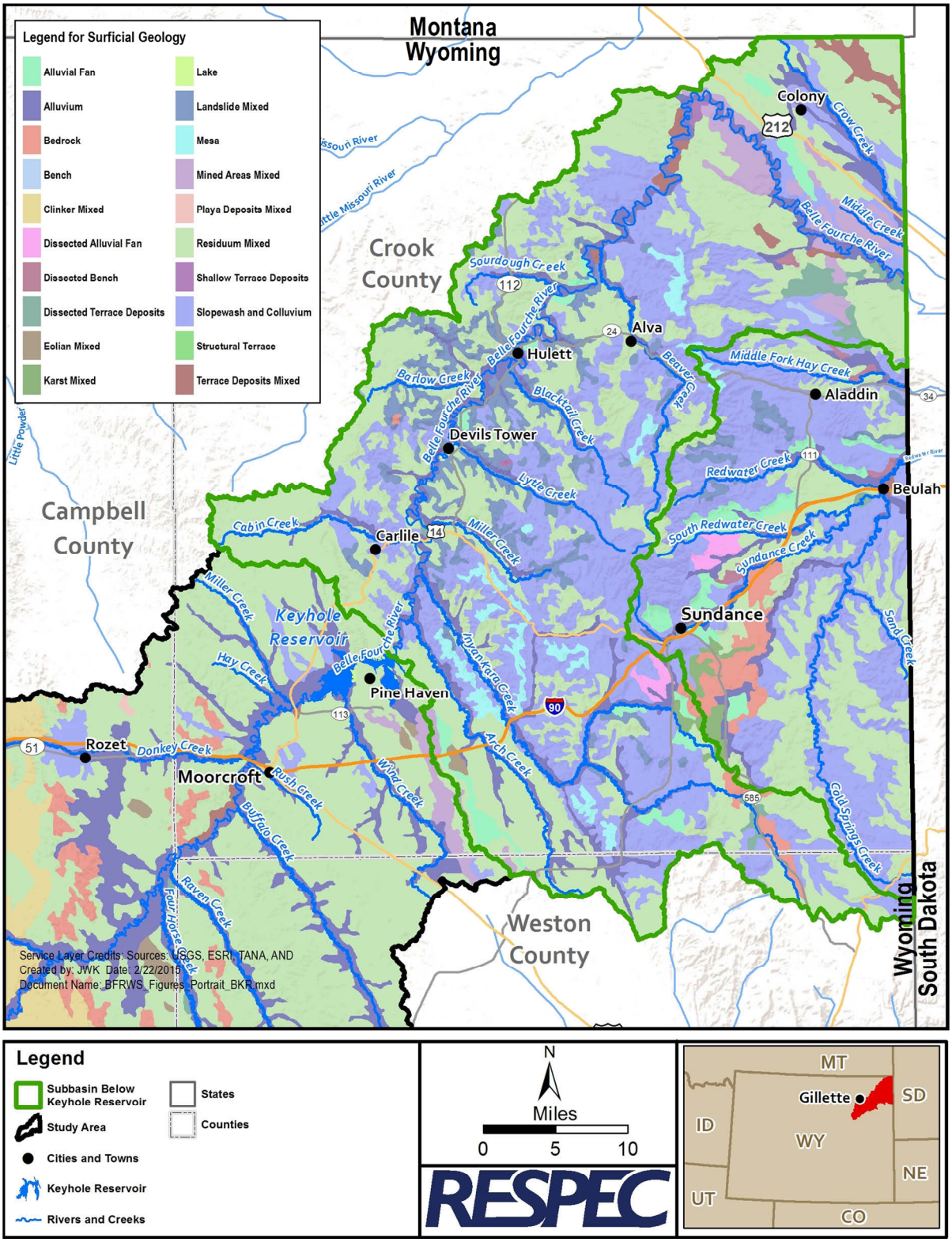

Figure 3.17. Surficial Geology of the Subbasin and the Study Area.

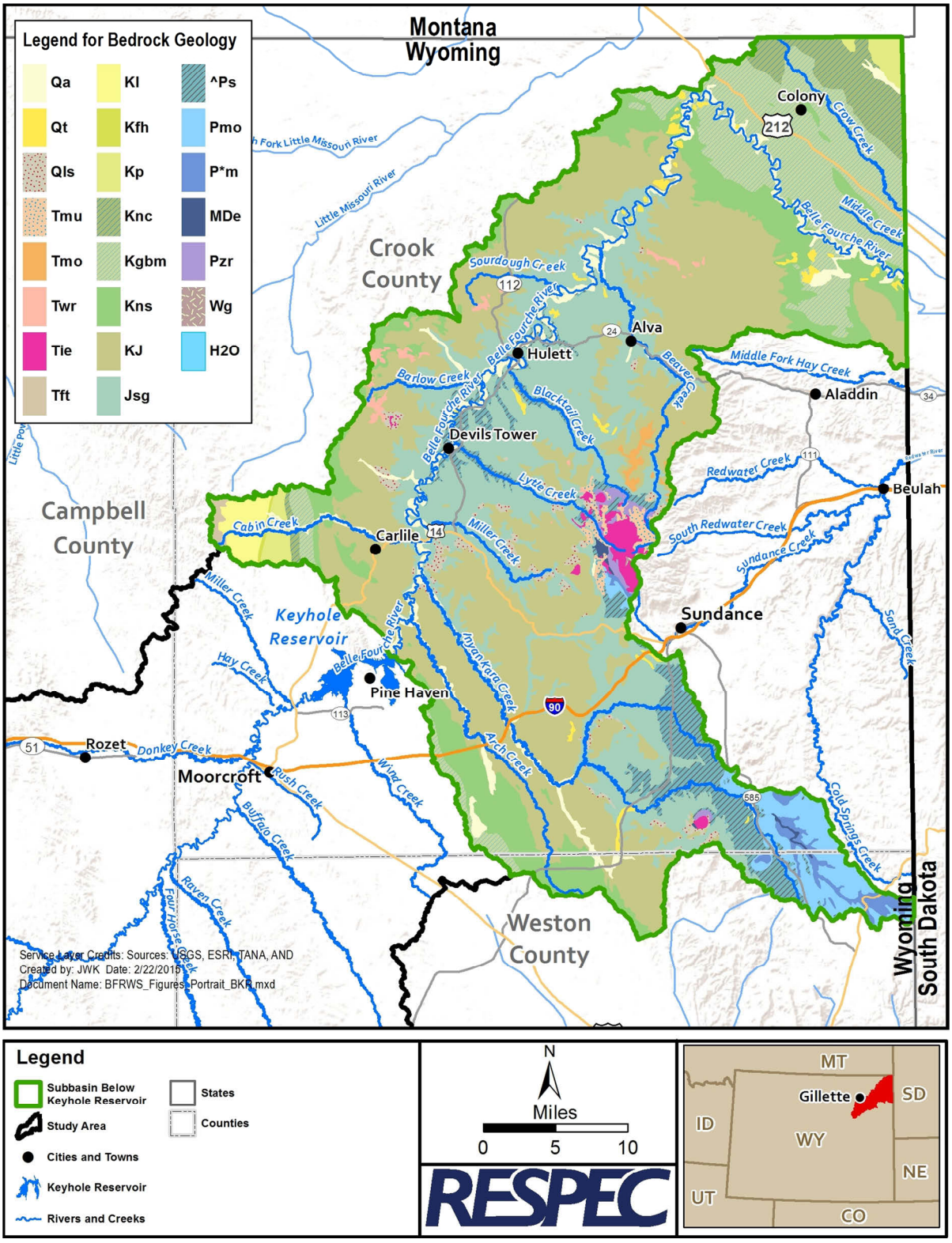

Figure 3.18. Bedrock Geology of the Subbasin.

Table 3.16. Bedrock Geologic Units Within the Subbasin

Unit Symbol	Geologic Unit Name	Area (acres)	Percent of Study Area
KJ	Cloverly and Morrison Formations	322,320	35.8
Jsg	Sundance and Gypsum Spring Formations	191,720	21.3
Kgbm	Greenhorn Formation, Belle Fourche and Mowry Shales	94,550	10.5
Kns	Newcastle Sandstone and Skull Creek Shale	83,380	9.3
Qa	Alluvium and colluvium	46,480	5.2
@Ps	Spearfish Formation	45,380	5.0
Pmo	Minnekahta Limestone and Opeche Shale	24,530	2.7
Knc	Niobrara Formation and Carlile Shale	23,510	2.6
Qls	Landslide deposits	10,850	1.2
Kp	Pierre Shale	8,850	1.0
P&m	Minnelusa Formation	8,210	0.9
Kl	Lance Formation	7,740	0.9
Tie	Intrusive and extrusive igneous rocks	7,090	0.8
Qt	Gravel, pediment, and fan deposits	6,060	0.7
Tmu	Upper Miocene rocks	5,300	0.6
Twr	White River Formation	4,040	0.4
Pzr	Madison Limestone, Darby Formation, Bighorn Dolomite, Gallatin Limestone, Gros Ventre Formation, Flathead Sandstone	3,200	0.4
Tmo	Lower Miocene and Upper Oligocene rocks, or rocks equivalent to Upper and Lower Miocene rocks and White River Formation	2,790	0.3
Tft	Tullock Member of Fort Union Formation	1,980	0.2
MDe	Pahasapa and Englewood Limestones	1,200	0.1
Other	Geologic units that comprise less than 0.1 percent of the study area	870	0.1
Total		**900,050**	**100.0**

Groundwater is locally important for livestock/wildlife water, private domestic wells, and municipal water. Approximately 1,403 wells are on file with the SEO within the subbasin. Well depths average 300 feet though vary from being completed in shallow alluvial aquifers with low water yield to wells over 800 feet deep penetrating deeper aquifers. Deeper bedrock aquifers that serve as a groundwater supply include the Inyan Kara, Minnelusa, and Madison Limestone. The permitted water wells also include 560 stock wells, 687 domestic wells, 18 industrial wells, 27 irrigation wells, and 7 municipal wells. Figure 3.21 shows the SEO water wells within the subbasin.

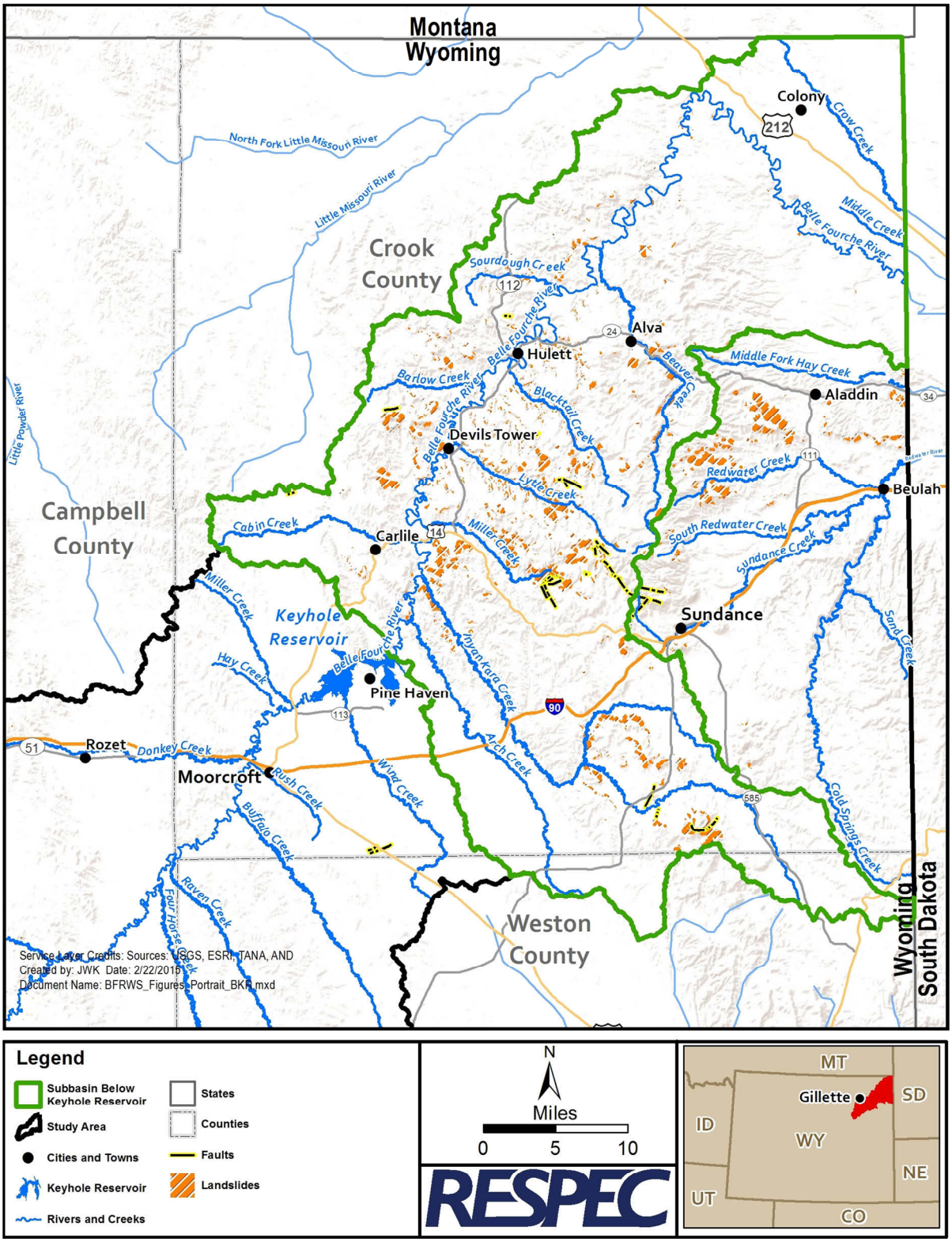

Figure 3.19. Hazardous Geologic Features Within the Subbasin.

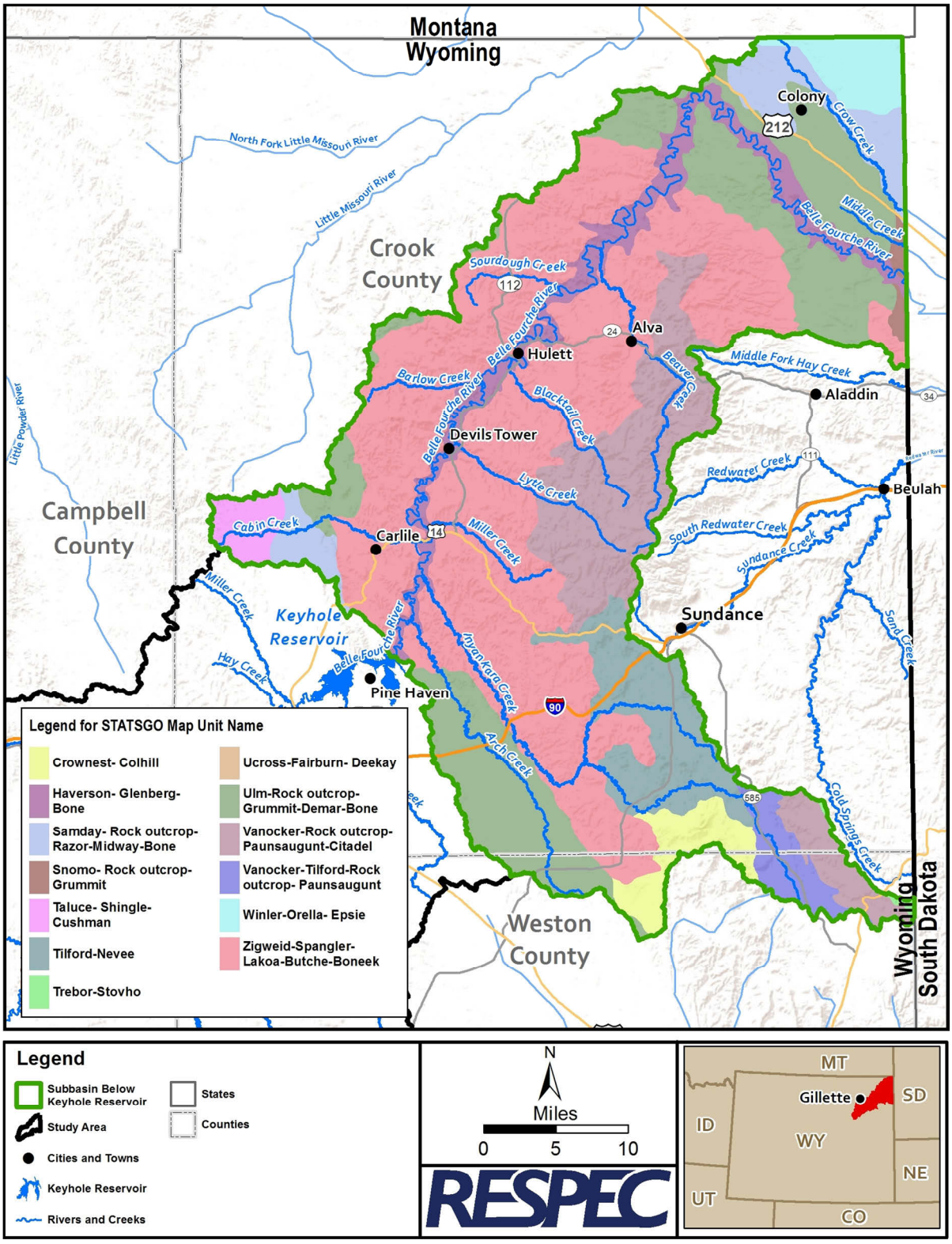

Figure 3.20. 1:250,000 Scale Soils Map of the Subbasin.

Table 3.17. Summary of Hydric Soil Map Units Within the Subbasin

Map Unit Name	Area (acres)	Percent of Subbasin
Lohmiller silty clay loam, occasionally flooded, 0 to 3 percent slopes	2,021.0	0.22
Colombo loam, occasionally flooded, 0 to 3 percent slopes	1,919.2	0.21
Higgins silt loam, 0 to 3 percent slopes	979.4	0.11
Total	**4,919.6**	**0.55**

Many springs and seeps exist in the subbasin, Many small springs and seeps exist within the subbasin and are shown in Figure 3.22. Downstream of Keyhole Reservoir, the number and density of springs dramatically increases to around 240 named and unnamed springs. Several of these springs support recharge to alluvium and perennial flows in some sections of the Belle Fourche River and its tributaries, though discharge is subject to pumping impacts and seasonal fluctuations of the water table [Whitcomb and Morris, 1964].

3.2.2 Surface Water

The subbasin begins at the outlet of Keyhole Reservoir where it flows generally northeast to the Wyoming-South Dakota state line approximately 10 miles northeast of Aladdin, Wyoming as shown in Figure 3.22. The subbasin includes all of the land draining to the Belle Fourche River below Keyhole Reservoir, which covers approximately 1,406 square miles or 900,050 acres in northeast Wyoming. The Belle Fourche River and its tributaries, Arch Creek, Barlow Creek, Beaver Creek, Cabin Creek, Crow Creek, Deep Creek, Inyan Kara Creek, Lytle Creek, Mason Creek, Oak Creek, and Owl Creek occur in the subbasin.

This subbasin includes the Wyoming portion of the eighth order HUC 10120201 that drains the area below Keyhole Reservoir. Table 3.18 lists the 6 watersheds (HUC-10) and the 34 subwatersheds (HUC-12) within the subbasin. Four USGS gaging stations are located within the subbasin and are listed in Table 3.19 and shown in Figure 3.23. Four active USGS gages are currently within the subbasin, and their discharge data along with historical discharge data for the inactive USGS gages are listed in Table 3.20.

In addition to the USGS gages, two temporary gages were installed to obtain streamflow on Inyan Kara Creek and Lytle Creek and are listed in Table 3.21 and also shown in Figure 3.23. A discussion of the temporary gages can be found in the basin wide summary report. Table 3.22 lists the discharge statistics and yield estimates for the temporary gages on Inyan Kara Creek and Lytle Creek.

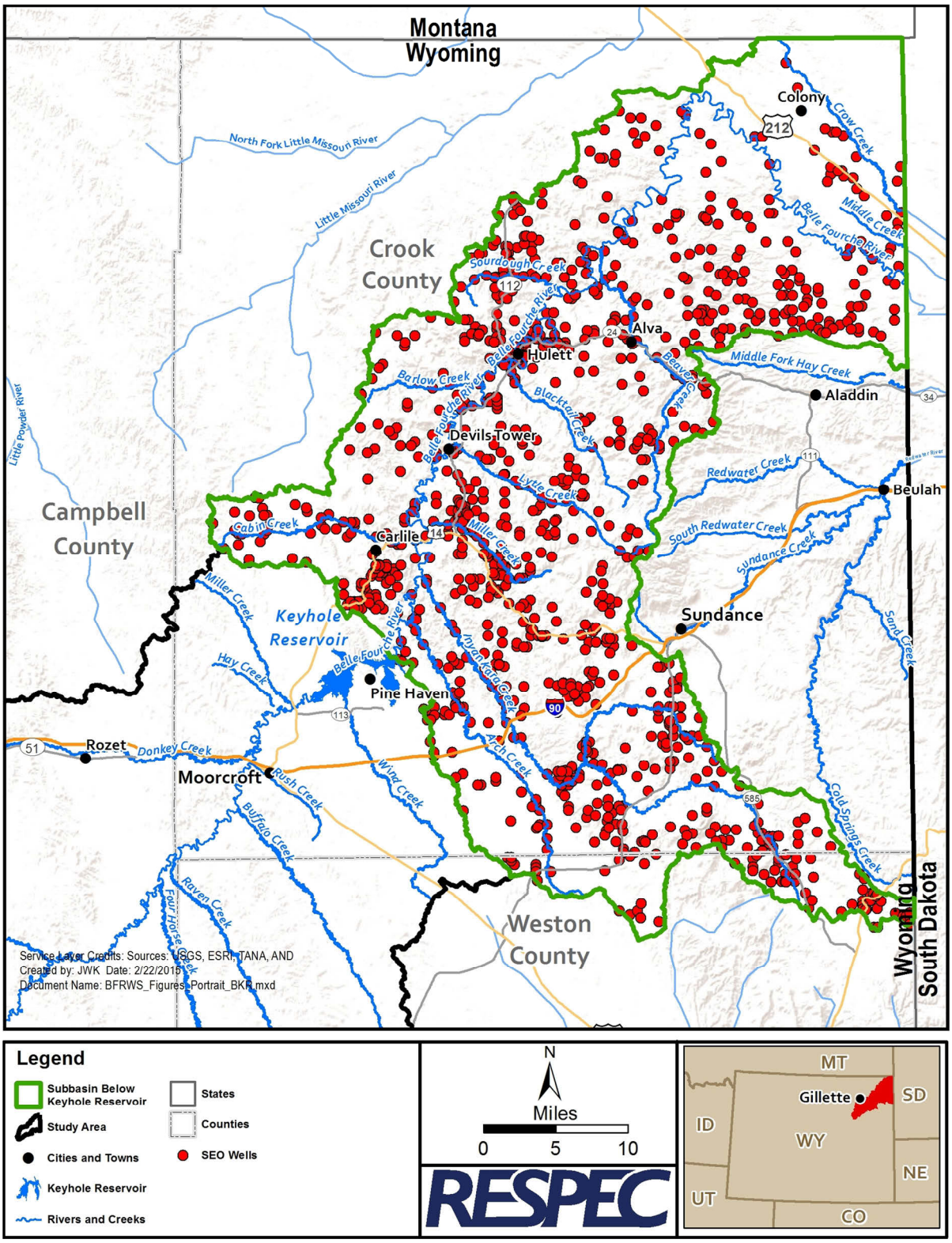

Figure 3.21. Permitted Water Wells Located Within the Subbasin.

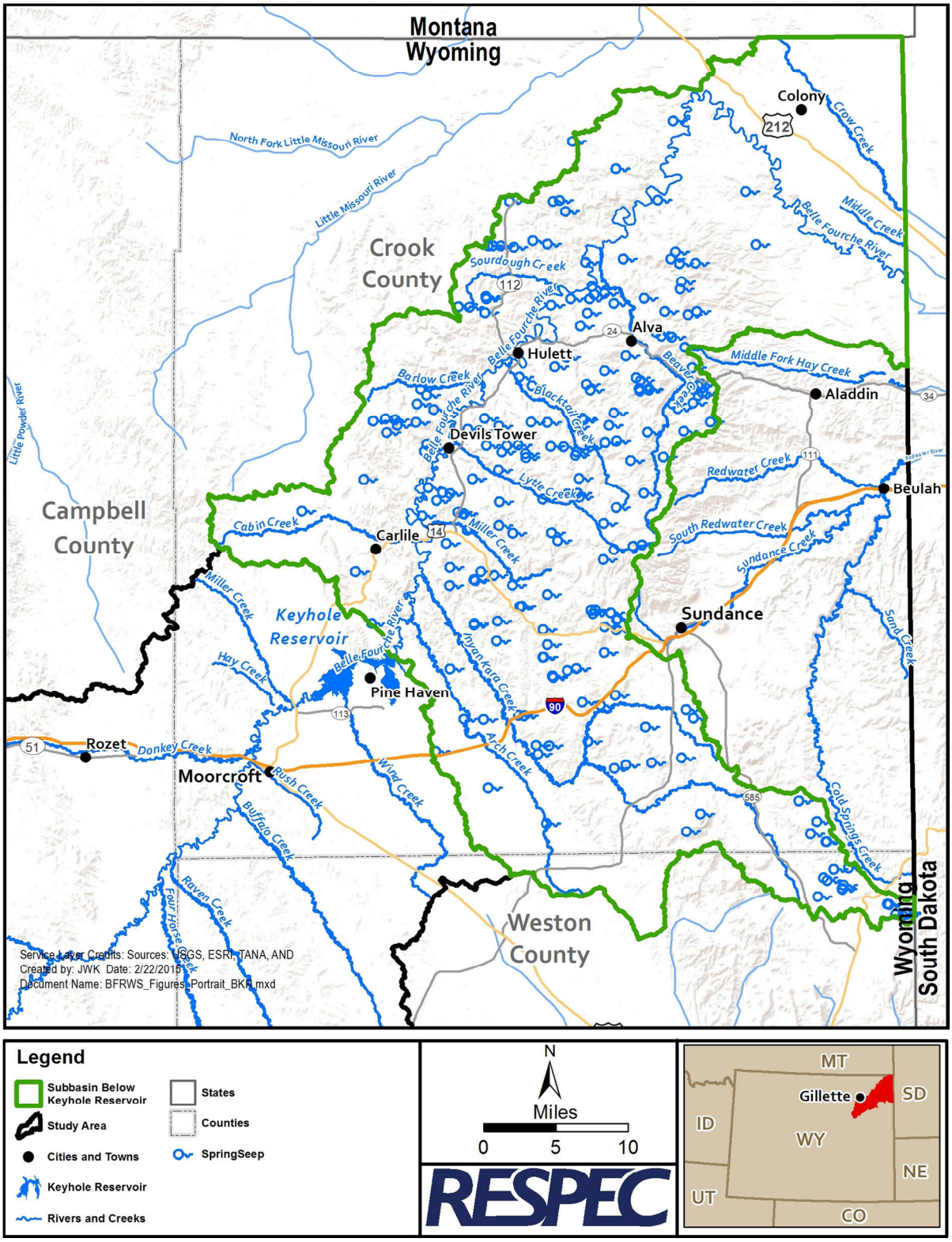

Figure 3.22. Springs Located Within the Subbasin.

Table 3.18. Hydrologic Unit Codes Within the Subbasin Below Keyhole Reservoir (Page 1 of 2)

HUC 2	HUC 4	HUC 6	HUC 8	HUC 10		HUC 12		Area (sq. mi.)
				Number	Name	Number	Name	
Region 10: Missouri	Subregion 1012: Cheyenne	Accounting Unit 101202: Belle Fourche	Cataloging Unit 10120201: Upper Belle Fourche	1012020107	Arch Creek-Belle Fourche River	101202010701	Spring Creek-Belle Fourche River	38.6
						101202010702	Upper Arch Creek	41.9
						101202010703	Lower Arch Creek	48.8
						101202010704	Cabin Creek	66.4
						101202010705	Miller Creek	55.1
						101202010706	Lake Creek-Belle Fourche River	49.5
						101202010707	Lytle Creek	38.0
				1012020108	Inyan Kara Creek	101202010801	Upper Inyan Kara Creek	62.4
						101202010802	Middle Inyan Kara Creek	53.6
						101202010803	Beaver Creek	57.7
						101202010804	Lower Inyan Kara Creek	62.0
						101202010805	Mason Creek	51.6
						101202010806	Houston Creek	50.5
				1012020109	Blacktail Creek-Belle Fourche River	101202010901	Whitetail Creek-Belle Fourche River	38.8
						101202010902	Barlow Creek	44.9
						101202010903	Blacktail Creek	42.7
						101202010904	Buck Creek-Belle Fourche River	69.3
						101202010905	Sourdough Creek	22.1
						101202010906	Upper Beaver Creek	50.5
						101202010907	Lower Beaver Creek	43.3

Table 3.18. Hydrologic Unit Codes Within the Subbasin Below Keyhole Reservoir (Page 2 of 2)

HUC 2	HUC 4	HUC 6	HUC 8	HUC 10		HUC 12		Area (sq. mi.)
				Number	Name	Number	Name	
Region 10: Missouri	Subregion 1012: Cheyenne	Accounting Unit 101202: Belle Fourche	Cataloging Unit 10120202: Lower Belle Fourche	1012020201	Upper Belle Fourche River	101202020101	Deer Creek	23.6
						101202020102	Arnold Creek-Belle Fourche River	42.2
						101202020103	Medicine Creek-Belle Fourche River	39.3
						101202020104	Spring Creek-Belle Fourche River	56.2
						101202020105	Horse Creek	15.4
						101202020106	Kilpatrick Creek-Belle Fourche River	38.1
						101202020107	Deep Creek	35.5
						101202020108	Oak Creek	43.8
						101202020109	Belle Fourche River-Grummit Canyon Creek	48.3
						101202020110	Middle Creek-Belle Fourche River	34.6
				1012020202	Middle Belle Fourche River	101202020202	Upper Crow Creek	65.2
						101202020203	Lower Crow Creek	46.7
				1012020203	Owl Creek	101202020301	Owl Creek-Shaue Gulch	54.9
						101202020302	Owl Creek-Ruben Creek	61.3

Table 3.19. Summary of U.S. Geological Survey Gaging Stations Within the Subbasin Below Keyhole Reservoir

USGS Station Number	Station Name	Period of Record	Drainage Area (sq. mi.)	Latitude	Longitude	Gage Elevation (ft, NGVD29)
06427500	Belle Fourche River Bel Keyhole Reservoir, WY	05/01/1951–09/30/1995	1,954	44°23'05"	104°46'50"	4,031
06428000	Belle Fourche River At Hulett, WY	05/01/1929–12/31/1951	2,800	44°40'54"	104°36'05"	3,742
06428200	Belle Fourche River Near Alva, WY	10/01/1988–12/07/2013	2,948	44°47'22"	104°28'51"	3,600
06428500	Belle Fourche R At WY-SD State Line	12/01/1946–Current	3,241	44°44'56"	104°03'04"	3,096

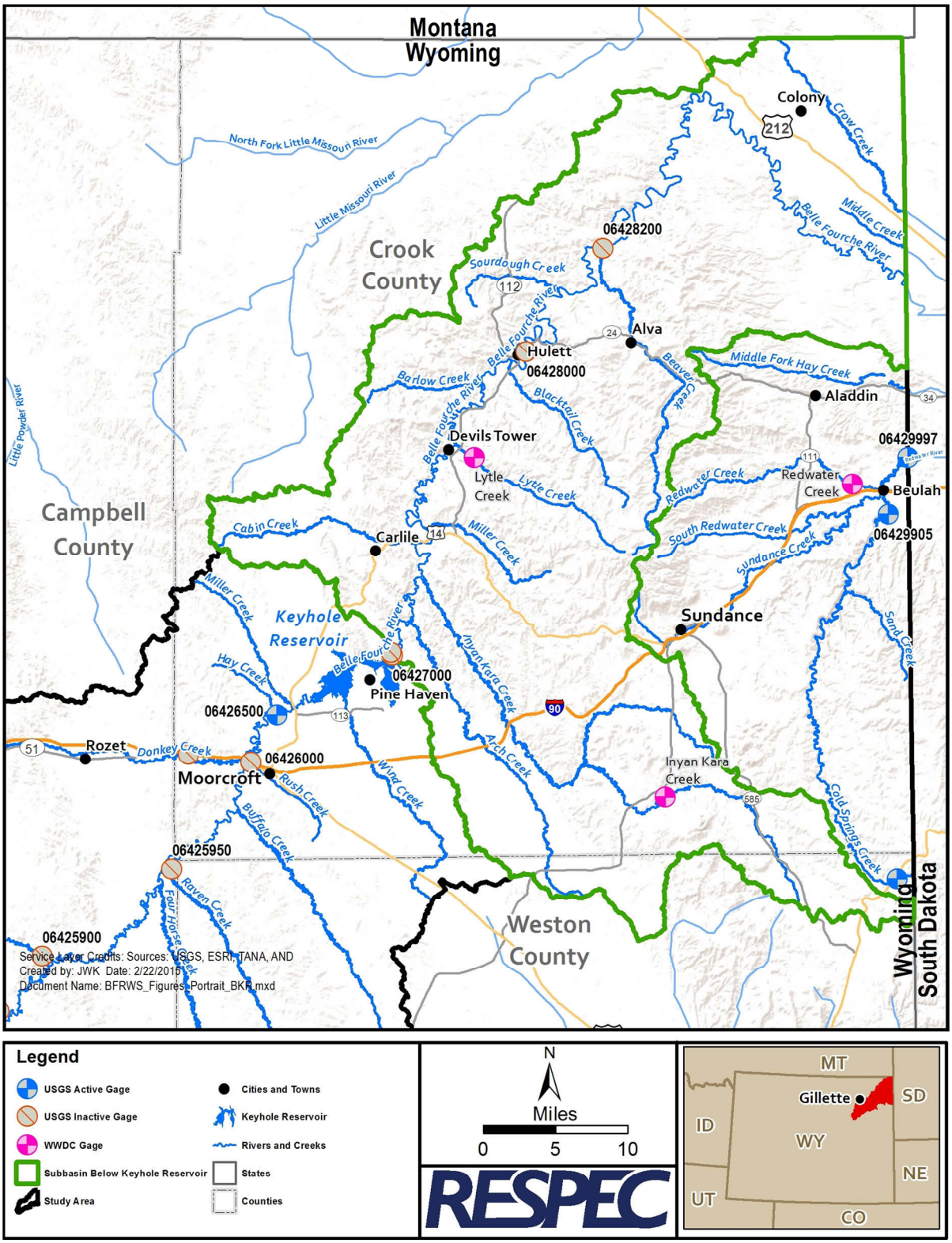

Figure 3.23. U.S. Geological Survey Gages and Wyoming Water Development Commission Temporary Gage Stations Within the Subbasin and Surrounding Area.

Table 3.20. Historical Monthly Mean Discharge Rates for U.S. Geological Survey Gaging Stations Within the Subbasin

USGS Station Number	Period of Record	Historical Monthly Mean Discharge (cfs)											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
06427500	Belle Fourche River Below Keyhole Reservoir, WY	1.5	4.2	17.3	14.0	33.0	35.2	65.7	66.3	17.3	2.3	1.6	1.5
06428000	Belle Fourche River At Hulett, WY	5.4	43.7	211.3	166.1	124.7	184.3	54.0	19.3	39.6	15.9	7.4	6.2
06428200	Belle Fourche River Near Alva, WY	NDA	NDA	96.0	106.1	175.3	140.6	84.5	67.1	32.2	12.4	NDA	NDA
06428500	Belle Fourche River at WY-SD State Line	20.1	43.0	169.5	181.1	225.9	194.4	93.0	71.7	34.5	29.2	26.9	17.6

Table 3.21. Wyoming Water Development Commission Temporary Stream Gage Within the Subbasin

Gage Name and Identifier	General Location	Drainage Area (acres)	Latitude/ Longitude	Elevation (ft)
Inyan Kara Creek (IKC)	Located approximately 0.7 mile south off of Highway 116, roughly 1.5 stream miles downstream (west) of the Inyan Kara Bridge on Crook County Road 62.	55,080	44.238418 104.399562	4,762
Lytle Creek (LC)	Located approximately 250 yards to the north off of Crook County Road 196, roughly 1.5 miles southeast from the intersection of Highway 24 and County Road 196 near Devils Tower National Monument.	20,760	44.579980 104.663618	3,940

The Inyan Kara Creek gaging site was installed on April 19, 2013. Flows in Inyan Kara Creek at this site were generally low during the 2013 gaging period with the exception of a large event peak June 1. The average flow was 3.8 cfs with the June 1 peak reaching 125 cfs. The transducer was removed in October. The gaging site was able to record a large snowmelt event in April and a high peak of 44.4 cfs in June. The average flow during the 2014 gaging period was 10.4 cfs. Hydrographs from the 2013 and 2014 gaging periods are displayed in Figure 3.24. The Inyan Kara Creek gaging station has the largest drainage area at 86 square miles. Throughout the gaging periods, the IKC drainage produced a mean yield of 14.5 acre-feet per square mile in 2013 and 57.3 acre-feet per square mile (ac-ft/mi^2) in 2014.

The Lytle Creek gaging site was installed on April 19, 2013. Lytle Creek had low base flows after an early spring melt. The average flow during the 2013 gaging period was 6.2 cfs with a peak flow of 263.8 cfs occurring on June 1. For the 2014 monitoring period, the pressure transducer was placed on March 13 and high flow events from spring snowmelt and precipitation occurred in April and May with a peak flow of 34.2 cfs occurring on May 7. This gage on Lytle Creek found the average 2014 flow to be 6.9 cfs. Hydrographs from the 2013 and 2014 monitoring periods are displayed in Figure 3.25. The drainage area for the Lytle Creek gaging station is 32 square miles. Yields at the gaging station for the monitoring periods were 2,544 ac-ft in 2013 and 3,111 ac-ft in 2014. The resulting mean yields are 78.7 ac-ft/mi^2 and 95.9 ac-ft/mi^2, respectively.

Table 3.22. Summary of Temporary Stream Gage Hydrology

Stream Gage	IKC	LC
Drainage Area (mi^2)	86	32
2013		
Start Date	04/19/13	04/19/13
End Date	10/04/13	11/14/13
Average Flow (cfs)	3.8	6.2
Median Flow (cfs)	2.1	3.2
Total Yield (ac-ft)	1,249	2,554
Mean Yield (ac-ft/ mi^2)	14.5	78.7
Peak Flow (cfs)	124.7	263.8
Date of Peak	06/01/13	06/01/13
Minimum Flow (cfs)	1.5	0.5
2014		
Start Date	03/13/14	03/13/14
End Date	11/7/14	10/25/14
Average Flow (cfs)	10.4	6.9
Median Flow (cfs)	9.1	3.9
Total Yield (ac-ft)	4,931	3,111
Mean Yield (ac-ft/ mi^2)	57.3	95.9
Peak Flow (cfs)	44.4	34.2
Date of Peak	06/22/14	05/07/14
Min. Flow (cfs)	4.9	0.7

3.3 STREAM GEOMORPHOLOGY

3.3.1 Rosgen Level I Classification

In the basin wide summary report, an extensive discussion regarding the stream geomorphology within the subbasin is included to explain the Level I geomorphic classification methods, applicable classification systems, and Level II field stream assessments performed for this study. Within the subbasin, a Level I evaluation of the reaches of the Belle Fourche River below Keyhole Reservoir and its major tributaries was conducted. Results of the Level I classification effort are presented in Table 3.23. Figure 3.26 displays the subbasin's stream types resulting from the classification effort.

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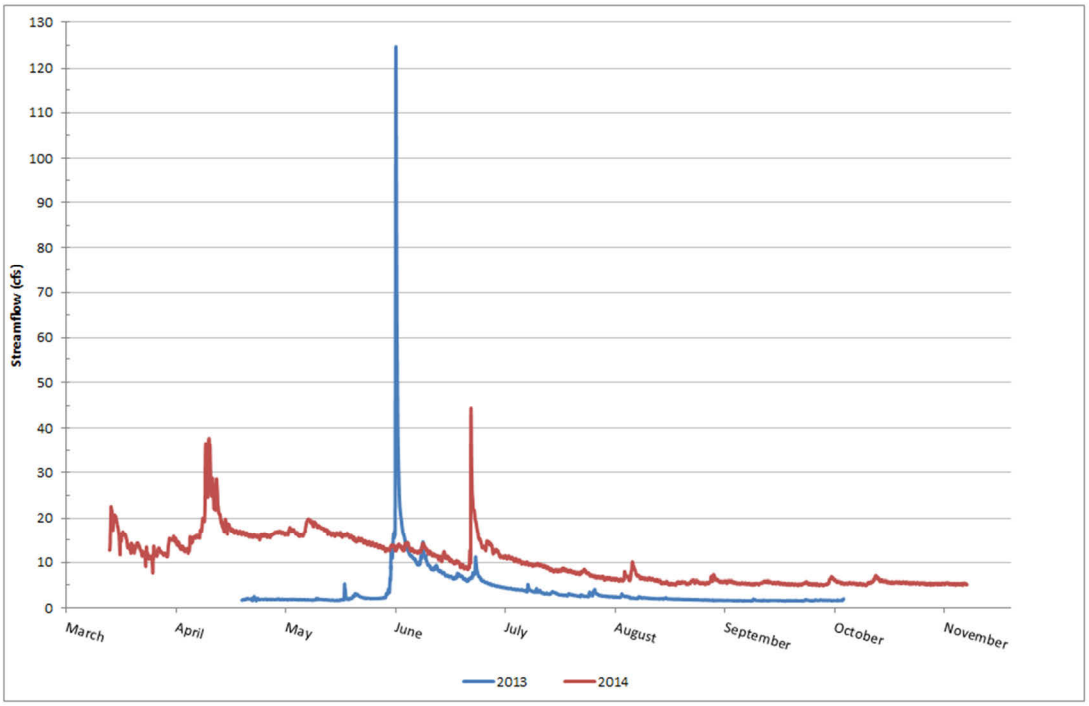

Figure 3.24. Hydrographs at Inyan Kara Creek for the 2013 and 2014 Gaging Periods.

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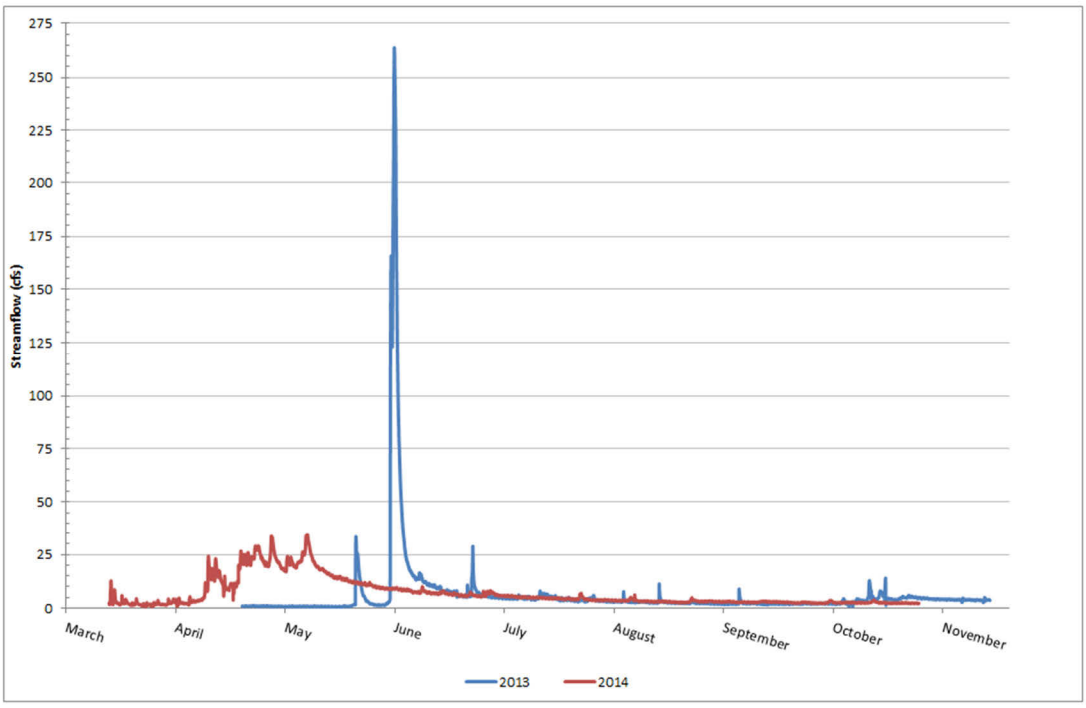


Figure 3.25. Hydrographs at Lytle Creek for 2013 and 2014 Gaging Periods.

Table 3.23. Summary of Rosgen Level I Classification Results in the Subbasin

Name	Reach Number	Station (Distance From Mouth)		Reach Length (ft)	Sinuosity	Slope	Rosgen Type
		Station Start (ft)	Station End (ft)				
Arch Creek	1	0	117,648	117,648	2.02	0.002	F
	2	117,648	236,287	118,639	1.62	0.004	B
Belle Fourche River	1	0	514,078	514,078	2.27	0.001	C
	2	514,078	814,261	300,183	2.09	0.001	C
	3	814,261	1,149,811	335,550	2.13	0.001	C
Inyan Kara Creek	1	0	152,434	152,434	2.42	0.002	C/F
	2	152,434	315,719	163,285	2.42	0.003	C/F
	3	315,719	457,662	141,943	2.13	0.004	C/F
	4	457,662	493,304	35,642	1.19	0.015	B
Lytle Creek	1	0	74,124	74,124	1.79	0.009	C/F
	2	74,124	118,298	44,174	1.23	0.041	B

3.3.2 Field Stream Assessment

A field stream channel assessment was conducted at sites selected on reaches of Inyan Kara Creek and Whitelaw Creek within the subbasin. The purpose of the field assessment was to obtain more detailed morphological description of the system by obtaining field data pertaining to channel entrenchment, dimensions, patterns, profile, and boundary materials. A detailed explanation about the Level II field stream assessments are included in the basin wide summary report. Field assessment data, Rosgen Level II parameters and stream types, and Channel Evolution Model (CEM) channel types are summarized in Table 3.24 for cross sections located along the reaches at the selected sites on Inyan Kara Creek and Whitelaw Creek.

Inyan Kara Creek (IKC)

Within the study reach of Inyan Kara Creek, the channel bed and banks appear to currently be generally stable and are well vegetated. Localized bank erosion was noted but appears to be the result of localized processes in lieu of systemic destabilization. Small headcuts or knick zones were noted but again, these appear to be limited and of relative minor magnitude.

Based strictly upon the values in Table 3.24, Inyan Kara Creek would likely be classified as a E5b-type channel. As previously discussed, E-type channels possess low width/depth ratios, are highly sinuous and are only slightly entrenched. Based upon field observations, Inyan Kara Creek is clearly entrenched and isolated from its floodplain. The low entrenchment ratios measured at the surveyed cross sections are artifacts of the presence of an entrenched floodplain forming as the channel stabilizes following historic incision.

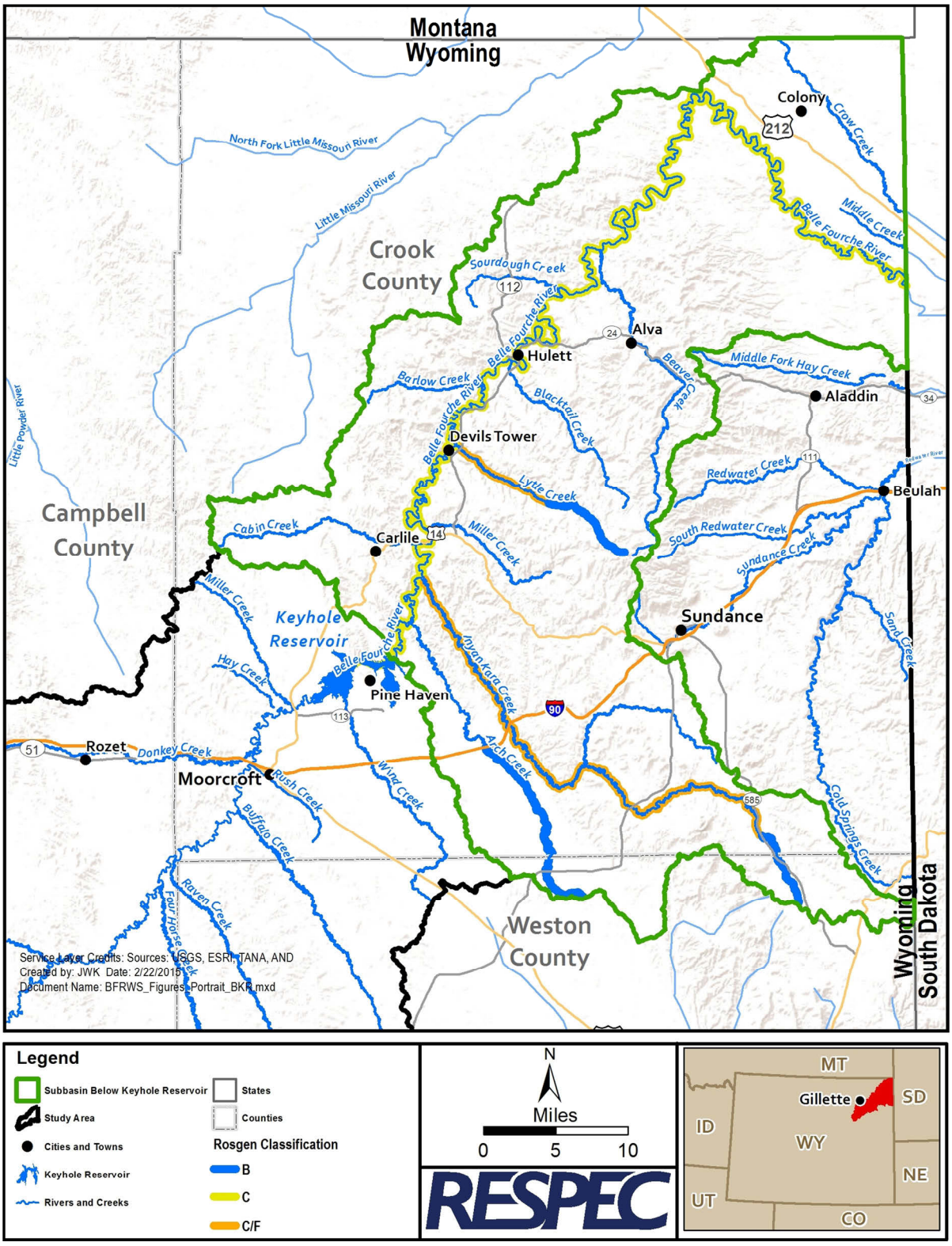


Figure 3.26. Rosgen Classification Stream Types Within the Subbasin.

Table 3.24. Geomorphic Parameters at Selected Sites on Inyan Kara Creek and Whitelaw Creek Within the Subbasin

Parameter	Inyan Kara Creek			Whitelaw Creek	
Cross Section	1	2	3	1	2
Bankfull Depth (ft)	1.71	4.88	3.24	1.17	1.39
Bankfull Width (ft)	6.6	14.2	12.0	10.0	5.5
Width/Depth Ratio	3.88	2.91	3.70	8.50	3.96
Floodprone Depth (ft)	3.42	9.76	6.49	2.30	2.78
Floodprone Width (ft)	91.3	50.0	119.0	33.0	63.0
Entrenchment Ratio	13.0	3.5	9.9	3.3	11.4
Slope	0.0008	0.0010	0.0090	0.0180	0.0240
Sinuosity	1.52	2.80	2.75	1.34	1.28
Rosgen Stream Type	E5b/F	E5b/F	E5b/F	C4b	C4b
Schumm CEM Type	IV to V	IV to V	IV to V	I	I

Based on observations of geomorphic processes occurring within the study reach; the classification has been amended with an F-type. Figure 3.27 displays a photo of the channel at Cross Section 2 and shows that the channel is considerably entrenched within its historic floodplain. Comparison of Inyan Kara Creek and the ambient and the geomorphic processes observed for the CEM types; it appears that the channel is likely in the Type IV to V stages where active incision and degradation have subsided and channel widening has been initiated. Formation of local berms and benches within the entrenched channel indicates stability while the limited bank erosion indicates channel widening may be occurring.

Whitelaw Creek (WC)

Historic season-long livestock grazing practices in the mid- to late twentieth century resulted in damaged upland and riparian areas and degraded streambanks on Whitelaw Creek. Following establishment of a Coordinated Resource Management (CRM) and partnering of WDEQ, landowners, and several local agencies initiated the Whitelaw Riparian Improvement Project in 1992. Best management practices (BMPs) focusing on improving riparian conditions, stabilizing stream banks, and enhancing water quality through improved grazing management were implemented.

RSI-2264-15-258

Figure 3.27. Inyan Kara Creek: Typical Channel Reach. The bench with snow within the entrenched channel is considerably entrenched within its historic floodplain.

Monitoring conducted by WDEQ and observations made during this Level I study indicate that the strategies have been successful and generally stable geomorphic conditions exist. The study reach was assessed by the consultant staff in the company of the landowner. Little evidence of channel instability was noted. Streambanks were generally low and stable. The channel bed is well armored with gravels, cobbles, and boulders which provide a condition resilient to disturbance. Stream banks were well vegetated. Based upon the values in Table 3.24, the reach on Whitelaw Creek as shown in Figure 3.28 is classified as a C5b-type.

RSI-2264-15-259

Figure 3.28. Typical Conditions of Whitelaw Creek.

Comparison of Whitelaw Creek and the ambient and the geomorphic processes observed for the CEM types, indicates the channel is likely in the Type I stage. Type I reaches are located upstream of the actively degrading reach and have not yet experienced significant bed or bank instabilities. These reaches are generally characterized by U-shaped cross sections with little or no recently deposited sediment stored in the channel bed. In the case of Whitelaw Creek, the Type I designation is not based upon observation of a degraded reach downstream, but of generally stable conditions at the actual site. Existence of coarse bed materials (gravels, cobbles and boulders) would likely prevent significant channel incision from occurring.

3.4 WATER QUALITY

3.4.1 Wyoming Pollutant Discharge Elimination System Permitted Discharges

The subbasin contains four Wyoming Pollution Discharge Elimination System (WYPDES) point source discharge permits with a total of four outfalls. A list of all WYPDES permits within the study area is included in the basin wide summary report. No permitted Municipal Separate Storm Sewer Systems (MS4s) are found within the subbasin.

3.4.2 Waters Requiring Total Maximum Daily Loads

One waterbody is listed as impaired in the state of Wyoming's 2012 Integrated Report within the subbasin [Wyoming Department of Environmental Quality, 2012]. The impaired waterbodies within the subbasin are shown in Figure 3.29 and summarized in Table 3.25. Fecal Coliform loadings have resulted in exceedances of the recreational use criterion in the Belle Fourche River from the confluence with Arch Creek downstream to the confluence with Sourdough Creek. A TMDL assessment for the Belle Fourche River was completed in August of 2013. Pollutant sources, load allocations, and estimated reductions necessary for the impaired waterbodies to meet water quality criteria were included in the TMDL.

3.5 WATER STORAGE

Water storage development within the watershed has been impacted by the Belle Fourche River Compact of 1943, which divides the water in northeast Wyoming between Wyoming and South Dakota. The compact recognizes all rights in Wyoming existing as of the date of the compact, and permits Wyoming unlimited use for stock water reservoirs not exceeding 20 acre-feet in capacity. Wyoming is allowed to use 10 percent of the available flow of the Belle Fourche River in excess of the amount that is needed to supply the water rights in existence at the date of the contract. No reservoir constructed subsequent to the date of the compact solely to use the water allocated to Wyoming shall have a capacity greater than 1,000 acre-feet.

Water storage within the subbasin has been the subject of past studies and are summarized in Section 3.9.3 of the basin wide summary report. Because of the constraints related to the

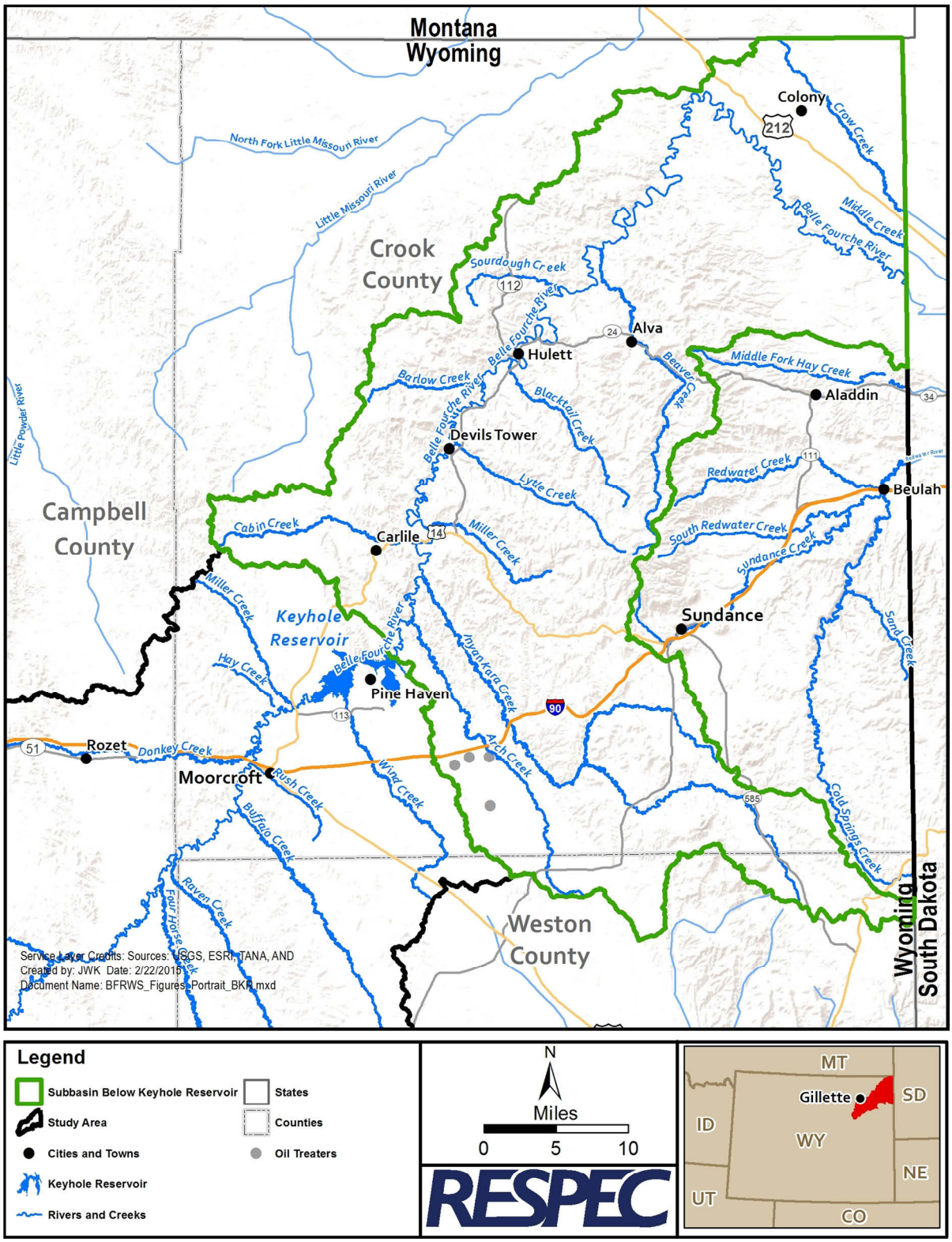


Figure 3.29. Impaired Waterbodies Within the Subbasin and Study Area.

Table 3.25. State of Wyoming's 2012 Impaired Waterbodies and Status Within the Subbasin

Waterbody	305(b) Identifier	Location	Class	Miles	Use	Cause	List Date	TMDL Date
Belle Fourche River	WYBF-101202010904_00	From the confluence with Arch Creek downstream to the confluence with Sourdough Creek	2ABww	60.7	Recreation	Fecal Coliform	1996	2009

compact, the investigation of water storage focused on existing stock ponds and potential sites with less than 20 acre-feet. Additional storage reservoirs or enlargements to existing reservoirs may be limited by constraints identified above, however, improvements to fully realize and sustain the capacity of the existing reservoirs are not limited by these constraints. Although, no large potential sites were identified by landowners within the subbasin, problems with existing reservoirs that limited storage capacity were identified and initial field reviews were conducted to determine necessary improvements, which are included in the Chapter 4.0.

3.5.1 Major Reservoirs

The Wyoming SEO developed a list of major reservoirs within the Northeast Wyoming Basin. To qualify, a reservoir must have storage capabilities of 1,000 acre-feet or more and also serve multiple users. Two major reservoirs, Keyhole Reservoir and Gillette Lake, are located within the study area but neither are located within the subbasin and are discussed in the basin wide summary report.

3.5.2 Minor Reservoirs

Over 1,240 stock pond and reservoir permits within the subbasin have been filed with the SEO. Permit age ranges from the year 1907 to 1999. The permitted minor reservoirs within the study area have a combined potential storage of 11,558 acre-feet. The majority of the ponds are small with only one having a storage volume greater than 1,000 acre-feet and approximately 4.3 percent with storage volumes greater than 20 acre-feet. Figure 3.30 shows the locations of the permitted ponds and reservoirs in the subbasin.

Although it is understood that additional large water storage reservoirs or enlargements to the existing storage reservoirs may be limited by the institutional constraints laid out in the Belle Fourche River Compact, improvements to fully realize and sustain the capacity of the existing reservoirs are not limited by these constraints.

3.5.3 Previously Proposed Water Storage Development

Several previous studies on potential reservoir development have been completed throughout the years within the study area. The WWDC has compiled a list of proposed reservoirs from these studies, which is included in the basin wide summary report. However, there have been no potential opportunities for large storage sites identified from recent studies or investigations within the subbasin [HKM Engineering Inc. et al., 2002; Short Elliott Hendrickson Inc., 2006]. The only reservoir and dam projects previously identified within the subbasin are summarized in Table 3.26 [HKM Engineering Inc. et al., 2002; Short Elliott Hendrickson Inc., 2006]. Using information found for the general location of the sites, Township, Range, and Section, proposed locations were mapped and are shown in Figure 3.31.

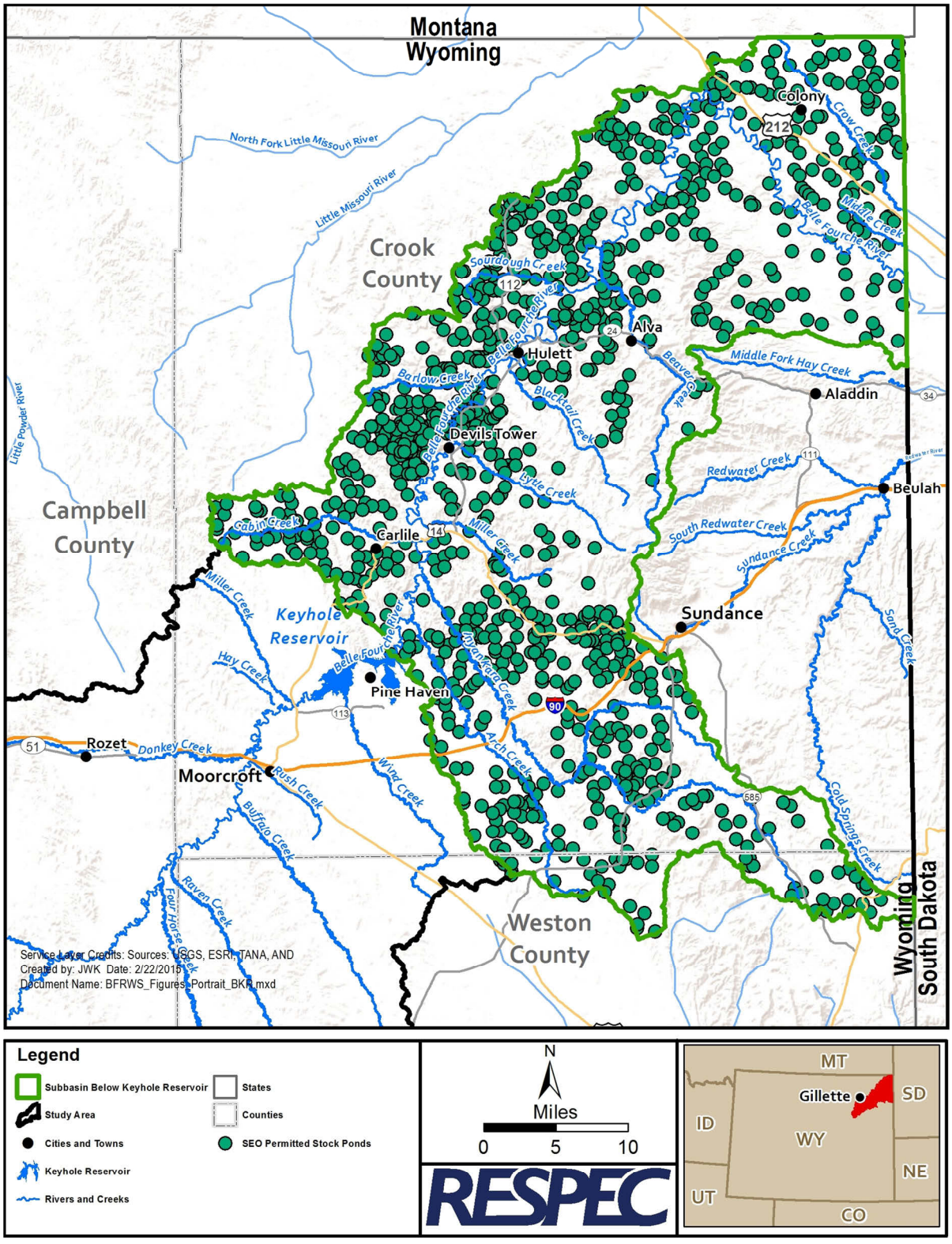


Figure 3.30. Wyoming State Engineer's Office Permitted Stock Ponds and Reservoirs Within the Subbasin.

Table 3.26. Previously Proposed Reservoirs Within the Subbasin

Project Name/Water Source	Approximate Location	Estimated Storage (ac-ft)	Water Use	Estimated Cost ($)
Water Resources of Missouri River Basin in Wyoming (Belle Fourche) L 1 / WY SEO / 1939 / WWDO & St Library				
Livingston/Inyan Kara	Sec 8, 9, 16, T49N, R62W, Crook County	1,008	A	37,260
Proposed Arch Creek Reservoir, Crook County, Wyoming, WY L2/St Plan. Bd&WPA/1939/WWDO and St Library				
Arch Creek Reservoir	Sec 32, T49N, R64W, Crook County	361	A	6,100
Crook County Reservoir Project Level 1 / WWDC&ESA / 1999/WWDO and St Library				
Crook County Res Alt 2/ Lytle Creek	Sec 15/16, T53N, R65W, Crook County	100	A, R	375,400
Crook County Res Alt 3/ Lytle Creek	Sec 15/16, T53N, R65W, Crook County	1,000	A, R	8,929,100
Crook County Res Alt 4/ Lytle Creek	Sec 15/16, T53N, R65W, Crook County	2,800	A, R	14,401,600
Northeast Wyoming River Basins Plan RP/WWDC/ 2002/WWDO & St Library				
Inyan Kara Creek Res	Sec 1, T51N, R66W, Crook County	1,000	A,M,R	NA
Driskill No. 1 Res Enl.	Sec 12, T55N, R64W, Crook County	2,800	A,M,R	NA
Miller Creek Res	Sec 15, T52N, R64W, Crook County	1,000	A,M,R	NA
Lytle Creek Res	Sec 15, T53N, R64W, Crook County	1,000	A,M,R	NA
Blacktail Creek Res	Sec 33, T53N, R64W, Crook County	1,000	A,M,R	NA
Beaver Creek Res	Sec 20, T55N, R63W, Crook County	1,000	A,M,R	NA
Crook County Reservoirs and Water Management Study L1/WWDC and S.E.H./ 2006/WWDO & St Library				
Blacktail Creek	Sec 30, T54N, R64W, Crook County	2,800	A,R	17,100,000
Lytle Cr	Sec 16, T53N, R65W, Crook County	1,000	A,R	11,900,000
Oak Cr	Sec 18, T55N, R60W, Crook County	3,100	A,R	18,200,000
Pine Cr	Sec 4, T55N, R61W, Crook County	1,900	A,R	7,500,000
Miller Cr	Sec 8, T52N, R65W, Crook County	500	A,R	6,400,000
Lower Inyan Kara Cr	Sec 6, T51N, R65W, Crook County	12,600	A,R	29,300,000
Upper Inyan Kara Cr	Sec 11, T50N, R65W, Crook County	6,400	A,R	16,400,000
Redwater Cr	Sec 21, T53N, R60W, Crook County	16,800	A,R	31,800,000

1 Water Use Codes: A = Agriculture, M = Municipal, R = Recreation

2) Work Level Completed: L 1 = Level 1/reconnaissance, L 2 = Level 2/concept designs, RP = report only

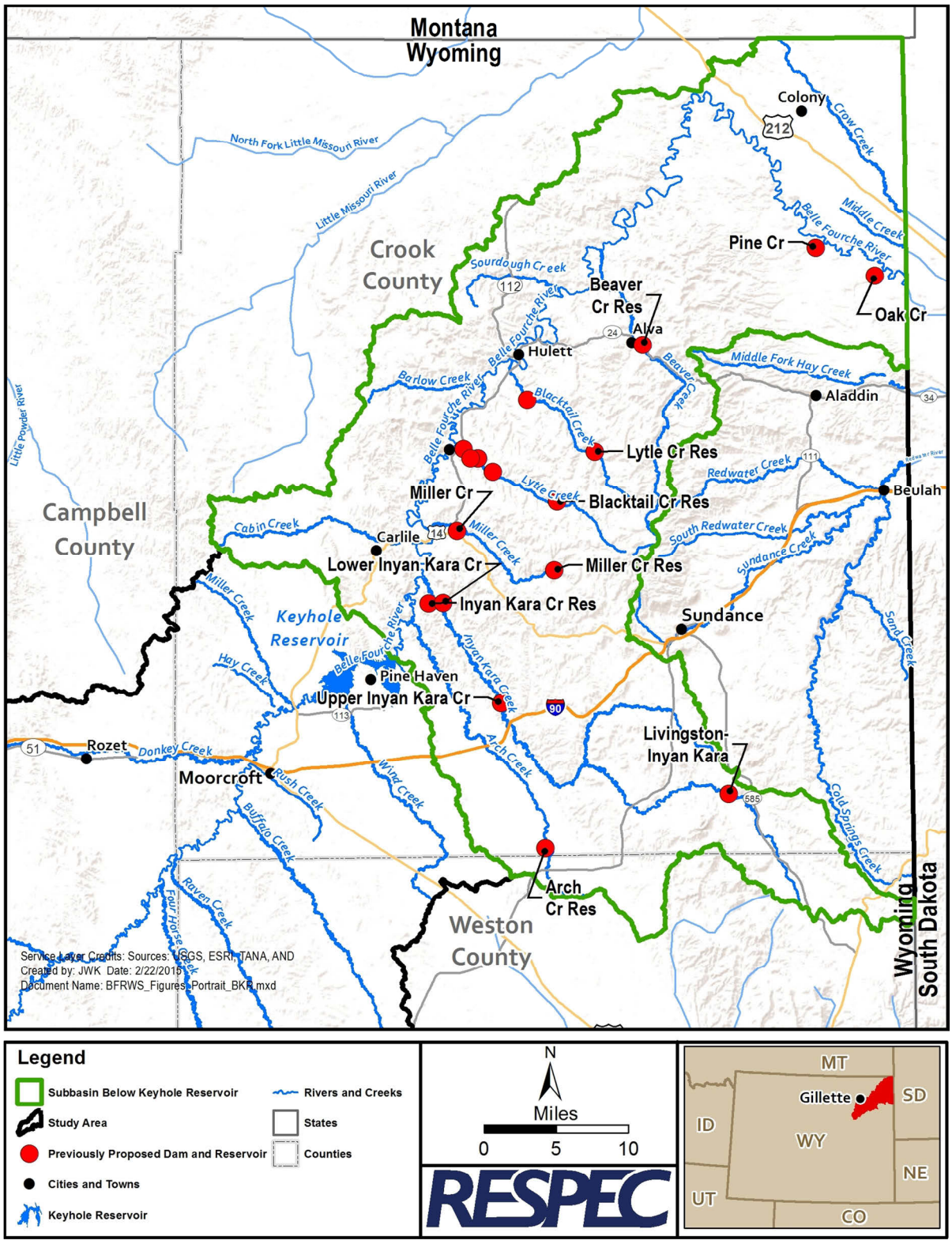


Figure 3.31. Previously Proposed Reservoir and Dam Project Locations Within the Subbasin.

4.0 SUBBASIN BELOW KEYHOLE RESERVOIR 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. This chapter includes the individual proposed projects within the Subbasin below Keyhole Reservoir Watershed Management and Rehabilitation Plan. These potential improvements were developed to address those issues described in Chapter 3.0 and include the following:

- **Irrigation System Conservation and Rehabilitation.** The inventory 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 on 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 on a review of the pertinent ESDs and the 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.

Individual conceptual plans developed for each project component to improve the existing water supply through conservation are included in this chapter. 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 4.4)
- Project Components "LW": Livestock/wildlife upland watering opportunities (Section 4.5)
- Project Components "G": Grazing management opportunities (Section 4.6)
- Project Components "S": Surface water storage opportunities (Section 4.7)

The proposed projects and components in this chapter are commonly referred to as best management practices (BMPs) or conservation practices, which include 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 and effects related to the implementation of these BMPs and conservation practices and are discussed in detail within the basin wide summary report.

4.2 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 Small Water Project Program (SWPP), the NRCS Environmental Quality Incentives Program (EQIP), or other participating conservation or watershed programs.

Irrigation system inventory efforts associated with this project consisted of evaluating structures, ditch conditions, and water storage structures 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. In an effort to assist the irrigator and the CCNRD in prioritizing potential improvements, 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 4.2.1 through 4.3.36, the individual structures inventoried and assessed are discussed. Each irrigation system improvement was assigned a unique identifier within the watershed plan. The inventoried structures and components in the watershed management plan are summarized in Table 4.1. This information has been incorporated in the study's GIS.

4.2.1 Irrigation Component I-03: Lytle Creek Irrigation Pipeline Project

Rehabilitation of the diversion structure and headgate on Lytle Creek is needed to supply water to the proposed regulating reservoir. This project involves the following components:

- **Item No. I-03.1:** Rehabilitate the diversion and check structure on Lytle Creek
- **Item No. I-03.2:** Install irrigation regulating reservoir
- **Item No. I-03.3:** Install approximately 7,040 feet of 15-inch plastic irrigation pipe (PIP) pipeline
- **Item No. I-03.4:** Install approximately 2,400 feet of 12-inch PIP pipeline
- **Item No. I-03.5:** Install approximately 2,480 feet of 12-inch PIP pipeline and flume
- **Item No. I-03.6:** Install approximately 2,140 feet of 10-inch PIP pipeline and headgate.

Table 4.1. Summary of Recommended Irrigation System Improvements

Item Number	Description	Priority
I-03	• Rehabilitate the diversion and check structure on Lytle Creek • Install irrigation regulating reservoir • Install approximately 7,040 feet of 15-inch PIP pipeline • Install approximately 2,400 feet of 12-inch PIP pipeline • Install approximately 2,480 feet of 12-inch PIP pipeline, headgate, and flume • Install approximately 2,140 feet of 10-inch PIP pipeline and headgate	1
I-03A I-03B	• Install diversion and pump • Install approximately 1,300 feet of 8-inch PIP pipeline and pump • Rehabilitate the diversion structure and pump	3
I-05	• Rehabilitate Pine (Deep) Creek Reservoir (see Section 4.7.1.4)	3
I-06	• Install diversion structure and headgate • Install approximately 7,020 feet of 12-inch PIP pipeline • Install approximately 650 feet of 10-inch PIP pipeline	3
I-07	• Rehabilitate Oak Creek Reservoir (see Section 4.7.1.5)	2
I-08	• Install diversion structure and headgate • Install irrigation regulating reservoir • Install approximately 4,510 feet of 12-inch PIP pipeline	2
I-09	• Install diversion structure and headgate • Install irrigation regulating reservoir • Install approximately 2,470 feet of 12-inch PIP pipeline	3
I-10	• Install two diversion structures and pumps • Install approximately 4,760 feet of 12-inch PIP pipeline	3
I-11	• Install diversion structure and headgate • Install irrigation regulating reservoir • Install approximately 4,540 feet of 12-inch PIP pipeline	3
I-12	• Install diversion structure and pump • Install approximately 1,820 feet of 12-inch PIP pipeline	3
I-13	• Install diversion structure and pump • Install approximately 1,820 feet of 12-inch PIP pipeline	3
I-14	• Install diversion structure and headgate • Install approximately 8,920 feet of 12-inch PIP pipeline	3
I-15	• Install two diversion structures and headgates • Install approximately 6,800 feet of 12-inch PIP pipeline	2

4.2.2 Irrigation Component I-03A and I-03B: Bear Lodge Irrigation Diversion Project

Installation or rehabilitation of a diversion/pump structure is needed. This project involves the following components:

- **Item No. I-03A.1:** Install diversion and pump
- **Item No. I-03A.2:** Install approximately 1,300 feet of 8-inch PIP pipeline and pump
- **Item No. I-03B.1:** Rehabilitate the diversion structure and pump.

4.2.3 Irrigation Component I-05: Pine (Deep) Creek Reservoir Rehabilitation Project

Rehabilitation of the Pine (Deep) Creek Reservoir is needed. This project involves the following components:

- **Item No. I-05.1:** Rehabilitate Pine (Deep) Creek Reservoir and dam.

4.2.4 Irrigation Component I-06: Pine (Deep) Creek Reservoir Irrigation Pipeline Project

Installation of a diversion structure and headgate would supply irrigation water to new areas. This project involves the following components:

- **Item No. I-06.1:** Install diversion structure and headgate
- **Item No. I-06.2:** Install approximately 7,020 feet of 12-inch PIP pipeline
- **Item No. I-06.3:** Install approximately 650 feet of 10-inch PIP pipeline.

4.2.5 Irrigation Component I-07: Oak Creek Reservoir Rehabilitation Project

Rehabilitation of the Oak Creek Reservoir is needed. This project involves the following components:

- **Item No. I-07.1:** Rehabilitate irrigation reservoir on Oak Creek.

4.2.6 Irrigation Component I-08: Oak Creek Reservoir Irrigation Pipeline Project

Installation of a diversion structure, regulating reservoir, and pipeline would supply irrigation water to new areas. This project involves the following components:

- **Item No. I-08.1:** Install diversion structure and headgate
- **Item No. I-08.2:** Install irrigation regulating reservoir
- **Item No. I-08.3:** Install approximately 4,510 feet of 12-inch PIP pipeline.

4.2.7 Irrigation Component I-09: Christofferson Draw Reservoir Rehabilitation and Irrigation Pipeline Project

Installation of a diversion structure, regulating reservoir, and pipeline would supply irrigation water to new areas. This project involves the following components:

- **Item No. I-09.1:** Install diversion structure and headgate
- **Item No. I-09.2:** Install irrigation regulating reservoir
- **Item No. I-09.3:** Install approximately 2,470 feet of 12-inch PIP pipeline.

4.2.8 Irrigation Component I-10: Bear Gulch Irrigation Pipeline Project

Installation of two diversion structures and pumps would supply irrigation water to two new areas. This project involves the following components:

- **Item No. I-10.1:** Install two diversion structures and pumps
- **Item No. I-10.2:** Install approximately 4,760 feet of 12-inch PIP pipeline.

4.2.9 Irrigation Component I-11: Horse Creek Reservoir and Irrigation Pipeline Project

Installation of a diversion structure, regulating reservoir, and pipeline would supply irrigation water to new areas. This project involves the following components:

- **Item No. I-11.1:** Install diversion structure and headgate
- **Item No. I-11.2:** Install irrigation regulating reservoir
- **Item No. I-11.3:** Install approximately 4,540 feet of 12-inch PIP pipeline.

4.2.10 Irrigation Component I-12: Iron Creek Irrigation Pipeline Project

Installation of a diversion structure and pump would supply irrigation water to new areas. This project involves the following components:

- **Item No. I-12.1:** Install diversion structure and pump
- **Item No. I-12.2:** Install approximately 1,820 feet of 12-inch PIP pipeline.

4.2.11 Irrigation Component I-13: Mule Shoe Reservoir Rehabilitation Project

Rehabilitation of the Mule Shoe Reservoir is needed. This project involves the following components:

- **Item No. I-13.1:** Rehabilitate reservoir and dam.

4.2.12 Irrigation Component I-14: Rand Ditch Irrigation Pipeline Rehabilitation Project

Installation of a diversion structure and headgate would supply irrigation water to new areas. This project involves the following components:

- **Item No. I-14.1:** Install diversion structure and headgate
- **Item No. I-14.2:** Install approximately 8,920 feet of 12-inch PIP pipeline.

4.2.13 Irrigation Component I-15: Wood Ditch Irrigation Pipeline Rehabilitation Project

Installation of a diversion structure and headgate would supply irrigation water to new areas. This project involves the following components:

- **Item No. I-15.1:** Install two diversion structures and headgates
- **Item No. I-15.2:** Install approximately 6,800 feet of 12-inch PIP pipeline.

4.3 LIVESTOCK AND WILDLIFE UPLAND WATERING SOURCES

Participating landowners identified places where existing water sources could be improved and conceptual wildlife and livestock water components and associated facilities were developed and located on parcels, allotments, and pastures. A more detailed discussion about the livestock/wildlife sources and current availability within the study area is included in the basin wide summary report. The following proposed projects 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 manage flows and water levels. Participation in the study was voluntary and a list of interested participants was created after the scoping meetings were held. On-site, field visits were scheduled and conducted with landowners and managers where the study team listened to concerns about water needs of the participants and visited potential project sites.

Participants identified areas that needed water development then conceptual water development projects were mapped and are summarized in Section 4.2.1 through Section 4.2.13. 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. The general locations of all of the proposed livestock/wildlife water projects are included in Chapter 4.0 of the basin wide summary report.

Because federal and state lands cover approximately 34 percent of the subbasin and are intermingled with private lands, some of the water development projects could involve

Table 4.2. Summary of Livestock/Wildlife Upland Water Development Components (Page 1 of 2)

Item Number	Plan Component	Priority	Project Name	Description	Solar Pump	Well Construct	Spring Development	Pipeline	Stock Tank	Storage Tank	Stock Pond Rehab-Construct	Fence
10	LW-10		Whitelaw	Solar Pump and Storage Tank	1					1		
11	LW-10A		Divide Allotment	Pipeline and Tank			1	700	2			7,000
23	LW-21		Miller Creek #2	Well, Solar Pump, and Tank	1	1		400	1			
24	LW-22		Dry Creek #5	Well, Solar Pump, and Tank	1	1		400	1			
25	LW-23		Corral Creek #1	Well, Pipeline, and Tank		1		5,000	4		1	
26	LW-24		Alvin Creek	Pipeline and Tank				2,000	2			
27	LW-25		Corral Creek #2	Well, Pipeline, and Tank	1	1		1,100	2	1		
28	LW-26		Corral Creek #3	Spring Development, Pipeline, Tank	1		1	2,900	2	1		
29	LW-27		Eggie Basin	Pipeline and Tank				5,700	2			
30	LW-28		Pine Ridge	Well, Pipeline, and Tank	1	1		3,400	2	1		
31	LW-29		Little Draw #1	Well, Pipeline, and Tank	1	1		400	1			
32	LW-30		Alma	Stock Reservoir							1	
33	LW-31		Lower Alma	Stock Reservoir							1	
34	LW-32		Mikel Creek	Well, Pipeline, and Tank	1	1		400	1			
35	LW-33		Little Draw #2	Well, Pipeline, and Tank	1	1		3,500	2			
41	LW-37		Little Wright Draw	Well, Pipeline, and Tank	1	1		6,200	3	1		
42	LW-38		Busby Draw	Well, Pipeline, and Tank	1	1		400	1			
43	LW-39		Wolfe Draw	Pipeline and Tank				3,800	2			
44	LW-40		Kruger #1	Well and Pipeline		1		1,900				

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

Item Number	Plan Component	Priority	Project Name	Description	Solar Pump	Well Construct	Spring Development	Pipeline	Stock Tank	Storage Tank	Stock Pond Rehab-Construct	Fence
45	LW-41		Kruger #2	Pipeline and Tank				11,400	4			
46	LW-42		Kruger #3	Pipeline and Tank				14,300	4			
47	LW-42A		Oak Creek	Well, Pipeline, and Tank	1	1		6,000	3			
48	LW-43		Kilpatrick Creek	Pipeline and Tank				12,900	4			
49	LW-44		Newland #4	Stock Reservoir							1	
50	LW-44A		Iron Creek	Well, Pipeline, and Tank	1	1		400	1			
51	LW-45		Sawmill	Well, Tank, and Stock Pond	1	1		400	1		1	
52	LW-46		Bear Gulch	Well, Pipeline, and Tank	1	1		400	1		1	
53	LW-46A		Bear	Stock Reservoir							1	
54	LW-46A		Bear Gulch	Stock Reservoir							1	
55	LW-47		Shield	Stock Reservoir							1	
56	LW-47A		Left Creek	Stock Reservoirs							1	
57	LW-48		Left Creek	Spring Development, Pipeline, Tank			1	1,300	1			
58	LW-49		Vines Draw	Well, Pipeline, and Tank	1	1		400	1		1	
59	LW-50		Grubb #3	Stock Reservoir							1	
60	LW-50A		Brimmer	Stock Reservoir							1	
61	LW-51		Arkansas Creek	Wildlife Guzzler and Pond					1		1	
66	LW-56		Kester #1	Spring Development, Pipeline, Tank			1	1,800	3			10,400
67	LW-57		Kester #2	Spring Development, Pipeline, Tank			1	4,700	2		1	

coordination with the BLM, USFS, and Wyoming Office of State Lands and Investments (OSLI) before initiating construction. Additionally, some projects could involve multiple landowners because of the locations of wells and routes for pipelines. For these projects spanning multiple owners, written agreements would be necessary to outline the responsibilities and liabilities of the parties involved with each individual project. Moreover, environmental evaluations would be required for any potential effects identified for a specific project or project component, especially on federal and state lands. Therefore, coordination is necessary with BLM and USFS before implementing any project on federal land and coordination with OSLI is required before constructing any improvements on state land.

There are 38 upland livestock/wildlife water development plan components described in Section 4.3.1.1 through Section 4.3.1.36 summarizing well construction, stock pond rehabilitation, and pipeline installation components. 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 and subbasin. However, these projects would need additional information and coordination with interested landowners before applications are submitted to the WWDO by any local sponsors.

4.3.1 LW-10: Whitelaw Solar Pump and Tank Project

This alternative would involve installing a storage tank and a solar pump system to supply water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- From an existing spring development and buried pipeline, a storage tank (~ 2,900-gallon capacity) would be installed to supply adequate water to an existing livestock/wildlife system.
- From the storage tank, a solar platform consisting of solar panel; solar-powered pump; batteries; and regulators, connections, and appurtenances would be installed to supply water via the existing buried pipelines to five existing stock tanks.
- 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 existing stock tanks.

4.3.2 LW-10A: Divide Allotment Spring Development and Tank Project

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

- The existing spring would be rehabilitated and equipped with collection pipe, spring box, and appurtenances would be installed.

- From the rehabilitated spring, a buried high-density polyethylene (HDPE) low-pressure pipeline would be installed to supply water to two stock tanks (1,200-gallon capacity each). This pipeline would be aligned easterly and require installing 700 linear feet of 2-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.

4.3.3 LW-23: Corral Creek #1 Well and Tank Rehabilitation Project

This alternative would involve rehabilitating an existing well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- A new well would be drilled to supply water. The well would be equipped with a pump and appurtenances.
- From the well and pump, two buried HDPE low-pressure pipelines would be installed to supply water to four stock tanks.
- One pipeline would be aligned northeasterly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 2,000 linear feet of 2-inch pipeline.
- The other pipeline would require installing approximately 3,000 linear feet of 2-inch pipeline southeasterly 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.

4.3.4 LW-24: Alvin Creek Pipeline and Tank Project

This alternative would involve extending an existing pipeline supplied from an well and pump to supply water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- From the existing pipeline, well, and pump, a buried HDPE pipeline would be installed northwesterly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 2,000 linear feet of 2-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.

4.3.5 LW-25: Corral Creek #2 Well and Tank Rehabilitation Project

This alternative would involve rehabilitating an existing well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components 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, a buried HDPE low-pressure pipeline would be installed easterly to supply a storage tank (~2,900-gallon capacity). This pipeline would require installing 300 linear feet of 2-inch pipeline.
- From the storage tank (~2,900-gallon capacity), a buried HDPE pipeline would be installed northerly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 800 linear feet of 2-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.

4.3.6 LW-26: Corral Creek #3 Spring Development and Tank Project

This alternative would involve rehabilitating an existing spring and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- The existing spring would be rehabilitated and equipped with collection pipe, spring box, and appurtenances would be installed.
- From the rehabilitated spring, a buried HDPE low-pressure pipeline would be installed to supply water to a storage tank (~2,900-gallon capacity).
- From the storage tank, a solar platform consisting of solar panel; solar-powered pump; batteries; and regulators, connections, and appurtenances would be installed to supply water via two buried HDPE low-pressure pipelines to two stock tanks (1,200-gallon capacity each).
- One pipeline would be aligned northerly to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 1,700 linear feet of 2-inch pipeline.
- The other pipeline would require installing approximately 1,200 linear feet of 2-inch pipeline southerly from the storage tank and solar pump 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.

4.3.7 LW-27: Eggie Basin Pipeline and Tank Project

This alternative would involve extending an existing pipeline supplied from an existing spring development, solar pump, and storage tank (~2,900-gallon capacity) to supply water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- From the existing pipeline, spring development, solar pump, and storage tank (approximately 2,900-gallon capacity), a buried HDPE pipeline would be installed south westerly to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 2,800 linear feet of 2-inch pipeline.
- From the installed pipeline and stock tanks, the other HDPE pipeline would be installed westerly to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 2,900 linear feet of 2-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.

4.3.8 LW-28: Pine Ridge Well and Tank Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components 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, a buried HDPE low-pressure pipeline would be installed to supply water to a storage tank (approximately 2,900-gallon capacity).
- From the storage tank (approximately 2,900-gallon capacity), a buried HDPE pipeline would be installed southerly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 3,400 linear feet of 2-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.

4.3.9 LW-29: Little Draw #1 Well and Tank Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components 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, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be supply a stock tank (1,200-gallon capacity). This pipeline would require installing 400 linear feet of 2-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 the proposed stock tank.

4.3.10 LW-30: Alma Reservoir Rehabilitation Project

This alternative would provide for the rehabilitation of a stock reservoir and associated wetlands. The existing stock reservoir is located on Mikel Creek, an intermittent tributary to Spring Creek, within Section 6 of Township 51 North, Range 66 West in Crook County. Currently, the stock reservoir has problems related the dam embankment and outlet facilities and is not capable of providing necessary storage.

This project would include the rehabilitation of the Alma Stock Reservoir (Permit No. P4565S). The reservoir has a permitted total capacity of 11.44 acre-feet. This stock reservoir could be rehabilitated to provide an additional source of livestock/wildlife water along with restoring function of the associated wetland and riparian areas. This alternative would involve installation of an inlet and outlet pipe control structure in the reservoir embankment and stabilizing the installed structures and spillway with rock riprap. This alternative includes the following features:

- Inspection of the embankment and rehabilitation of problem areas as needed. The embankment is approximately 400 feet long and less than 15 feet high at its highest point. The top-width of the embankment is approximately 15 feet wide.
- Installation of an inlet and outlet control mechanism would be used to control reservoir water levels. The installed structures would be stabilized with rock riprap.
- Investigation of site-specific soil and geologic conditions to define the extent necessary to excavate existing sediment and to determine if alternatives to bentonite liner treatment should be considered because of karstic bedrock or other conditions of the underlying bedrock formation.

- Excavation of the earthen, grass-lined spillway to adequately convey necessary water volumes along with stabilization with rock riprap for spillway protection.
- Contingent upon determination of adequate sources of borrow material and rock riprap for dam embankment repairs and spillway stabilization.
- As delineated, the project involves privately owned lands only.

4.3.11 LW-31: Lower Alma Reservoir Rehabilitation Project

This alternative would provide for the rehabilitation of a stock reservoir and associated wetlands. The existing stock reservoir is directly downstream of the Alma Stock Reservoir (Permit No. P4565S) and also located on Mikel Creek, an intermittent tributary to Spring Creek, within Section 6 of Township 51 North, Range 66 West in Crook County. Currently, the stock reservoir has problems related the dam embankment and outlet facilities and experiences seepage loss of the impounded water behind the embankment.

This stock reservoir could be rehabilitated to provide an additional source of livestock/wildlife water along with restoring function of the associated wetland and riparian areas. The stock reservoir encompasses 1.2 acres with a total capacity of less than 2 acre-feet. This alternative would include the following features:

- Inspection of the embankment and rehabilitation of problem areas as needed. The embankment is approximately 200 feet long and less than 15 feet high at its highest point. The top-width of the embankment is approximately 10 feet wide.
- Investigation of site-specific soil and geologic conditions to define the extent necessary to excavate existing sediment and to determine if alternatives to bentonite liner treatment should be considered because of karstic bedrock or other conditions of the underlying bedrock formation.
- Installation of an inlet and outlet control mechanism would be used to control reservoir water levels. The installed structures would be stabilized with rock riprap.
- Excavation of the spillway to adequately convey overflow volumes along with stabilization with rock riprap for protection.
- Contingent upon determination of adequate sources of borrow material and rock riprap for dam embankment repairs and spillway stabilization.
- Potential construction options for reducing seepage in small stock ponds and reservoirs include the installation of geotextile liners, bentonite mat liners, or placement of agricultural grade bentonite. Potential options are detailed in the NRCS Construction Specifications for Pond Sealing or Lining (NRCS WY-521A, WY-521C, or WY-521D).
- As delineated, the project involves privately owned lands only.

4.3.12 LW-32: Mikel Creek Well and Tank Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components 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, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be supply a stock tank (1,200-gallon capacity). This pipeline would require installing 400 linear feet of 2-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 the proposed stock tank.

4.3.13 LW-33: Little Draw #2 Well and Tank Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components 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, a buried HDPE low-pressure pipeline would be installed southeasterly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 3,500 linear feet of 2-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 the proposed stock tank.
- 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.

4.3.14 LW-37: Little Wright Draw Well, Pipeline, and Tank Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components 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, a buried HDPE low-pressure pipeline would be installed to supply water to a storage tank (~2,900-gallon capacity).
- From the storage tank (~ 2,900-gallon capacity), a buried HDPE pipeline would be installed northerly to supply three stock tanks (1,200-gallon capacity each). This pipeline would require installing 6,200 linear feet of 2-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.

4.3.15 LW-38: Busby Draw Well and Tank Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components 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, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be supply a stock tank (1,200-gallon capacity). This pipeline would require installing 400 linear feet of 2-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 the proposed stock tank.

4.3.16 LW-39: Wolfe Draw Pipeline and Tank Project

This alternative would involve extending an existing pipeline supplied from a well and pump to supply water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- From the existing pipeline, well, and pump, a buried HDPE pipeline would be installed easterly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 3,800 linear feet of 2-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.

4.3.17 LW-40: Kruger #1 Well and Pipeline Project

This alternative would involve drilling a new well and extending an existing pipeline supplied from a proposed well to supply water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- A new well would be drilled to supply water. The well would be equipped with a pump and appurtenances.
- From the proposed well and pump, a buried HDPE pipeline would be installed easterly to supply four existing stock tanks (1,200-gallon capacity each). This pipeline would require installing 1,900 linear feet of 2-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.

4.3.18 LW-41: Kruger #2 Pipeline and Tank Project

This alternative would involve extending an existing pipeline supplied from a proposed well, pump, pipeline, and stock tanks to supply water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- From the existing pipeline, proposed well and pump, a buried HDPE pipeline would be installed easterly to supply three stock tanks (1,200-gallon capacity each). This pipeline would require installing 7,900 linear feet of 2-inch pipeline.
- From the proposed pipeline and stock tanks, another HDPE pipeline would be installed northerly to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 1,200 linear feet of 2-inch pipeline.
- From the proposed pipeline and stock tanks, another HDPE pipeline would be installed northerly to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 2,300 linear feet of 2-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.

4.3.19 LW-42: Kruger #3 Pipeline and Tank Project

This alternative would involve extending an existing pipeline described in the *LW-41: Kruger #2 Pipeline and Tank Project*, supplied from an existing well, pump, pipeline, and stock tanks to supply water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- From the existing pipeline, proposed well and pump, a buried HDPE pipeline would be installed southerly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 7,200 linear feet of 2-inch pipeline.
- From the proposed pipeline and stock tanks, another HDPE pipeline would be installed westerly to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 3,800 linear feet of 2-inch pipeline.
- From the proposed pipeline and stock tanks, another HDPE pipeline would be installed southerly to supply a stock tank (1,200-gallon capacity). This pipeline would require installing 3,300 linear feet of 2-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.

4.3.20 LW-42A: Oak Creek Well and Tank Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components 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, a buried HDPE low-pressure pipeline would be installed southeasterly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 3,500 linear feet of 2-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 the proposed stock tank.

4.3.21 LW-43: Kilpatrick Creek Pipeline and Tank Project

This alternative would involve extending an existing pipeline supplied from an existing well, pump, pipeline, and stock tanks to supply water to a portion of the watershed lacking adequate

livestock/wildlife water sources. Under this alternative, the following components would be installed:

- From the existing pipeline, well and pump, a buried HDPE pipeline would be installed northwesterly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 9,000 linear feet of 2-inch pipeline.
- From the proposed pipeline and stock tanks, another HDPE pipeline would be installed southerly to supply two stock tanks (1,200-gallon capacity each). This pipeline would require installing 3,900 linear feet of 2-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.

4.3.22 LW-44: Newland #4 Stock Reservoir Rehabilitation Project

This alternative would provide for the rehabilitation of a stock reservoir and associated wetlands. The existing stock reservoir is located on Iron Creek, a tributary to the Belle Fourche River, within Section 36 of Township 57 North, Range 62 West in Crook County. Currently, the stock reservoir has problems related the dam embankment and outlet facilities and experiences seepage loss of the impounded water behind the embankment.

This project would include the rehabilitation of the Newland #4 Stock Reservoir (Permit No. P6205R). The reservoir has a permitted total capacity of 53.45 acre-feet. This stock reservoir could be rehabilitated to provide an additional source of livestock/wildlife water along with restoring function of the wetland and riparian areas. This alternative would include the following features:

- Inspection of the embankment and rehabilitation of problem areas as needed. The embankment is approximately 600 feet long and less than 20 feet high at its highest point. The top-width of the embankment is approximately 12 feet wide.
- Installation of an inlet and outlet control mechanism would be used to control reservoir water levels. The installed structures would be stabilized with rock riprap.
- Excavation of the spillway to adequately convey overflow volumes along with stabilization with rock riprap for protection.
- Contingent upon determination of adequate sources of borrow material and rock riprap for dam embankment repairs and spillway stabilization.
- Potential construction options for reducing seepage in small stock ponds and reservoirs include the installation of geotextile liners, bentonite mat liners, or placement of agricultural grade bentonite. Potential options are detailed in the NRCS Construction Specifications for Pond Sealing or Lining (NRCS WY-521A, WY-521C, or WY-521D).
- As delineated, the project involves state owned lands only.

4.3.23 LW-44A: Iron Creek Well and Tank Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components 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, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be supply a stock tank (1,200-gallon capacity). This pipeline would require installing 400 linear feet of 2-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 the proposed stock tank.

4.3.24 LW-45: Sawmill Well, Tank, and Stock Pond/Reservoir Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components 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, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be supply a stock tank (1,200-gallon capacity). This pipeline would require installing 400 linear feet of 2-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 the proposed stock tank.

In addition to the installation of a well, solar pump, pipeline, and stock tank, this alternative would also provide for the construction of a stock pond/reservoir to provide an additional source of livestock/wildlife water along with providing associated wetland areas. This alternative would include the following features:

- A small stock pond/reservoir would have a capacity of less than 2 acre-feet and would be constructed to collect overflow.
- Investigation of site-specific soil and geologic conditions to define the extent necessary to excavate existing sediment and to determine if alternatives to bentonite liner treatment

should be considered because of karstic bedrock or other conditions of the underlying bedrock formation.

- As proposed, the project involves private lands only.

4.3.25 LW-46: Bear Gulch Well and Tank Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components 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, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be supply a stock tank (1,200-gallon capacity). This pipeline would require installing 400 linear feet of 2-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 the proposed stock tank.

4.3.26 LW-46A: Bear Stock Reservoir Rehabilitation Project

This alternative would provide for the rehabilitation of a stock reservoir and associated wetlands. The existing stock reservoir is located on Bear Gulch, a tributary to Left Creek, within Section 29 of Township 53 North, Range 62 West in Crook County. Currently, the stock reservoir has problems related the dam embankment and outlet facilities and experiences seepage loss of the impounded water behind the embankment.

This project would include the rehabilitation of the Bear Stock Reservoir (Permit No. P4312S). The reservoir has a permitted total capacity of 1.09 acre-feet. This stock reservoir could be rehabilitated to provide an additional source of livestock/wildlife water along with restoring function of the wetland and riparian areas. This alternative would include the following features:

- Inspection of the embankment and rehabilitation of problem areas as needed. The embankment is approximately 130 feet long and less than 10 feet high at its highest point. The top-width of the embankment is approximately 10 feet wide.
- Investigation of site-specific soil and geologic conditions to define the extent necessary to excavate existing sediment and to determine if alternatives to bentonite liner treatment should be considered because of karstic bedrock or other conditions of the underlying bedrock formation.

- Installation of an inlet and outlet control mechanism would be used to control reservoir water levels. The installed structures would be stabilized with rock riprap.
- Excavation of the spillway to adequately convey overflow volumes along with stabilization with rock riprap for protection.
- Contingent upon determination of adequate sources of borrow material and rock riprap for dam embankment repairs and spillway stabilization.
- Potential construction options for reducing seepage in small stock ponds and reservoirs include the installation of geotextile liners, bentonite mat liners, or placement of agricultural grade bentonite. Potential options are detailed in the NRCS Construction Specifications for Pond Sealing or Lining (NRCS WY-521A, WY-521C, or WY-521D).
- As delineated, the project involves privately owned lands only.

4.3.27 LW-46B: Bear Gulch Stock Reservoir Rehabilitation Project

This alternative would provide for the rehabilitation of a stock reservoir and associated wetlands. The existing stock reservoir is located on Bear Gulch, a tributary to Left Creek, within Section 20 of Township 53 North, Range 62 West in Crook County. Currently, the stock reservoir has problems related the dam embankment and outlet facilities.

This stock reservoir could be rehabilitated to provide an additional source of livestock/wildlife water along with restoring function of the associated wetland and riparian areas. The stock reservoir encompasses 1.6 acres with a total capacity of less than 5 acre-feet. This alternative would include the following features:

- Inspection of the embankment and rehabilitation of problem areas as needed. The embankment is approximately 220 feet long and less than 10 feet high at its highest point. The top-width of the embankment is approximately 10 feet wide.
- Installation of an inlet and outlet control mechanism would be used to control reservoir water levels. The installed structures would be stabilized with rock riprap.
- Excavation of the spillway to adequately convey overflow volumes along with stabilization with rock riprap for protection.
- Contingent upon determination of adequate sources of borrow material and rock riprap for dam embankment repairs and spillway stabilization.
- Potential construction options for reducing seepage in small stock ponds and reservoirs include the installation of geotextile liners, bentonite mat liners, or placement of agricultural grade bentonite. Potential options are detailed in the NRCS Construction Specifications for Pond Sealing or Lining (NRCS WY-521A, WY-521C, or WY-521D).
- As delineated, the project involves privately owned lands only.

4.3.28 LW-47: Shield Stock Reservoir Rehabilitation Project

This alternative would provide for the rehabilitation of a stock reservoir and associated wetlands. The existing stock reservoir is located on Bear Gulch, a tributary to Left Creek, within Section 27 of Township 53 North, Range 62 West in Crook County. Currently, the stock reservoir has problems related the dam embankment and outlet facilities and experiences seepage loss of the impounded water behind the embankment.

This project would include the rehabilitation of the Shield Stock Reservoir (Permit No. P2471S). The reservoir has a permitted total capacity of 2.38 acre-feet. This stock reservoir could be rehabilitated to provide an additional source of livestock/wildlife water along with restoring function of the wetland and riparian areas. This alternative would include the following features:

- Inspection of the embankment and rehabilitation of problem areas as needed. The embankment is approximately 100 feet long and less than 10 feet high at its highest point. The top-width of the embankment is approximately 10 feet wide.
- Investigation of site-specific soil and geologic conditions to define the extent necessary to excavate existing sediment and to determine if alternatives to bentonite liner treatment should be considered because of karstic bedrock or other conditions of the underlying bedrock formation.
- Installation of an inlet and outlet control mechanism would be used to control reservoir water levels. The installed structures would be stabilized with rock riprap.
- Excavation of the spillway to adequately convey overflow volumes along with stabilization with rock riprap for protection.
- Contingent upon determination of adequate sources of borrow material and rock riprap for dam embankment repairs and spillway stabilization.
- Potential construction options for reducing seepage in small stock ponds and reservoirs include the installation of geotextile liners, bentonite mat liners, or placement of agricultural grade bentonite. Potential options are detailed in the NRCS Construction Specifications for Pond Sealing or Lining (NRCS WY-521A, WY-521C, or WY-521D).
- As delineated, the project involves privately owned lands only.

4.3.29 LW-47A: Left Creek Stock Reservoirs Rehabilitation Project

This alternative would provide for the reconstruction and repair of two breached stock reservoirs. The stock reservoirs are located on Left Creek, a tributary to the Belle Fourche River, within Section 22 of Township 53 North, Range 62 West in Crook County. The stock reservoirs have been breached which has resulted in failure of the embankments.

This alternative includes reconstruction and repair of the breached reservoirs which could provide additional sources of livestock/wildlife water, potential fisheries, along with restoring function of the wetland and riparian areas. This alternative would include the following features:

- Removal of the existing breached embankments and construction of new embankments at the same locations.
- The upper stock reservoir's embankment was approximately 500 feet long and less than 15 feet high at its highest point. The top-width of the embankment is approximately 15 feet wide.
- The lower stock reservoir's embankment was approximately 450 feet long and less than 15 feet high at its highest point. The top-width of the embankment is approximately 15 feet wide.
- Investigation of site-specific soil and geologic conditions to determine the feasibility of reconstruction alternatives and identify any other conditions of the underlying bedrock formation.
- Installation of an inlet and outlet control mechanism would be used to control reservoir water levels. The installed structures would be stabilized with rock riprap.
- Excavation of the spillway to adequately convey overflow volumes along with stabilization with rock riprap for protection.
- Contingent upon determination of adequate sources of borrow material and rock riprap for a dam embankment reconstruction and repair and spillway stabilization.
- As delineated, the project involves privately owned lands only.

4.3.30 LW-48: Left Creek Spring Development and Tank Project

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

- The existing spring would be rehabilitated and equipped with collection pipe, spring box, and appurtenances would be installed.
- From the rehabilitated spring, a buried HDPE low-pressure pipeline to a stock tank (1,200-gallon capacity) would be installed to provide livestock/wildlife water. This pipeline would be aligned westerly and require installing 1,300 linear feet of 2-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 the proposed stock tank.

4.3.31 LW-49: Vines Draw Well, Tank, and Stock Pond Project

This alternative would involve drilling a new well and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components 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, a buried HDPE low-pressure pipeline would be installed.
- The pipeline would be supply a stock tank (1,200-gallon capacity). This pipeline would require installing 400 linear feet of 2-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 the proposed stock tank.

In addition to the installation of a well, solar pump, pipeline, and stock tank, this alternative would also provide for the construction of a stock pond/reservoir to provide an additional source of livestock/wildlife water along with providing associated wetland areas. This alternative would include the following features:

- A small stock pond/reservoir would have a capacity of less than 2 acre-feet and would be constructed to collect overflow.
- Investigation of site-specific soil and geologic conditions to define the extent necessary to excavate existing sediment and to determine if alternatives to bentonite liner treatment should be considered because of karstic bedrock or other conditions of the underlying bedrock formation.
- As proposed, the project involves private lands only.

4.3.32 LW-50: Grubb #3 Stock Reservoir Rehabilitation Project

This alternative would provide for the rehabilitation of a stock reservoir and associated wetlands. The existing stock reservoir is located on East Brimmer Creek, a tributary to the Belle Fourche River, within Section 10 of Township 53 North, Range 65 West in Crook County. Currently, the reservoir has problems related the dam and outlet facilities and experiences seepage loss of the impounded water behind the embankment.

This project would include the rehabilitation of the Grubb #3 Stock Reservoir (Permit No. P2215S). The reservoir has a permitted total capacity of 1.06 acre-feet. This stock reservoir could be rehabilitated to provide an additional source of livestock/wildlife water along with restoring function of the wetland and riparian areas. This alternative would include the following features:

- Inspection of the embankment and rehabilitation of problem areas as needed. The embankment is approximately 100 feet long and less than 10 feet high at its highest point. The top-width of the embankment is approximately 10 feet wide.
- Investigation of site-specific soil and geologic conditions to define the extent necessary to excavate existing sediment and to determine if alternatives to bentonite liner treatment should be considered because of karstic bedrock or other conditions of the underlying bedrock formation.
- Installation of an inlet and outlet control mechanism would be used to control reservoir water levels. The installed structures would be stabilized with rock riprap.
- Excavation of the spillway to adequately convey overflow volumes along with stabilization with rock riprap for protection.
- Contingent upon determination of adequate sources of borrow material and rock riprap for dam embankment repairs and spillway stabilization.
- Potential construction options for reducing seepage in small stock ponds and reservoirs include the installation of geotextile liners, bentonite mat liners, or placement of agricultural grade bentonite. Potential options are detailed in the NRCS Construction Specifications for Pond Sealing or Lining (NRCS WY-521A, WY-521C, or WY-521D).
- As delineated, the project involves privately owned lands only.

4.3.33 LW-50A: Brimmer Stock Reservoir Rehabilitation Project

This alternative would provide for the rehabilitation of a stock reservoir and associated wetlands. The existing stock reservoir is located on East Brimmer Creek, a tributary to the Belle Fourche River, within Section 2 of Township 53 North, Range 65 West in Crook County. Currently, the stock reservoir has problems related the dam embankment and outlet facilities and experiences seepage loss of the impounded water behind the embankment.

This alternative includes reconstruction and repair of the breached reservoirs which could provide additional sources of livestock/wildlife water, potential fisheries, along with restoring function of the wetland and riparian areas. This alternative would include the following features:

- Inspection of the embankment and rehabilitation of problem areas as needed. The embankment is approximately 100 feet long and less than 10 feet high at its highest point. The top-width of the embankment is approximately 10 feet wide.
- Investigation of site-specific soil and geologic conditions to define the extent necessary to excavate existing sediment and to determine if alternatives to bentonite liner treatment should be considered because of karstic bedrock or other conditions of the underlying bedrock formation.

- Installation of an inlet and outlet control mechanism would be used to control reservoir water levels. The installed structures would be stabilized with rock riprap.
- Excavation of the spillway to adequately convey overflow volumes along with stabilization with rock riprap for protection.
- Contingent upon determination of adequate sources of borrow material and rock riprap for dam embankment repairs and spillway stabilization.
- Potential construction options for reducing seepage in small stock ponds and reservoirs include the installation of geotextile liners, bentonite mat liners, or placement of agricultural grade bentonite. Potential options are detailed in the NRCS Construction Specifications for Pond Sealing or Lining (NRCS WY-521A, WY-521C, or WY-521D).
- As delineated, the project involves privately owned lands only.

4.3.34 LW-51: Arkansas Creek Wildlife Guzzler and Pond Project

This alternative would involve installing a water harvesting catchment (NRCS Conservation Practice WY-636) or "wildlife guzzler" system and a small pond for supplying water to a portion of the watershed lacking adequate wildlife upland water sources. Under this alternative, the following components would be installed:

- A water harvesting catchment or collection surface, typically made of impervious textured HDPE, corrugated metal sheeting, UV protected plastic sheeting, or fiberglass sheeting would be installed on the ground surface or elevated with a support structure secured and protected by fencing from trampling by wildlife or livestock. A catchment storage tank (1,000-gallon capacity) would be installed underground to collect and store wildlife water.
- From the catchment and storage tank, a buried HDPE low-pressure pipeline would be installed to provide wildlife water for a wildlife guzzler tank and/or integral drinker and overflow pipe. This pipeline would be aligned southerly and require installing 400 linear feet of 2-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 the proposed stock tank.

In addition to the installation of a catchment, storage tank, pipeline, and wildlife guzzler tank/drinker, this alternative would also provide for the construction of a small pond to provide an additional source of wildlife water along with providing associated wetland areas. This alternative would include the following features:

- A small stock pond would have a capacity of less than 1 acre-foot and would be constructed to collect overflow.

- Investigation of site-specific soil and geologic conditions to define the extent necessary to excavate existing sediment and to determine if alternatives to bentonite liner treatment should be considered because of karstic bedrock or other conditions of the underlying bedrock formation.
- As proposed, the project involves private lands only.

4.3.35 LW-56: Kester #1 Spring Development, Pipeline, and Tank Project

This alternative would involve rehabilitating an existing spring and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- The existing spring would be rehabilitated and equipped with collection pipe, spring box, and appurtenances would be installed.
- From the rehabilitated spring, a buried HDPE low-pressure pipeline to two stock tanks (1,200-gallon capacity each) would be installed to provide livestock/wildlife water. This pipeline would be aligned westerly and require installing 1,800 linear feet of 2-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 the proposed stock tank.

4.3.36 LW-57: Kester #2 Spring Development, Pipeline, and Tank Project

This alternative would involve rehabilitating an existing spring and supplying water to a portion of the watershed lacking adequate livestock/wildlife water sources. Under this alternative, the following components would be installed:

- The existing spring would be rehabilitated and equipped with collection pipe, spring box, and appurtenances would be installed.
- From the spring, a buried HDPE low-pressure pipeline to two stock tanks (1,200-gallon capacity each) would be installed to provide livestock/wildlife water. This pipeline would be aligned westerly and require installing 1,800 linear feet of 2-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 the proposed stock tank.

In addition to the rehabilitation of an existing spring, pipeline, and stock tanks, this alternative would also provide for the rehabilitation of a stock pond to provide an additional source of livestock/wildlife water along with providing associated wetland areas. This alternative would include the following features:

- A small stock pond/reservoir would have a capacity of less than 2 acre-feet and would be constructed to collect overflow.
- Investigation of site-specific soil and geologic conditions to define the extent necessary to excavate existing sediment and to determine if alternatives to bentonite liner treatment should be considered because of karstic bedrock or other conditions of the underlying bedrock formation.
- As proposed, the project involves state lands only.

4.4 GRAZING MANAGEMENT OPPORTUNITIES

In Section 3.1.3.5 of Chapter 3.0 and within the basin wide summary report, the ecological sites within the subbasin were presented and the concept of the ESD was discussed. 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.

The ESDs and their associated STMs for the four predominant ESDs that are available within the subbasin were obtained directly from the NRCS and are detailed in the following Sections 4.4.1.1 through 4.4.1.4. The four rangeland ESDs and associated HCPCs and STMs cover approximately 415,397 acres or 46.1 percent of the subbasin. The four predominant rangeland ESDs within the mapped area of the subbasin are likely to be one of the following:

- *R061XY122WY Loamy (Ly) 15–19-inch Black Hills PZ*
- *R061XY162WY Shallow Loamy (SwLy) 15–19-inch Black Hills PZ*
- *R061XY104WY Clayey (Cy) 15–19-inch Black Hills PZ*
- *R061XY158WY Shallow Clayey (SwCy) 15–19-inch Black Hills PZ.*

In addition to the ESDs and the associated STMs, other tools are available to maintain and/or improve watershed function particularly when coupled with implementation of appropriate grazing management strategies. Other components are explained in detail in the Watershed Management and Rehabilitation Plan found in the basin wide summary report. Some of those grazing management components and supporting conservation practices include but are certainly not limited to the following:

- **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-7:** Application of chemicals may be used as a tool to assist in the restoration of range health areas benefitting by this treatment according to the STMs. Delineation of specific areas potentially benefitting from this practice was beyond the scope of this Level I project.

4.4.1 Loamy (Ly) 15–19-Inch Black Hills Precipitation Zone

The most predominant rangeland ecological site in the subbasin is the Loamy (Ly) 15–19-inch Precipitation Zone, Black Hills (R061XY122WY) covering approximately 160,433 acres or 17.8 percent of the subbasin. The STM for the Loamy (Ly) 15–19-inch Precipitation Zone, Black Hills ESD is shown Figure 4.1.

Rhizomatous Wheatgrasses/Needleandthread/Big Bluestem Plant Community

This plant community is the interpretive plant community for this site and is considered to be the HCPC. This plant community evolved with grazing by large herbivores and is well suited for grazing by domestic livestock. This plant community can be found on areas that are properly managed with grazing and/or prescribed burning, and on areas receiving occasional short periods of rest. The potential vegetation is about 75 percent grasses or grass-like plants, 15 percent forbs, and 10 percent woody plants. A mix of warm- and cool-season mid-grasses dominates the state.

The major grasses include western wheatgrass, needleandthread, big bluestem, little bluestem, and green needlegrass. Other grasses occurring on the state include threadleaf sedge, Sandberg bluegrass, bluebunch wheatgrass, blue grama, and sideoats grama. A variety of forbs and half-shrubs also occur, as shown in the preceding table. Big sagebrush is a conspicuous element of this state, occurs in a mosaic pattern, and makes up 5 to 10 percent of the annual production. Plant diversity is high.

The total annual production (air-dry weight) of this state is about 2,200 pounds per acre, but it can range from about 1,500 pounds per acre in unfavorable years to about 3,000 pounds per acre in above average years.

This plant community is extremely stable and well adapted to the Black Hills Foot Slopes 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).

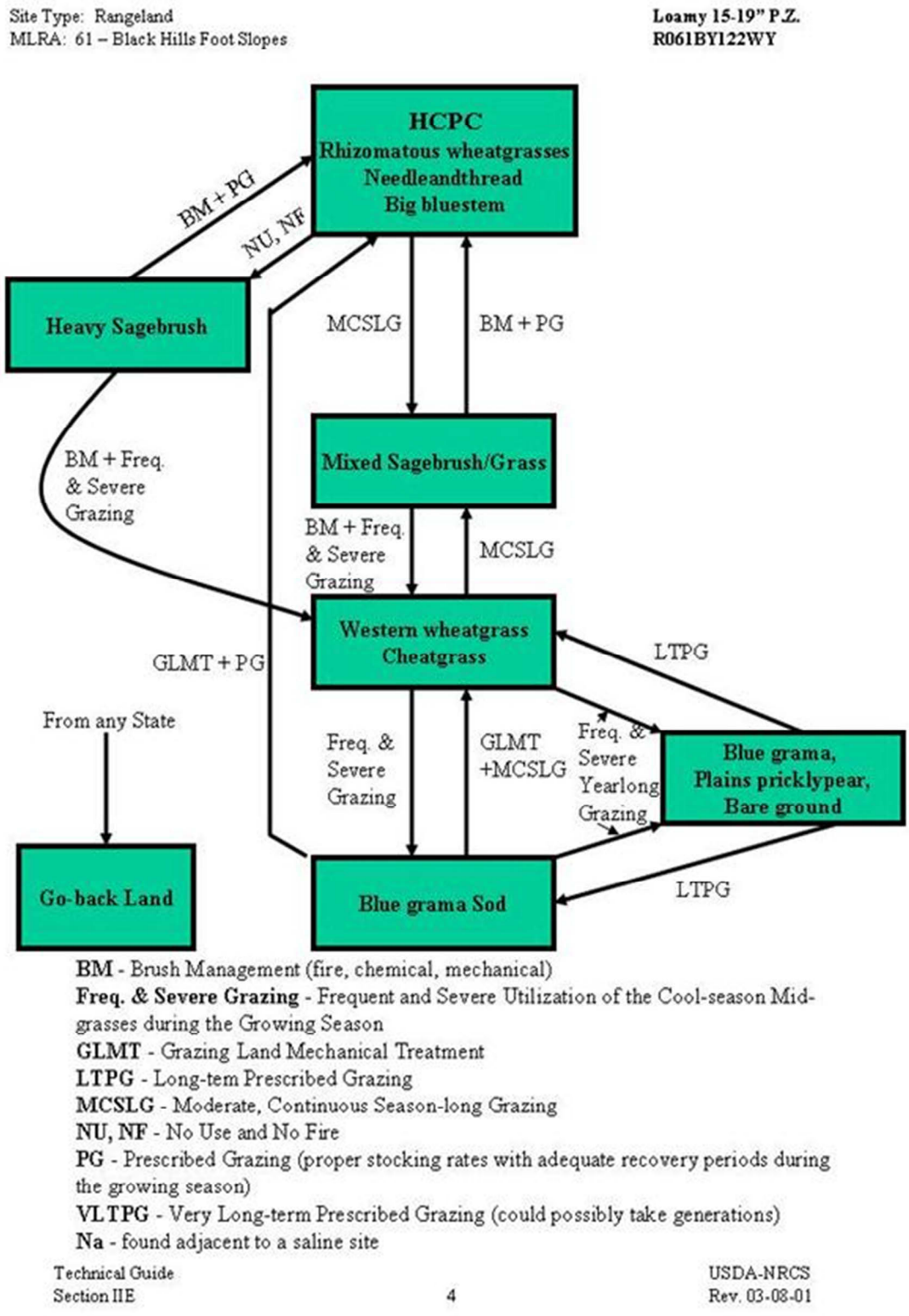


Figure 4.1. State and Transition Model: Loamy (Ly) 15–19-Inch Black Hills Precipitation Zone.

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

- No use and no fire for 20 years or more will convert this plant community to the Heavy Sagebrush Plant Community
- Moderate, continuous season-long grazing will convert the plant community to the Mixed Sagebrush/Grass Plant Community
- When cropped annually and then abandoned without reseeding, the state is converted to the Go-back Land Plant Community.

4.4.2 Shallow Loamy (SwLy) 15–19-Inch Black Hills Precipitation Zone

The second most predominant rangeland ecological site in the subbasin is the Shallow Loamy (SwLy) 15–19-inch Black Hills PZ (R061XY162WY) covering approximately 113,621 acres or 12.6 percent of the subbasin. The STM for the Shallow Loamy (SwLy) 15–19-inch Black Hills PZ ESD is shown Figure 4.2.

Rhizomatous Wheatgrasses/Needleandthread/Blue Grama Plant Community

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 about 80 percent grasses or grass-like plants, 10 percent forbs, and 10 percent woody plants. The state is dominated by cool-season midgrasses.

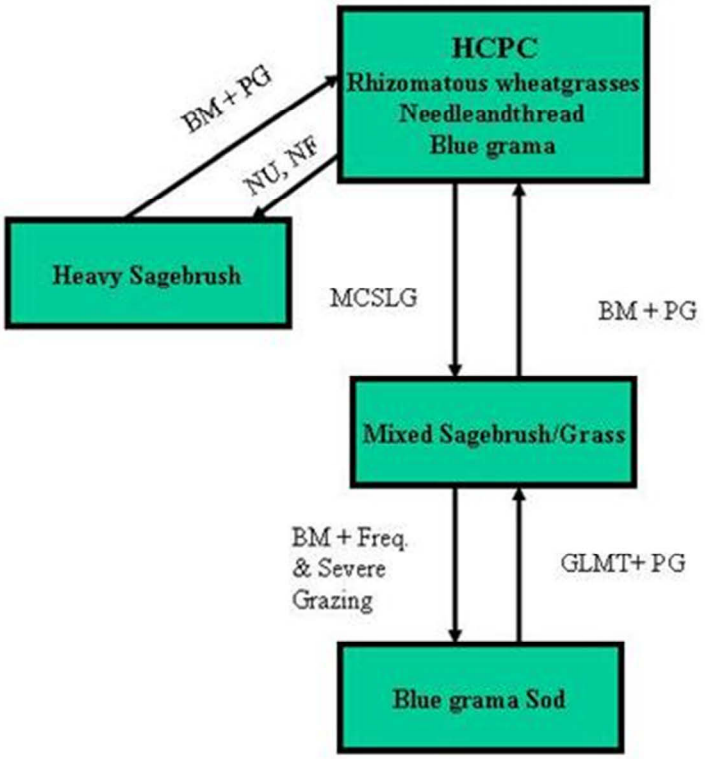
The major grasses include little bluestem, bluebunch wheatgrass, needleandthread, sideoats grama, and western wheatgrass. Other grasses occurring on the state include Sandberg bluegrass, blue grama, plains muhly, spikefescue and prairie junegrass. Big sagebrush is a conspicuous element of this state and occurs in a mosaic pattern. Big sagebrush may become dominant on some areas with absence of fire. Natural fire occurred frequently in this community and prevented big sagebrush from being the dominant landscape. Wildfires are actively controlled in recent times so chemical control using herbicides has replaced the historic role of fire on this state. Recently controlled burning has regained some popularity.

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 1,800 pounds per acre in above average years.

The state is extremely stable and well adapted to the Black Hills Foot Slopes 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).

Site Type: Rangeland
MLRA: 61 – Black Hills Foot Slopes

Shallow Loamy 15-19" P.Z
R061XY162WY



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 4.2. State and Transition Model: Shallow Loamy (SwLy) 15–19-Inch Black Hills Precipitation Zone.

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

- Protection from grazing and fire will convert this plant community to the Heavy Sagebrush Plant Community
- Moderate, continuous season-long grazing will convert the plant community to the Mixed Sagebrush/Grass Plant Community
- Frequent and severe grazing and brush management will convert the plant community to the Blue Grama Plant Community.

4.4.3 Clayey (Cy) 15–19-Inch Black Hills Precipitation Zone

The third most predominant rangeland ecological site in the subbasin is the Clayey (Cy) 15-19-inch Black Hills PZ (R061XY104WY) covering approximately 83,066 acres or 9.2 percent of the subbasin. The STM for the Clayey (Cy) 15–19-inch Black Hills PZ ESD is shown Figure 4.3.

Rhizomatous Wheatgrasses/Green Needlegrass Community

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 about 85 percent grasses or grass-like plants, 10 percent forbs, and 5 percent woody plants. The state is a mix of cool-season midgrasses and warm-season grasses.

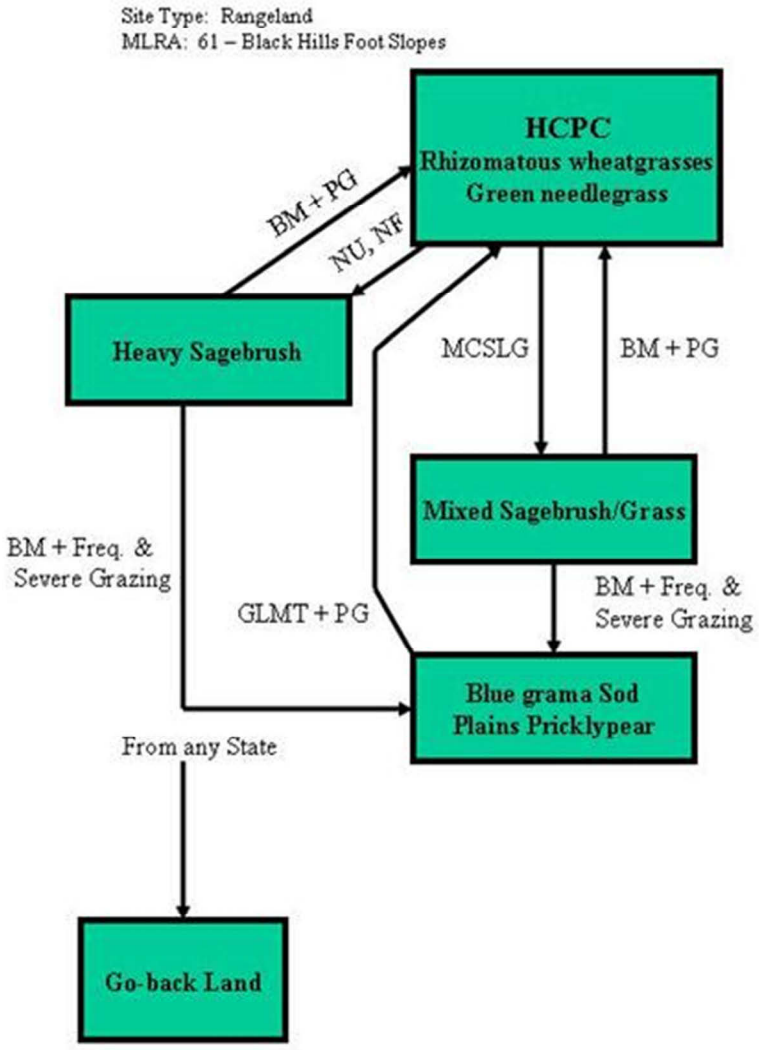
The major grasses include western wheatgrass, big bluestem, sideoats grama, and green needlegrass. Other grasses occurring in this state include Sandberg bluegrass, little bluestem, blue grama, and Fowl bluegrass. Big sagebrush is a conspicuous element of this state, occurs in a mosaic pattern, and makes up 5 to 10 percent of the annual production. Big sagebrush may become dominant on some areas with absence of fire. Natural fire occurred frequently in this community and prevented big sagebrush from being the dominant landscape. Wildfires are actively controlled in recent times so chemical control using herbicides has replaced the historic role of fire on this site. Recently, controlled burning has regained some popularity.

The total annual production (air-dry weight) of this state is about 2,000 pounds per acre, but it can range from about 1,400 pounds per acre in unfavorable years to about 2,900 pounds per acre in above average years.

The state is stable and well adapted to the Black Hills Foot Slopes climatic conditions. The diversity in plant species allow 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:

- Protection from grazing and fire, will convert this plant community to the Heavy Sagebrush Plant Community



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 - Moderate Sodium in Soil

Figure 4.3. State and Transition Model: Clayey (Cy) 15–19-Inch Black Hills Precipitation Zone.

- Moderate, continuous season-long grazing will convert the plant community to the Mixed Sagebrush/Grass Plant Community
- Frequent and severe grazing and Brush Management that eliminates the sagebrush will convert the plant community to the Blue grama/Plains Pricklypear Plant Community
- When cropped annually and then abandoned without reseeding, this state is converted to the Go-back Land Plant Community.

4.4.4 Shallow Clayey (SwCy) 15–19-Inch Black Hills Precipitation Zone

The third most predominant rangeland ecological site in the subbasin is the Shallow Clayey (SwCy) 15–19-inch Black Hills PZ (R061XY158WY) covering approximately 58,277 acres or 6.5 percent of the subbasin. The STM for the Shallow Clayey (SwCy) 15–19-inch Black Hills PZ ESD is shown Figure 4.4.

Rhizomatous Wheatgrasses, Green Needlegrass Plant Community

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 about 75 percent grasses or grass-like plants, 15 percent forbs, and 10 percent woody plants. The state is dominated by cool-season midgrasses.

The major grasses include rhizomatous wheatgrasses, green needlegrass, little bluestem, and bluebunch wheatgrass. Other grasses include Sandberg bluegrass, blue grama, prairie junegrass, and plains reedgrass. Big sagebrush and winterfat are conspicuous elements of this state, occur in a mosaic pattern, and make up 5 to 10 percent of the annual production. Big sagebrush may become dominant on some areas with absence of fire. Natural fire occurred frequently in this community and prevented sagebrush from being the dominant landscape. Wildfires are actively controlled in recent times so chemical control using herbicides has replaced the historic role of fire on this state. Recently, controlled burning has regained some popularity.

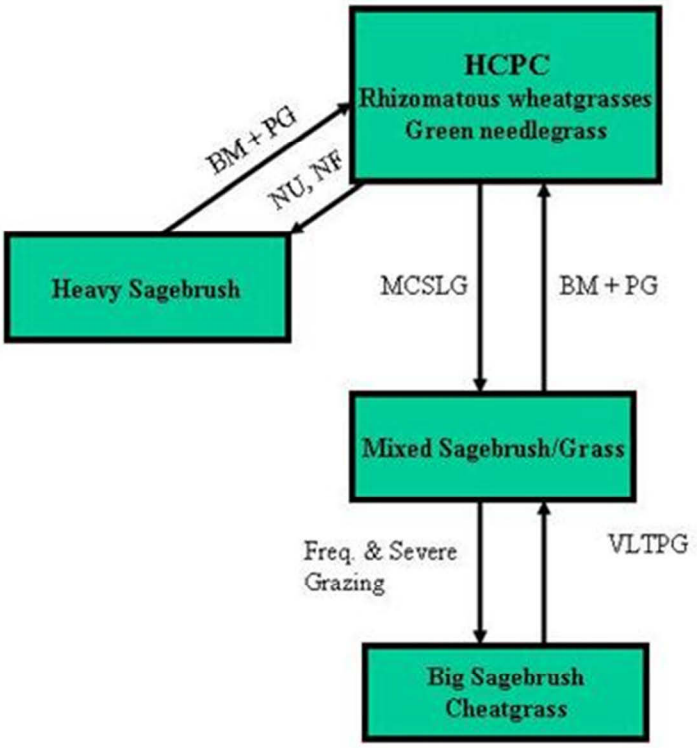
The total annual production (air-dry weight) of this state is about 1,400 pounds per acre, but it can range from about 900 pounds per acre in unfavorable years to about 1,800 pounds per acre in above average years. The state is extremely stable and well adapted to the Black Hills Foot Slopes climatic 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:

- Protection from grazing and fire will convert this plant community to the Heavy Sagebrush Plant Community

Site Type: Rangeland
MLRA: 61 – Black Hills Foot Slopes

Shallow Clayey 15-19" P.Z.
R061XY158WY



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 - Moderate Sodium in Soil

Figure 4.4. State and Transition Model: Shallow Clayey (SwCy) 15–19-Inch Black Hills Precipitation Zone.

- Moderate, continuous season-long grazing will convert the plant community to the Mixed Sagebrush/Grass Plant Community
- Frequent & Severe season-long grazing will convert the plant community to the Big sagebrush/Cheatgrass Plant Community.

4.5 SURFACE WATER STORAGE OPPORTUNITIES

Investigations to identify large water storage reservoirs within the watershed have been the subject of several past studies and are summarized in the basin wide summary report. Landowners and water users identified problems with several existing reservoirs and associated facilities that limited the potential to store water in these facilities. Additionally, participants identified potential sites and possible opportunities for water storage facilities within the subbasin. Accordingly, site visits and initial reviews were conducted on some of the stock ponds, stock reservoirs, storage reservoirs, and previously proposed sites identified by participants.

A "long list" of ten potential surface water storage sites were identified within the study area and included in the basin wide summary report. From the "long list," seven sites are located within the subbasin and are listed in Table 4.3. These alternatives involve rehabilitation and/or enlargement of existing facilities and construction of a new facility and are described in Section 4.2.1 through 4.2.13.

Table 4.3. Potential Storage Project Sites Identified Within the Subbasin

Item Number	Potential Storage Project Site	Potential and Project Alternative Type
S-02	S-02: Driskill #1 Reservoir	Rehabilitation and Enlargement
S-04	S-04: Pine (Deep) Creek Reservoir (2B)	Rehabilitation and Enlargement
S-05	S-05: Oak Creek Reservoir (2A)	Rehabilitation and Enlargement
S-06	S-06: Horse Creek	New
S-07	S-07: Newland #4 Reservoir	Rehabilitation
S-08	S-08: Christofferson Draw	Rehabilitation and Enlargement
S-09	S-09: Mule Shoe Reservoir	Rehabilitation and Enlargement

However, four sites (S-02: Driskill #1 Reservoir, S-04: Pine (Deep) Creek Reservoir (2B), S-05: Oak Creek Reservoir (2A), and S-06: Horse Creek) were included in the "short list" of potential sites that could provide substantial storage opportunities separate from those sites with minimal volumes, rehabilitation needs, or solely provide livestock/wildlife water. The short list of potential sites is discussed in more detail within the basin wide summary report along

with the initial screening of these alternatives. Relevant information was collected about the potential sites to provide an initial screening of these alternatives based on environmental, hydrologic, geologic, potential benefits, costs, and other data. The information was organized in the Reservoir Evaluation Matrix presented in the basin wide summary report.

4.5.1 S-02: Driskill #1 Reservoir

The Driskill #1 Reservoir is located on Lytle Creek near Devils Tower, Wyoming. The reservoir and dam are located on Lytle Creek, a tributary to the Belle Fourche River, and is within the Subbasin below Keyhole Reservoir. The reservoir is located in Section 16 of Township 53 North, Range 65 West in Crook County. The reservoir was permitted in 1976 (Permit No. P8232R) with a total capacity of 104.59 acre-feet. The reservoir's inlet and spillway structures are shown in Figure 4.5 and Figure 4.6.

RSI-2264-14-108

Figure 4.5. A View of Driskill #1 Reservoir's Inlet Structure.

This reservoir and alternatives storage sites were studied in 1999 and reported in the *Final Report Crook County Reservoir Project Level I* [ESA Consultants Inc., 1999], and then was evaluated in 2006 and included in the *Crook County Reservoirs and Water Management Study – Level I* [Short Elliot Hendrickson Inc., 2006]. This alternative includes conclusions from Alternative 3 of ESA Consultants Inc. [1999] and Short Elliot Hendrickson Inc. [2006] and is shown in Figure 4.7. Alternative 3/1B includes the potential to construct a moderate size

reservoir located on Lytle Creek as a 1,000 acre-foot option. This alternative was previously studied and was assumed that this storage would serve a portion of the existing supplemental irrigation needs in the lower portion of the study area rather than irrigation of new acreage. This dam and reservoir were sized to comply with the Belle Fourche River Compact limitation of storage capacity for new reservoirs.

RSI-2264-14-108

Figure 4.6. A View of Driskill #1 Reservoir's Emergency Spillway.

The design for Alternative 3 described in ESA Consultants Inc. [1999] was assumed, and the associated cost escalated to 2006 dollars in Short Elliot Hendrickson Inc. [2006]. These costs were not updated for the purposes of this study effort. This alternative had key factors influencing the previously completed conceptual design and estimated costs and included the site's anticipated geological conditions, flood hydrology, associated spillway sizing, land ownership, access considerations, and permitting/environmental constraints and mitigation [Short Elliot Hendrickson Inc., 2006]. A number of technical issues have been identified that may significantly impact the feasibility and cost of this alternative including the number of irrigated acres and CCID members served, Sundance and/or Gypsum geologic conditions, marginal foundational strength, and known cultural resource sites [Short Elliot Hendrickson Inc., 2006].

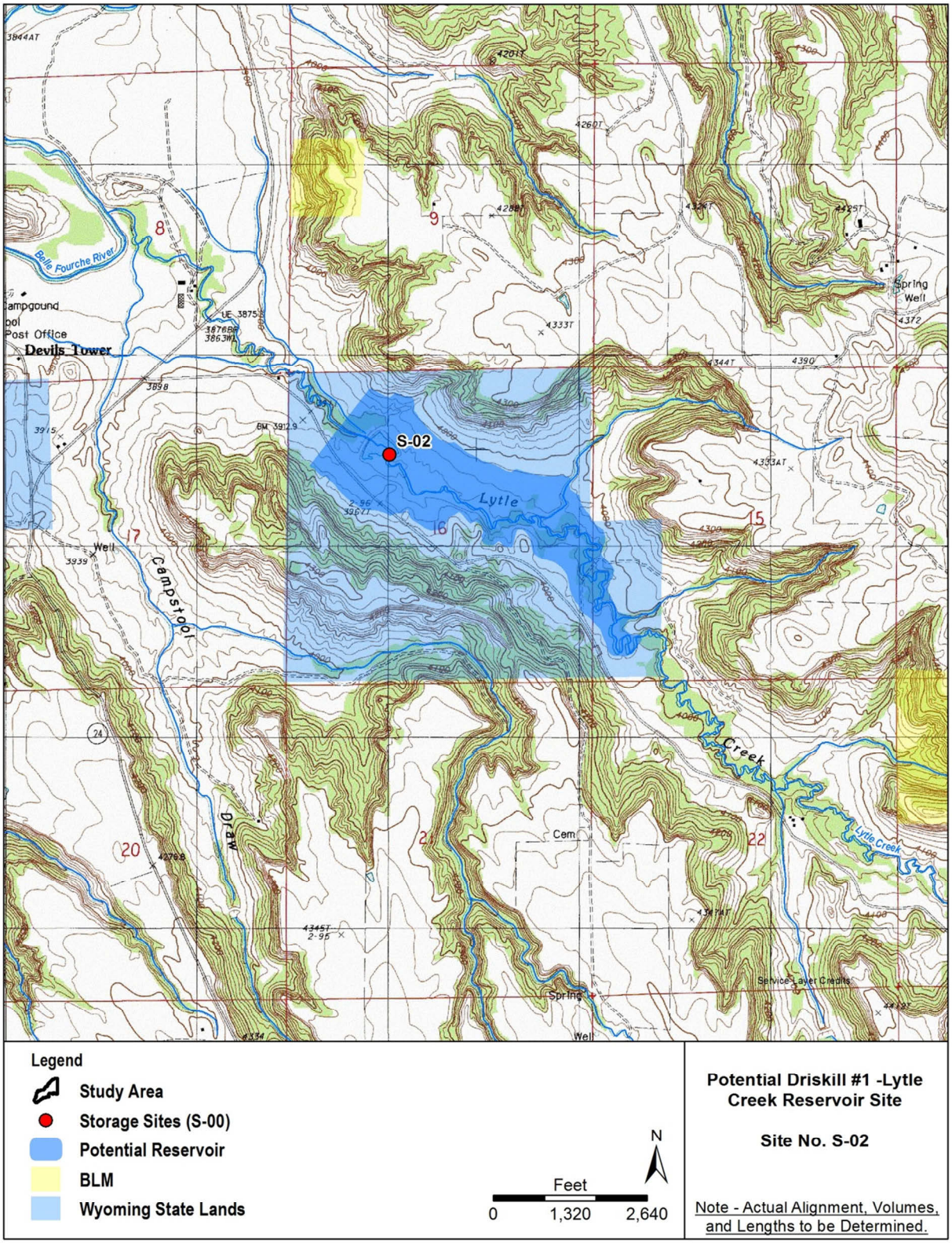


Figure 4.7. Map of the S-02: Driskill #1 Reservoir Storage Site on Lytle Creek.

4.5.2 S-04: Pine (Deep) Creek Reservoir (2B)

The Pine Creek Reservoir storage site is located on Deep Creek, a tributary to the Belle Fourche River, and is within the Subbasin below Keyhole Reservoir. The site is located in Section 4 of Township 55 North, Range 61 West in Crook County. Although no permit information was available for the breached structure, the site was studied as Alternative 2B – Pine Creek in the *Crook County Reservoirs and Water Management Study – Level I* [Short Elliot Hendrickson Inc., 2006]. A view looking upstream from the existing breached dam structure at this site is shown in Figure 4.8. Also, a view of the existing breached dam is shown in Figure 4.9.

RSI-2264-14-108

Figure 4.8. A View Looking Upstream From Pine (Deep) Creek Reservoir's Breached Dam.

This alternative includes conclusions from Alternative 2B of the *Final Report Crook County Reservoirs and Water Management Study – Level I* and a map of the alternative site is shown in Figure 4.10. Approximately 55 percent of the existing dry year shortage on irrigated are along the Belle Fourche River occurs below the confluence of Pine (Deep) Creek [Short Elliot Hendrickson Inc., 2006]. Pine Creek has approximately 1,200 acre-feet of available annual flows in normal years [Short Elliot Hendrickson Inc., 2006].

Alternative 2B includes the potential to construct a moderate size reservoir located on Pine Creek to minimize conveyance losses and serve a portion of the existing supplemental irrigation needs and possibly deliver irrigation water to approximately 340 acres of potential new irrigable

ground [Short Elliot Hendrickson Inc., 2006]. However, the current water shortages are experienced by 2 of the 17 CCID members [Short Elliot Hendrickson Inc., 2006]. A single large reservoir at this site or Oak Creek may result in the need for a more expensive full probable maximum flood (PMF) spillway, which would probably increase costs and offset any benefits from the economy of scale by constructing just one reservoir [Short Elliot Hendrickson Inc., 2006].

RSI-2264-14-108

Figure 4.9. A View of Pine (Deep) Creek Reservoir's Breached Dam.

Additionally, a portion of the Pine Creek site is possibly underlain by Skull Creek Shale, which warrants caution since the formation is relatively weak and soft where weathered near surface and thus require more detailed investigations to determine whether or not this site could support construction of a roller-compacted concrete (RCC) gravity dam [Short Elliot Hendrickson Inc., 2006]. Another potential problem at this site is the presence of highly erodible, friable Newcastle sandstone in the lower right abutment of the existing structure, which resulted in severe, erosional downcutting in an unlined spillway and would require protection against piping if the material were used in constructing an earthen dam [Short Elliot Hendrickson Inc., 2006]. The cost of this alternative was estimated in 2006 dollars in the *Crook County Reservoirs and Water Management Study – Level I* and were not updated for this study.

Figure 4.10. Map of the S-04: Pine (Deep) Creek Reservoir Storage Site.

4.5.3 S-05: Oak Creek Reservoir (2A)

The Oak Creek Reservoir is located on Oak or Alum Creek near the Wyoming-South Dakota state line. The reservoir and dam are located on Oak or Alum Creek, a tributary to the Belle Fourche River, and is within the Subbasin below Keyhole Reservoir. The reservoir is located in Section 18 of Township 55 North, Range 60 West in Crook County. The reservoir was permitted in 1975 (Permit No. P7668R) with a total capacity of 914.77 acre-feet. The reservoir is shown in Figure 4.11 and an irrigation ditch below the reservoir in shown in Figure 4.12.

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Figure 4.11. A View of Oak Creek Reservoir.

This site was studied as Alternative 2A – Oak Creek in the *Crook County Reservoirs and Water Management Study – Level I* [Short Elliot Hendrickson Inc., 2006]. This alternative includes conclusions from Alternative 2A of Short Elliot Hendrickson Inc. [2006] and a map of the alternative site is shown in Figure 4.13. Approximately 20 percent of the existing dry year shortage on irrigated are along the Belle Fourche River occurs below the confluence of Oak Creek [Short Elliot Hendrickson Inc., 2006]. Pine Creek has approximately 1,500 acre-feet of available annual flows in normal years [Short Elliot Hendrickson Inc., 2006].

Alternative 2B includes the potential to enlarge the reservoir located on Oak Creek to minimize conveyance losses and serve a portion of the existing supplemental irrigation needs and possibly deliver irrigation water to approximately 230 acres of potential new irrigable ground [Short Elliot Hendrickson Inc., 2006]. However, the current water shortages are experienced by 1 of the 17 CCID members [Short Elliot Hendrickson Inc., 2006]. Similar to the

Pine Creek site, a single large reservoir on Oak Creek may result in the need for a more expensive full (PMF) spillway, which would probably increase costs and offset any benefits from the economy of scale by constructing just one reservoir [Short Elliot Hendrickson Inc., 2006].

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Figure 4.12. A View of a Downstream Irrigation Ditch From Oak Creek Reservoir.

Additionally, the Oak Creek site is underlain by Skull Creek Shale, which warrants caution since the formation is relatively weak and soft where weathered near surface and thus require more detailed investigations to determine whether or not this site could support construction of an RCC gravity dam. Another potential issue that needs more investigation is the possible presence of weak layers, such as bentonitic claystone or clay, in the foundation because if these layers are present at depths in the foundation too deep to economically remove, but shallow enough to be impacted by the load of either an earthen or RCC dam could induce foundation and dam instability. Furthermore, as part of any future in-depth investigation, this site should be checked for the presence of gypsiferous interbeds or gypsum-enriched units which could be problematic, especially if used as a source of impervious fill for the dam or embankment [Short Elliot Hendrickson Inc., 2006]. The cost of this alternative was estimated in 2006 dollars in Short Elliot Hendrickson Inc. [2006], and was not updated for this study effort.

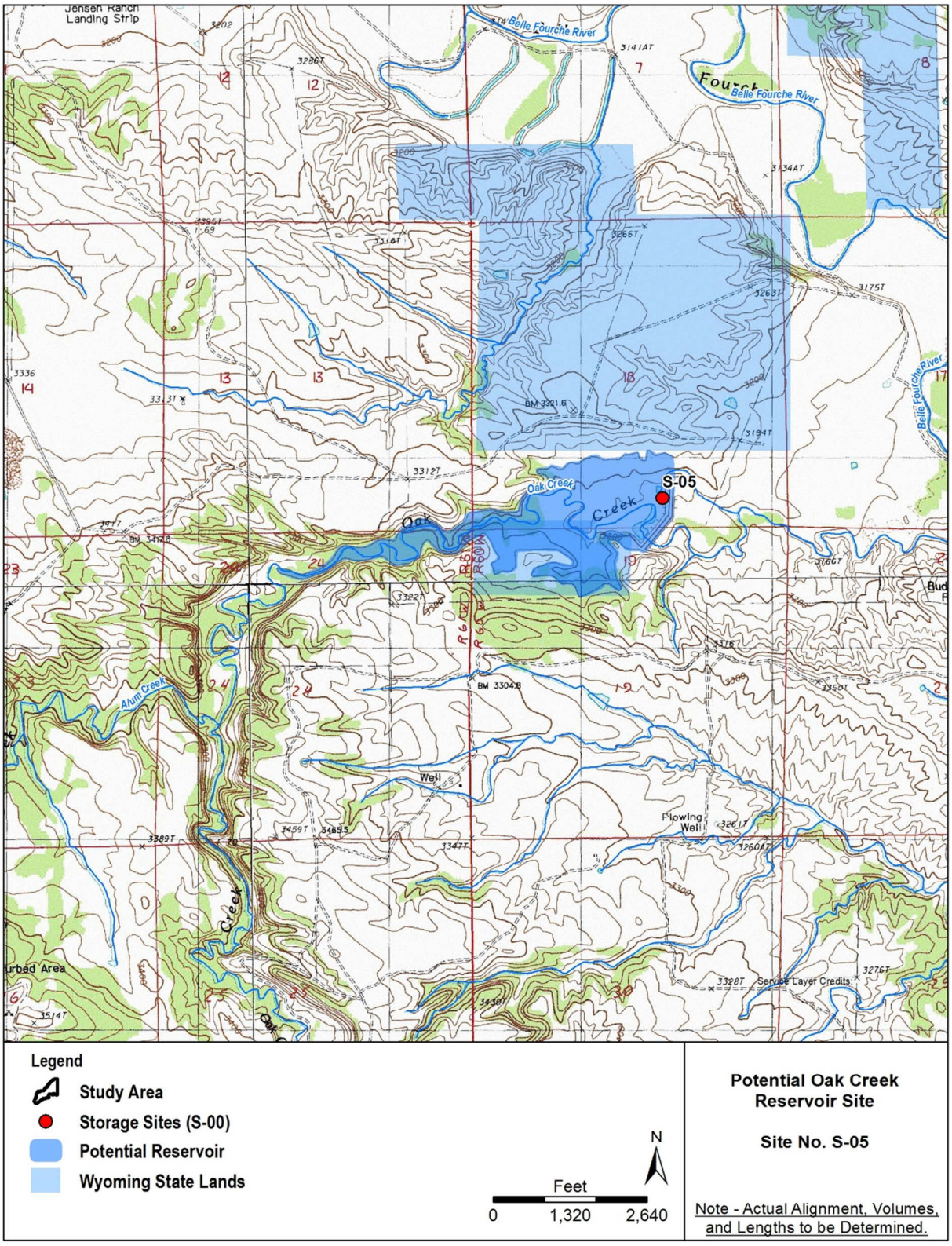

Figure 4.13. Map of the S-05: Oak Creek Reservoir Storage Site.

4.5.4 S-06: Horse Creek

The Horse Creek storage site is located on Horse Creek, a tributary to the Belle Fourche River, and is within the Subbasin below Keyhole Reservoir. The site is located in Section 24 of Township 56 North, Range 62 West in Crook County. A view of the site is shown in Figure 4.14. The site is located approximately 7 miles south of Colony, Wyoming, on private lands, as illustrated in Figure 4.15. This alternative would involve construction of a new reservoir at this site, thus requiring an investigation of geologic structure and identification of permitting requirements.

RSI-2264-14-108

Figure 4.14. A View Looking Downstream of the Horse Creek Storage Site.

This alternative is limited to storage provided by Horse Creek which was estimated to be approximately 514 acre-feet of available annual flows in normal years [Short Elliot Hendrickson Inc., 2006]. This site is estimated to have similar available annual flows as the existing 55-acre Kilpatrick Reservoir located downstream on Kilpatrick Creek. It is assumed that this alternative storage site would serve a portion of the existing supplemental irrigation needs in the lower portion of the study area and would be sized to comply with the Belle Fourche River Compact limitation of storage capacity for new reservoirs. However, this site is similar to others since the current water shortages are experienced by 2 of the 17 CCID members [Short Elliot Hendrickson Inc., 2006]. Additionally, coordination with the WWDO and SEO should be conducted before proceeding with any future work because of the constraints regarding the Belle Fourche River Compact. Lastly, this potential site's reservoir embankment and storage pool could be entirely contained within private lands owned by a single parcel owner; as mapped in Figure 4.15.

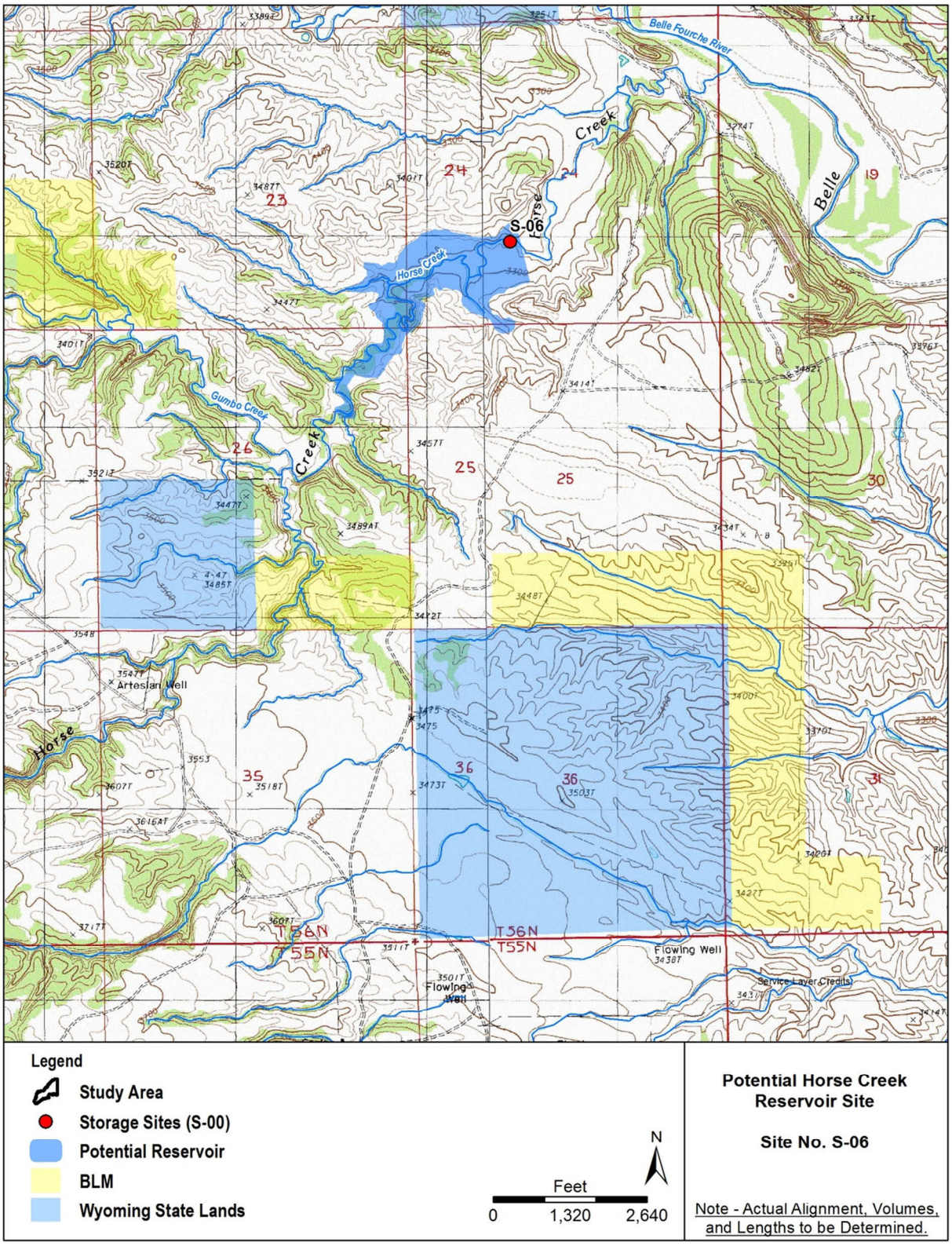

Figure 4.15. Map of the S-06: Horse Creek Storage Site.

4.5.5 S-07: Newland #4 Reservoir

Newland #4 Reservoir, is located on Cow Creek, an intermittent tributary to Iron Creek, which is also an intermittent tributary to the Belle Fourche River. The Newland #4 Reservoir is located in Section 36 of Township 57 North, Range 62 West in Crook County. The reservoir was permitted in 1954 (Permit No. P6205R) with a capacity of 53.45 acre-feet. This alternative would provide for either relocation onto Iron Creek or the rehabilitation of the existing reservoir facilities, and associated wetland and riparian areas. A view of the reservoir and dam is shown in Figure 4.16 and a map of the potential relocation site on Iron Creek is shown in Figure 4.17.

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Figure 4.16. A View of Newland #4 Reservoir Dam.

The alternative involving rehabilitation of the existing reservoir facilities includes installation of an inlet and outlet pipe control structure in the embankment and stabilizing the installed structures and spillway with rock riprap. This reservoir could be rehabilitated to provide an additional source of livestock and wildlife water along with restoring function of the associated wetland and riparian areas. The reservoir's embankment is approximately 589 feet long and 21 feet high at its highest point with an embankment volume of approximately 6,564 cubic yards. The existing reservoir is located entirely on state of Wyoming land but the relocated and/or enlarged facility would involve state of Wyoming and private lands as shown in Figure 4.17.

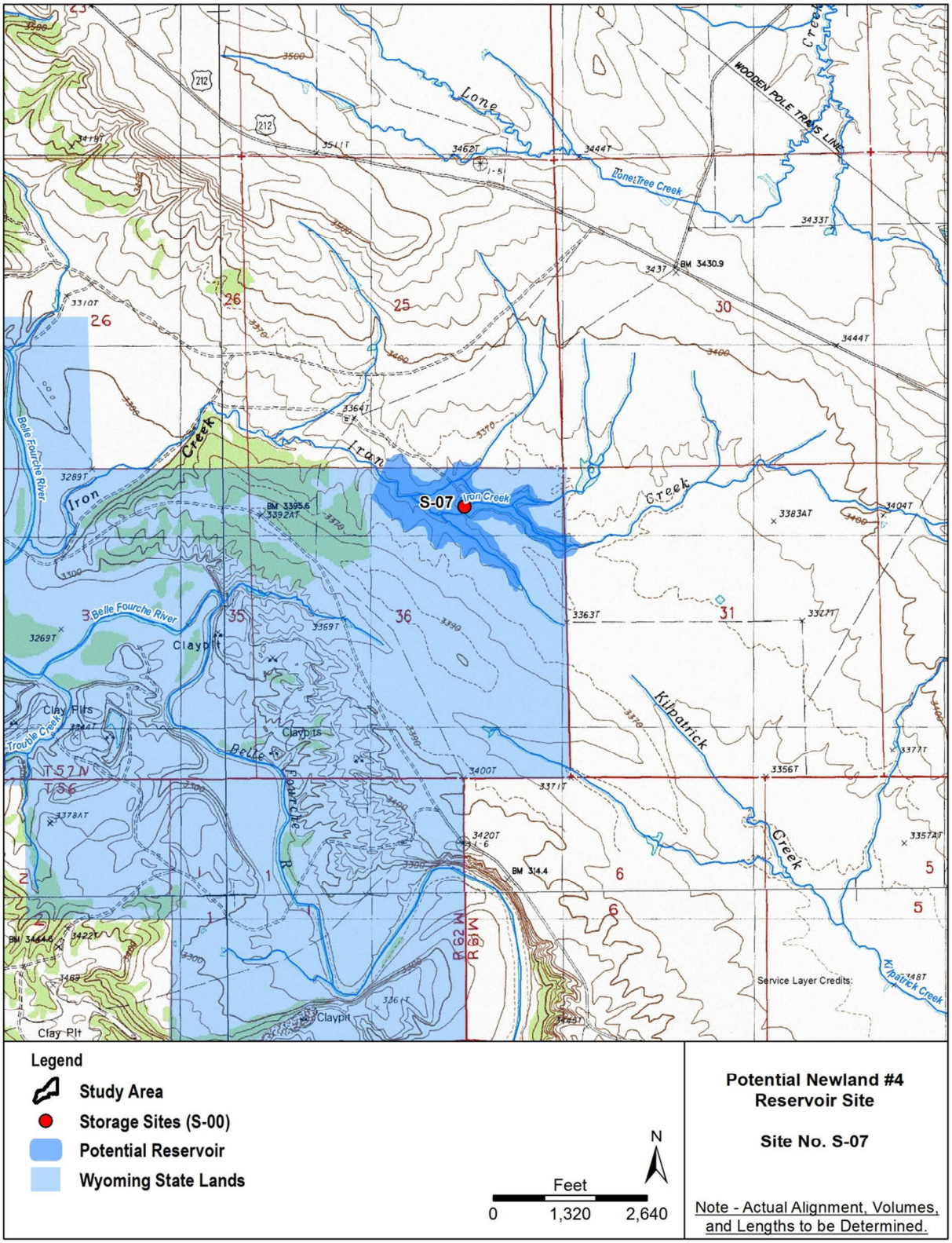

Figure 4.17. Map of the S-07: Newland #4 Reservoir Storage Site.

4.5.6 S-08: Christofferson Draw

The Christofferson Draw storage site is located on Christofferson Draw, a tributary to the Belle Fourche River, and is within the Subbasin below Keyhole Reservoir. The site is located in Section 13 of Township 56 North, Range 62 West in Crook County. A view looking upstream from the existing breached dam is shown in Figure 4.18. The site is located approximately 6.3 miles south of Colony, Wyoming, on private lands, as illustrated in Figure 4.19. This alternative would involve construction of a new reservoir at this site, thus requiring a detailed investigation of geologic structure and identification of permitting requirements. An existing breached dam structure is present at the site.

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Figure 4.18. A View Upstream of the Breached Dam at the Christofferson Draw Storage Site.

This alternative is limited to storage provided by Christofferson Draw, which is an intermittent stream throughout much of its drainage area. Since storage opportunities are limited for this site, this alternative may only involve construction of a new reservoir facility to provide an additional source of livestock and wildlife water along with restoring function of the associated wetland and riparian areas. Any future investigations within the lower portion of the study area should include a preliminary investigation into whether an indirect source of water could be supplied from the Belle Fourche River to this site as an off-channel alternative. Additionally, coordination with the WWDO and SEO should be conducted before proceeding with any future work because of the constraints regarding the Belle Fourche River Compact. The existing breached reservoir is located entirely on state of Wyoming land but a newly constructed reservoir and/or enlarged facility would involve state of Wyoming and privately owned lands as shown in Figure 4.19.

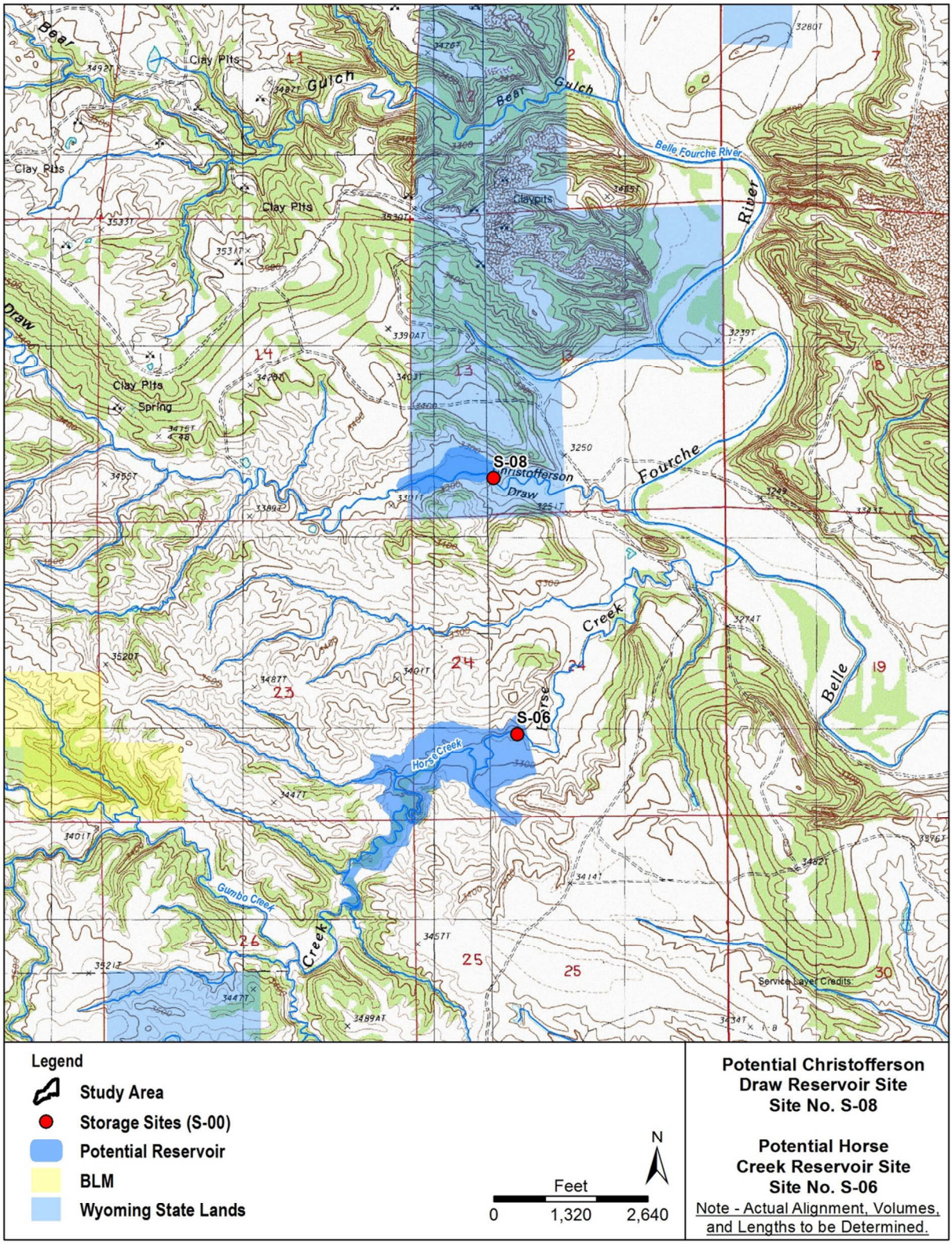

Figure 4.19. Map of the S-08: Christofferson Draw Storage Site.

4.5.7 S-09: Mule Shoe

The Mule Shoe storage site is located on an unnamed, intermittent tributary to the Belle Fourche River, and is within the Subbasin below Keyhole Reservoir. The site is located in Section 32 of Township 56 North, Range 61 West in Crook County. A view looking upstream from the existing breached dam is shown in Figure 4.20. The site is located approximately 8.1 miles south of Colony, Wyoming, on private lands, as illustrated in Figure 4.21. This alternative would involve construction of a new reservoir at this site, thus requiring a detailed investigation of geologic structure and identification of permitting requirements. An existing breached dam structure is present at the site.

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Figure 4.20. A View Looking Upstream From the Breached Dam at the Mule Shoe Storage Site.

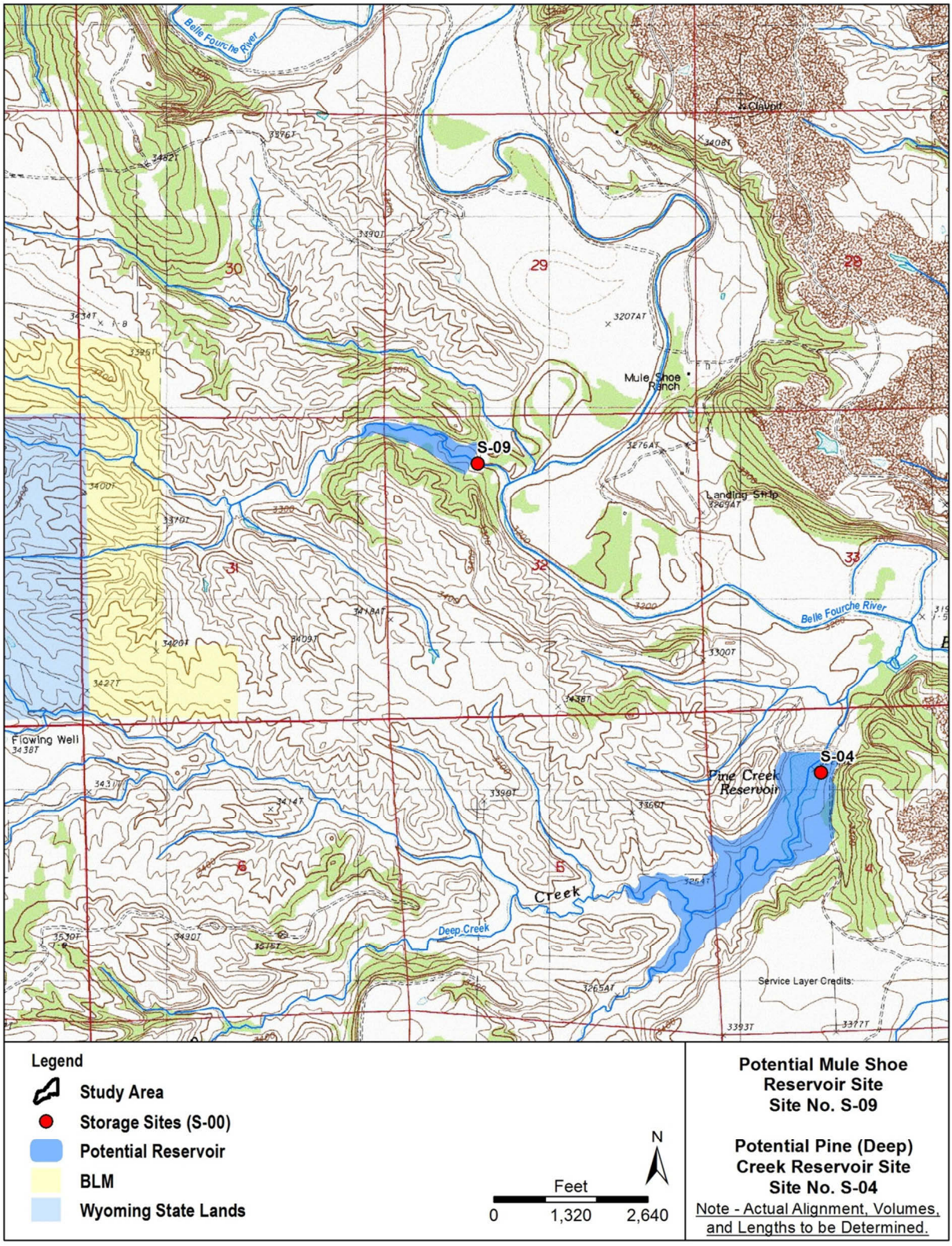

Figure 4.21. Map of the S-09: Mule Shoe Storage Site.

5.0 PERMITS

5.1 PERMITS, CLEARANCES, AND APPROVALS

Information regarding the initial permitting and regulatory process for the proposed projects outlined in Chapter 4.0 of this report are contained within the basin wide summary report. Some of the proposed projects and future potential projects described in this study involving federal lands, funding, and programs are subject to the National Environmental Policy Act (NEPA) and other federal regulations, which requires coordination with the possibly several federal agencies. Coordination with state agencies may also be required depending on project locations and activities. Local ordinances and permits may be needed depending on the specific town, city, and/or county where the project is located. Right-of-way access is also required from the Wyoming Department of Transportation (WYDOT), utility entities, and energy companies when projects involve those properties. And finally, the state of Wyoming's "Wyoming Underground Facilities Notification Act" requires that before any excavation begins, the excavator is required to provide advance notice to the One-Call of Wyoming Notification Center at 811 (or if calling from out-of-state, 1.800.849.2476) [Wyoming State Legislature, 2013].

5.2 PROPOSED, THREATENED, AND ENDANGERED SPECIES

Two species have the potential to occur on proposed project areas within the subbasin: Endangered: Black-footed ferret (*Mustela nigripes*) and Threatened: Grizzly Bear (*Ursus arctos arctos*) [Wyoming Natural Diversity Database, 2014].

5.3 OTHER SPECIES OF CONCERN

The WYNDD records and maintains a list of animal and plant species in Wyoming that are thought to be rare or sensitive and included in Sections 5.2 and 5.3 of this report. 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. 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. No core areas for sage-grouse are located within the subbasin as shown in Figure 3.14.

5.4 LAND OWNERSHIP AND PROPERTY OWNERS

Permission should be negotiated for easements, right-of-way access for all construction activities associated with a project. **Note that the WWDC has stated that lands will NOT**

be “taken” or condemned to construct projects recommended within the watershed management plan. WWDC representatives 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 in Tables 6.1 and 6.2, representing 2014 dollars, are explained in the basin wide summary report for each of the proposed project categories. However, cost estimates for surface water storage sites and alternatives were not adjusted for this study and represent values reported in the final reports. For each storage site, a conceptual layout of the reservoir pool was prepared in the study's GIS from previous study reports and using USGS topographic mapping. The reservoir layouts were primarily used to determine areas of attributes affected at the site and were used in the initial screening of the potential sites. Costs were estimated and extrapolated using the values previously stated for these alternatives and reported in the *Final Report Crook County Reservoir Project Level I* [ESA Consultants Inc., 1999] and the *Crook County Reservoirs and Water Management Study – Level I* [Short Elliot Hendrickson Inc., 2006]. The previous reported estimated costs represent 2006 dollars and were not adjusted for the purpose of this study.

Table 6.1. Irrigation Cost Estimates

Rehabilitation Item Number	Priority	Pipeline less than or equal to 12" diameter	Pipeline greater than 12" diameter	Structure for Water Control Medium	Structure for Water Control Large	Regulating Reservoir	Pumping Plant	Calculated Costs	Construction Costs	Engineering Costs (10%)	Construction & Engineering Subtotal	Contingency (15%)	Total Construction Costs	Final Plans and Specs	Permits, Fees, Access	Total Project Costs
I-03	1	4,880	7,040	1	1	1	1	$278,856	$278,856	$27,886	$306,742	$46,011	$352,753	$3,500	$3,500	$359,753
I-03A/B	3	1,300		1			2	$50,320	$50,320	$5,032	$55,352	$8,303	$63,655	$3,500	$3,500	$70,655
I-05	3							TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
I-06	3	7,670			1			$113,168	$113,168	$11,317	$124,485	$18,673	$143,158	$2,000	$2,000	$147,158
I-07	2							TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
I-08	2	4,510		1				$67,723	$67,723	$6,772	$74,495	$11,174	$85,670	$2,000	$2,000	$89,670
I-09	3	2,470			1			$49,208	$49,208	$4,921	$54,129	$8,119	$62,248	$3,500	$3,500	$69,248
I-10	3	4,760		3			1	$106,338	$106,338	$10,634	$116,972	$17,546	$134,518	$2,000	$2,000	$138,518
I-11	3	4,540			1			$74,669	$74,669	$7,467	$82,136	$12,320	$94,456	$2,000	$2,000	$98,456
I-12	3	1,820			1		1	$52,253	$52,253	$5,225	$57,478	$8,622	$66,100	$2,000	$2,000	$70,100
I-13	3							TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
I-14	3	8,920		1	1			$140,793	$140,793	$14,079	$154,872	$23,231	$178,103	$2,000	$2,000	$182,103
I-15	2	6,800		2				$108,140	$108,140	$10,814	$118,954	$17,843	$136,797	$3,500	$3,500	$143,797

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

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 ($)	Total Project Costs ($)
10	LW-10	Whitelaw Solar Pump and Storage Tank	1	$13,300	$1,330	$14,630	$2,195	$16,825	$2,000	$2,000	$20,825
11	LW-10A	Divide Allotment Pipeline and Tank	2	$29,850	$2,985	$32,835	$4,925	$37,760	$2,000	$2,000	$41,760
25	LW-23	Corral Creek #1 Well, Pipeline, and Tank	1	$87,400	$8,740	$96,140	$14,421	$110,561	$2,000	$2,000	$114,561
26	LW-24	Alvin Creek Pipeline and Tank	2	$15,200	$1,520	$16,720	$2,508	$19,228	$2,000	$2,000	$23,228
27	LW-25	Corral Creek #2 Well, Pipeline, and Tank	2	$51,950	$5,195	$57,145	$8,572	$65,717	$2,000	$2,000	$69,717
28	LW-26	Corral Creek #3 Spring Development, Pipeline, Tank	3	$36,250	$3,625	$39,875	$5,981	$45,856	$2,000	$2,000	$49,856
29	LW-27	Eggie Basin Pipeline and Tank	1	$31,850	$3,185	$35,035	$5,255	$40,290	$2,000	$2,000	$44,290
30	LW-28	Pine Ridge Well, Pipeline, and Tank	3	$62,300	$6,230	$68,530	$10,280	$78,810	$2,000	$2,000	$82,810
31	LW-29	Little Draw #1 Well, Pipeline, and Tank	3	$41,200	$4,120	$45,320	$6,798	$52,118	$2,000	$2,000	$56,118
32	LW-30	Alma Stock Reservoir	2	$25,000	$2,500	$27,500	$4,125	$31,625	$3,500	$3,500	$38,625
33	LW-31	Lower Alma Stock Reservoir	2	$25,000	$2,500	$27,500	$4,125	$31,625	$3,500	$3,500	$38,625
34	LW-32	Mikel Creek Well, Pipeline, and Tank	3	$41,200	$4,120	$45,320	$6,798	$52,118	$2,000	$2,000	$56,118
35	LW-33	Little Draw #2 Well, Pipeline, and Tank	1	$59,150	$5,915	$65,065	$9,760	$74,825	$2,000	$2,000	$78,825
41	LW-37	Little Wright Draw Well, Pipeline, and Tank	1	$78,000	$7,800	$85,800	$12,870	$98,670	$2,000	$2,000	$102,670
42	LW-38	Busby Draw Well, Pipeline, and Tank	2	$41,200	$4,120	$45,320	$6,798	$52,118	$2,000	$2,000	$56,118
43	LW-39	Wolfe Draw Pipeline and Tank	2	$23,300	$2,330	$25,630	$3,845	$29,475	$2,000	$2,000	$33,475
44	LW-40	Kruger #1 Well and Pipeline	1	$36,050	$3,605	$39,655	$5,948	$45,603	$2,000	$2,000	$49,603
45	LW-41	Kruger #2 Pipeline and Tank	2	$63,700	$6,370	$70,070	$10,511	$80,581	$2,000	$2,000	$84,581
46	LW-42	Kruger #3 Pipeline and Tank	2	$76,750	$7,675	$84,425	$12,664	$97,089	$2,000	$2,000	$101,089
47	LW-42A	Oak Creek Well, Pipeline, and Tank	2	$73,500	$7,350	$80,850	$12,128	$92,978	$2,000	$2,000	$96,978
48	LW-43	Kilpatrick Creek Pipeline and Tank	3	$70,450	$7,045	$77,495	$11,624	$89,119	$2,000	$2,000	$93,119
49	LW-44	Newland #4 Stock Reservoir	1	$25,000	$2,500	$27,500	$4,125	$31,625	$3,500	$3,500	$38,625
50	LW-44A	Iron Creek Well, Pipeline, and Tank	3	$41,200	$4,120	$45,320	$6,798	$52,118	$2,000	$2,000	$56,118
51	LW-45	Sawmill Well, Tank, and Stock Pond	1	$66,200	$6,620	$72,820	$10,923	$83,743	$2,000	$2,000	$87,743
52	LW-46	Bear Gulch Well, Pipeline, and Tank	2	$66,200	$6,620	$72,820	$10,923	$83,743	$2,000	$2,000	$87,743
53	LW-46A	Bear Stock Reservoir	3	$25,000	$2,500	$27,500	$4,125	$31,625	$3,500	$3,500	$38,625
54	LW-46B	Bear Gulch Stock Reservoir	3	$25,000	$2,500	$27,500	$4,125	$31,625	$3,500	$3,500	$38,625
55	LW-47	Shield Stock Reservoir	3	$25,000	$2,500	$27,500	$4,125	$31,625	$3,500	$3,500	$38,625
56	LW-47A	Left Creek Stock Reservoirs	3	$25,000	$2,500	$27,500	$4,125	$31,625	$3,500	$3,500	$38,625
57	LW-48	Left Creek Spring Development, Pipeline, Tank	2	$12,650	$1,265	$13,915	$2,087	$16,002	$2,000	$2,000	$20,002
58	LW-49	Vines Draw Well, Pipeline, and Tank	3	$66,200	$6,620	$72,820	$10,923	$83,743	$2,000	$2,000	$87,743
59	LW-50	Grubb #3 Stock Reservoir	3	$25,000	$2,500	$27,500	$4,125	$31,625	$3,500	$3,500	$38,625
60	LW-50A	Brimmer Stock Reservoir	3	$25,000	$2,500	$27,500	$4,125	$31,625	$3,500	$3,500	$38,625
61	LW-51	Arkansas Creek Wildlife Guzzler and Pond	3	$28,100	$2,810	$30,910	$4,637	$35,547	$2,000	$2,000	$39,547
66	LW-56	Kester #1 Spring Development, Pipeline, Tank	1	$46,060	$4,606	$50,666	$7,600	$58,266	$2,000	$2,000	$62,266
67	LW-57	Kester #2 Spring Development, Pipeline, Tank	2	$56,050	$5,605	$61,655	$9,248	$70,903	$2,000	$2,000	$74,903

7.0 FUNDING OPPORTUNITIES

Sources of funding and financing for proposed projects within the subbasin and the associated technical support and assistance are available from various local, private, state, and federal entities. Local coordination is crucial in developing viable financing approaches that could be used in implementing proposed projects and realizing benefits. Voluntary cooperation between landowners, managers, irrigators, residents, organizations, and agencies is essential in addressing the identified land and water resource concerns within the subbasin.

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 within the basin wide summary report. Funding and program information for potential conservation and watershed project and program assistance was obtained primarily from the following sources:

- **Water Management and Conservation Assistance Programs Directory**, is an overview of local, state, and federal programs with associated contact information, (*http://wwdc.state.wy.us/wconsprog/2014WtrMgntConsDirectory.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*)

Important local contact information within the subbasin for local conservation and civic organizations include, but are certainly not limited to, the following contacts:

- Crook County Natural Resource District (307.283.2870)
- Weston County Natural Resource District (307.746.3264)
- NRCS Newcastle Field Office (307.746.3264)
- NRCS Sundance Field Office (307.283.2870)
- BLM Newcastle Field Office (307.746.6600)
- USFS Bearlodge Ranger District (307.283.1361)
- WGFD Casper Regional Office (307.473.3400).

8.0 CONCLUSIONS AND RECOMMENDATIONS

8.1 CONCLUSIONS

Resource issues and concerns within the subbasin 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

8.1.1 Irrigation System Components

- Proposed projects and associated components for issues identified during field inventories for irrigation system infrastructure were completed for 13 irrigation systems.
- Recommended improvements to existing irrigation systems mainly involve replacement and/or rehabilitation of existing but weakened diversion structures, headgates, and pumps along with replacement of ditches with pipelines to reduce conveyance losses.
- Irrigation system improvements could be implemented individually or entirely at once depending on the goals of the landowner or manager.

8.1.2 Livestock/Wildlife Upland Watering Opportunities

- 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.
- Twenty-two USFS grazing allotments encompass 84,720 acres of rangeland and forest lands and another 73 BLM grazing allotments encompass 23,276 acres of rangeland and forest lands consisting of private, state, and federal lands in the subbasin.
- Coordination with the USFS and the BLM regarding grazing allotment management is necessary and requires more involvement in developing proposed livestock/wildlife water supply projects beyond the conceptual level projects included within the study.
- Thirty-eight potential livestock/wildlife water projects were 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

- Water storage development within the watershed has been impacted by the Belle Fourche River Compact of 1943 which divides the water in Northeast Wyoming between Wyoming and South Dakota.
- Landowners and study participants identified problems with several existing reservoirs that limited the ability to store water and also identified potential opportunities for water storage within the study area.
- Four sites, S-02: Driskill #1 Reservoir; S-04: Pine (Deep) Creek Reservoir (2B); S-05: Oak Creek Reservoir (2A); and S-06: Horse Creek, were included on the "short list" of potential sites selected from the long list that may provide substantial storage opportunities and was screened based on environmental, hydrologic, geologic, potential benefits, costs, and other data.

8.1.4 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.

8.2 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.
- Surface water opportunities exist within the watershed but would require a partnership of local organizations including but certainly not limited to the CCID and the Crook County Natural Resource District in order to pursue additional investigations, feasibility studies, along with financing to implement potential projects.
- 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 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 surface water storage projects.
- Innovative strategies for coordinated project funding and financing involving private, local, state, and federal sources will need to be pursued since many of the opportunities are unique in this watershed and do not conform to traditional programs and guidelines.
- It is essential that this approach be based on local, collaborative endeavors that integrate more than one watershed issue that could result in achievement of multiple benefits.

9.0 REFERENCES

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