Hydrogeology of the Ashland Ranger District, Custer National Forest, southeastern Montana

Montana Bureau of Mines and Geology

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ABSTRACT

The Ashland Ranger District (District) of the Custer National Forest is located in southeastern Montana and includes an area of approximately 435,000 acres. The forest is managed by the Ashland Ranger District located in Ashland, Montana. The District lies within the Powder River Basin (PRB) which includes mineable coal deposits and reserves of coalbed methane (CBM). There are currently no active coal mines or CBM development within the forest boundaries, but development of either is possible in the future. Both coal mining and CBM development can remove large quantities of ground water from aquifers. Livestock and wildlife on the District are dependent on ground water availability. Therefore understanding the ground-water resources and potential impacts that future energy development might have is critical for resource management.

The average annual precipitation across the District is estimated to be about 16 inches. In this area, potential evapotranspiration may be as high as 30 inches per year, far exceeding annual precipitation. Typically, ground-water recharge only occurs under limited situations when soil moisture capacity is satisfied and precipitation occurs faster than evapotranspiration but slow enough to allow percolation rather than surface runoff.

The geologic strata exposed at the surface in the Ashland Ranger District consist almost entirely of the Paleocene Tongue River Member of the Fort Union Formation, a sequence of interbedded and laterally discontinuous sandstone, siltstone, shale and coal units. As many as 20 persistent coal beds occur within the Tongue River Member. Natural coal burning in outcrop areas results in the formation of clinker – partially baked and fused shales, silts, and sands of overlying strata. Clinker is resistant to erosion and often forms prominent cliffs and caps the higher ridges and plateaus.

Aquifers within the Ashland Ranger District include sandstone units, coal beds, clinker and alluvium along streams. There are two generalized types of flow systems within the Fort Union Formation: a deep system of aquifers, recharged primarily in Wyoming and along the edges of the PRB in Montana with flow toward the Yellowstone River; and local flow systems where shallow aquifers are primarily recharged within a watershed with flow directions controlled by topography. In most areas, these flow systems can be distinguished by chemistry, with sodium (Na^+) and bicarbonate (HCO_3^-) ions dominating the water quality of deep systems and magnesium (Mg^{2+}), calcium (Ca^{2+}) and sulfate (SO_4^{2-}) ions more prevalent in the shallower systems. Coalbed methane occurs in the deeper systems dominated by ions of Na^+ and HCO_3^-.

Recharge occurs along the edges of the PRB in areas of outcrop, along alluvial reaches where streams cross coal or sandstone subcrops, and on clinker-capped ridges. In the Fort Union Formation, vertical flow is controlled by the numerous shale units, which are between aquifer units and impede ground-water flow. Recharge in the Ashland Ranger District is probably limited to localized flow systems recharged primarily on clinker capped ridges.

Discharge occurs where aquifers crop out along hillsides and beneath alluvium, forming springs and providing baseflow to streams. Generally, discharge from the regional flow systems occurs on the northern end of flow paths. Ground water is also discharged to wells that supply water for stock and domestic uses. Within the District, coal beds and sandstone units in the Tongue River Member are the main aquifers that supply water to wells. Wells are completed in alluvium much less frequently because alluvial aquifers exist over only small areas.

The majority of ground water used in the District to support livestock and wildlife is obtained from springs and wells completed in sandstone and coals of the Tongue River Member. Within the study area, 34 stock water wells were inventoried. The typical discharge rates for these wells are between 5 and 15 gallons per minute (gpm).

A total of 284 springs in the District had measurable discharge during inventory work in 2003 and 2004. Discharge from these springs range from 0.01 to 15 gpm and support a wide variety of uses including livestock and wildlife. Total spring discharge in the District during the inventory was 256.8 gpm. By far, the stratigraphic interval associated with the most springs and spring discharge is from the Pawnee coal up to the Anderson/Dietz coal zone.

During an inventory of perennial stream reaches in the District during the fall, 2004, there was measurable stream flow in 25 stream segments representing 19 different creeks in the District. Cumulative stream flow, excluding Otter Creek, during this inventory was 399 gpm, which, due to long-term drought conditions, is considered lower than normal. The greatest volume of flow was in the southern part of the District, with less flow in streams located to the north. At the time of the inventory the maximum flow rate for Otter Creek was 135 gpm.

Under an assumed scenario of maximum CBM development in the District, 24 springs were identified as being most susceptible to impact, and 17 additional springs are of concern. Of the 25 stream reaches inventoried, 5 appear to be susceptible to impact and 2 more require careful monitoring in the event of CBM development. Nineteen wells should be monitored if development occurs, of which 3 are considered most vulnerable to impact. This assessment was based on an assumed CBM development scenario representing the maximum aerial extent that could likely occur within the District. Actual impacts to water supplies will vary from this assessment and will be dependent upon the stratigraphic intervals developed for CBM and the areal extent of development. Monitoring of springs, wells and streams should be based on proposed CBM drilling plans.

If CBM production occurs only outside the District, impacts to water supplies in the District will be limited to those that are within about 5 miles of development. CBM development is most likely to occur along the southern edge of the District, with less potential for development along the western and eastern edges.

Springs, pipeline wells and East Fork Hanging Woman Creek are monitored on a regular basis. Future monitoring will be based on anticipated needs and adjusted as CBM production approaches the District boundaries. Continued monitoring will assist with decision making, identification of impacts (and lack of impacts), and overall better water management regardless of whether or not coalbed methane is eventually developed in the Ashland Ranger District.

INTRODUCTION

The Ashland Ranger District of the Custer National Forest (District) is located in southeastern Montana and includes an area of approximately 435,000 acres. The forest is managed by the Ashland Ranger District located in Ashland, Montana which is the closest community. The District lies within the Powder River Basin which includes mineable coal deposits and reserves of coalbed methane (CBM). Currently there are no active coal mines or CBM development within the forest boundaries. Both coal mining and CBM development can remove large quantities of ground water from aquifers (Wheaton and Donato, 2004). Livestock and wildlife on the District are dependent on ground water and therefore understanding the ground-water resources and potential impacts that future energy development might have is critical for resource managers.

Purpose and Scope

The purpose of this report is to provide background information about ground-water resources for the Ashland District of the Custer National Forest, provide hydrogeologic information for decision making on energy development, and describe an ongoing ground-water monitoring system. Interpretations presented in this report are based on data collected at springs, streams and wells within the forest boundary and adjacent to the forest. Data from past research is also included in the interpretations. Unfortunately, there are few wells that can be monitored in the forest and aquifer descriptions are based in large part on extrapolation of data from springs and regional monitoring outside the forest boundaries.

Location and Description of Area

The District is located in southeastern Montana between the Powder River and the Tongue River (Figure 1). Current land uses for the District consist of timber production,

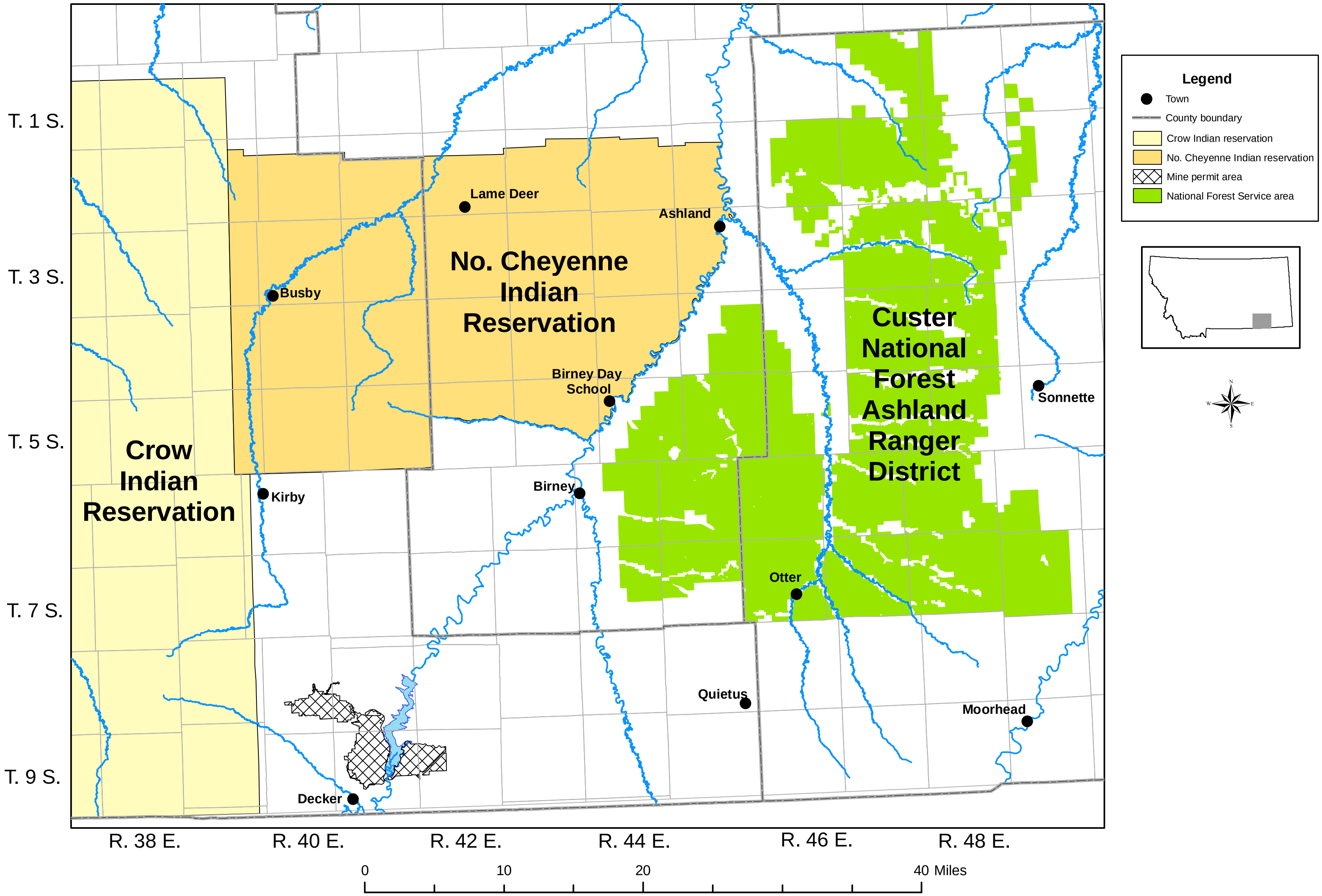

Figure 1. Location map of the study area. The Ashland Ranger District is located in southeast Montana.

wildlife habitat, range land, public hunting, hiking, and fishing ponds. Water is used for range cattle, wildlife, recreation and fire fighting. The Custer National Forest has one of the largest grazing programs in the National Forest system consisting of 138,000 Animal Unit Months (AUM). Approximately 20,597 head of cattle are run on the District, generally from June through October yearly, which encompasses over 60 permit holders for this livestock. The primary water source for these cattle are numerous springs, a few stream reaches, and over 200 miles of pipeline fed by wells from private and federal sources. Other water sources for livestock include reservoirs, but these are unreliable water sources dependent upon the amount of rainfall and/or snowfall accumulation for any given year. Many grazing allotments rely almost exclusively on water from springs. The forest is used for hunting, hiking, and some fishing but not to the extent that it is used for range land. Three spring-fed ponds are stocked for fishing, but again, are not used as a large scale recreation program. The ponderosa pine forest is made up primarily of trees less than 200 years old. Although there are many opinions as to why the forest is made up of young timber stands, it is most widely believed that it is due to drought and fire frequency. Water use during forest fires is minimal and primarily consists of tank fill ups at reservoirs or springs and helicopter bucket use. Most water use during fires is for initial attacks on smaller fires.

Currently, ongoing research on the District includes studies of amphibian and aquatic reptiles, fish surveys, and continued hydrologic monitoring. Over time, activities on the District such as grazing and recreation have likely influenced water resources and these impacts should be considered when discussing the impacts or changes that coal mining or CBM development may have on the area.

Topography

The general terrain of the District is gently rolling hills and plateaus broken up by rock outcrops and highly eroded river breaks. Although the general terrain at a distance appears to be made up of valley floors, gentle valley bottoms and plateaus, the landscape hides a mix of topography which varies from flat to slopes in excess of 70 percent. One of the lowest elevations in the District is the Breaks Coulee area (township 1 south, range 46 east) with an altitude of 3123 feet (ft) consisting of draw bottoms with dry creek beds, rolling hills, and grassy plateaus. One of the highest elevations in the forest is at Home Creek Butte (township 3 south, range 47 east, section 4) where the altitude is 4,407 ft. This area consists of steep slopes climbing to plateaus with mature timber. An elevation midway between the highest and lowest elevation is the Cow Creek area with altitudes of 3,500 ft to 3,700 ft, consisting of areas of gentle slopes, springs, streams, rock outcrops, and timbered areas. Even though there is not a large gain in elevation, the area has a large amount of topographical relief lending to stair-stepping hills, and numerous plateaus with steep draws and valleys.

Climate

Due to the topographic relief of the District and in surrounding areas, precipitation patterns vary across the District, generally higher amounts of precipitation fall in the higher elevations. The average annual precipitation across the District is estimated to range between 14 and 18 inches based on analysis of data from 1961 through 1990 by the Spatial Climate Analysis Service (SCAS) at Oregon State University (http://www.prism.oregonstate.edu/products/matrix.phtml).

Cumulative departure from annual average precipitation can be helpful in examining long-term ground-water level and spring flow trends. Cumulative departure for a specific site is the running total of the difference between total precipitation received each year and annual average precipitation. Data used for this calculation were from the nearest U. S. Weather Service station, which is at Broadus, Montana. At Broadus the average annual precipitation is 13.56 inches, based on the period of record from 1948 through the present (Western Regional Climate Center http://www.wrcc.dri.edu/cgi-bin/cliMAIN.pl?mt1127). The cumulative departure from annual average precipitation indicates a precipitation shortfall of 18.35 inches since 1978 at Broadus (Figure 2). The cumulative departure for the District would not be the same as that of Broadus because weather patterns vary across the area, but the Broadus trend provides insight into the regional trends.

As part of the current study, a meteorologic station has been operated since November, 2005 near Poker Jim lookout (township 06 south, range 44 east, section 23). Comparison of monthly precipitation totals from the Broadus U. S. Weather Service station and data collected at Poker Jim indicate variability in the regional weather patterns (Figure 3).

The wettest months in this area are May and June, and the driest are November through February. The annual mean temperature is 45.4ºF, and recorded daily extremes are -47ºF and 108ºF. The warmest days are in July and August, and the coldest are in December and January. Average daily wind speeds for the Ashland Ranger District are 7.36 miles per hour (mph), and wind events with gusts greater than 75 mph have been recorded. The Ashland Ranger District lies within a convergence area of two weather patterns. Due to this convergence, this area has the most frequently occurring lightning storms in Montana.

Evaporation from surface water and moist soil represents a loss from water supplies, in the same way that precipitation represents a gain. Potential evaporation rates are measured in standard pans at several stations in Montana, of which the nearest to Ashland is the Huntley Agricultural Experiment station. For the period of record (1911 through 2005) the average pan evaporation rate at Huntley is 41.27 inches per year (http://www.wrcc.dri.edu/htmlfiles/westevap.final.html#MONTANA). Evaporation from surface water bodies, such as ponds or streams, is less than pan evaporation rates due primarily to the temperature of the water. Adjusting the pan evaporation rate by a factor of 0.75 provides a reasonable estimate of average annual free-water-surface evaporation

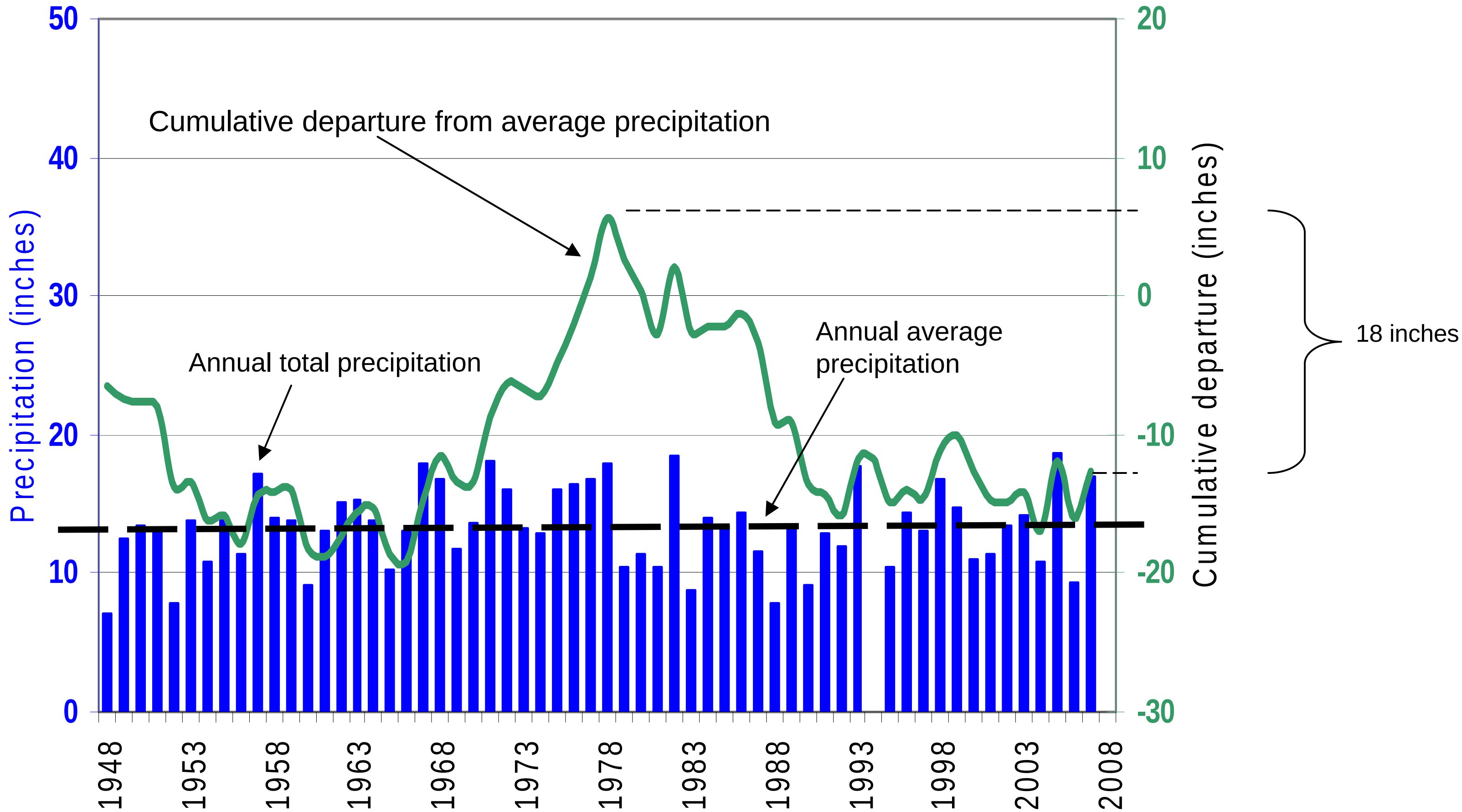

Figure 2. Precipitation data for Broadus, Montana indicate that since 1978 the area is about 18 inches below normal moisture. Cumulative precipitation directly affects ground-water recharge. Mean annual total precipitation for the period of record (1949 through 2007 excluding 1994 for lack of data) is 13.56 inches. (Western Regional Climate Center: http://www.wrcc.dri.edu/summary/Climsmemt.html)

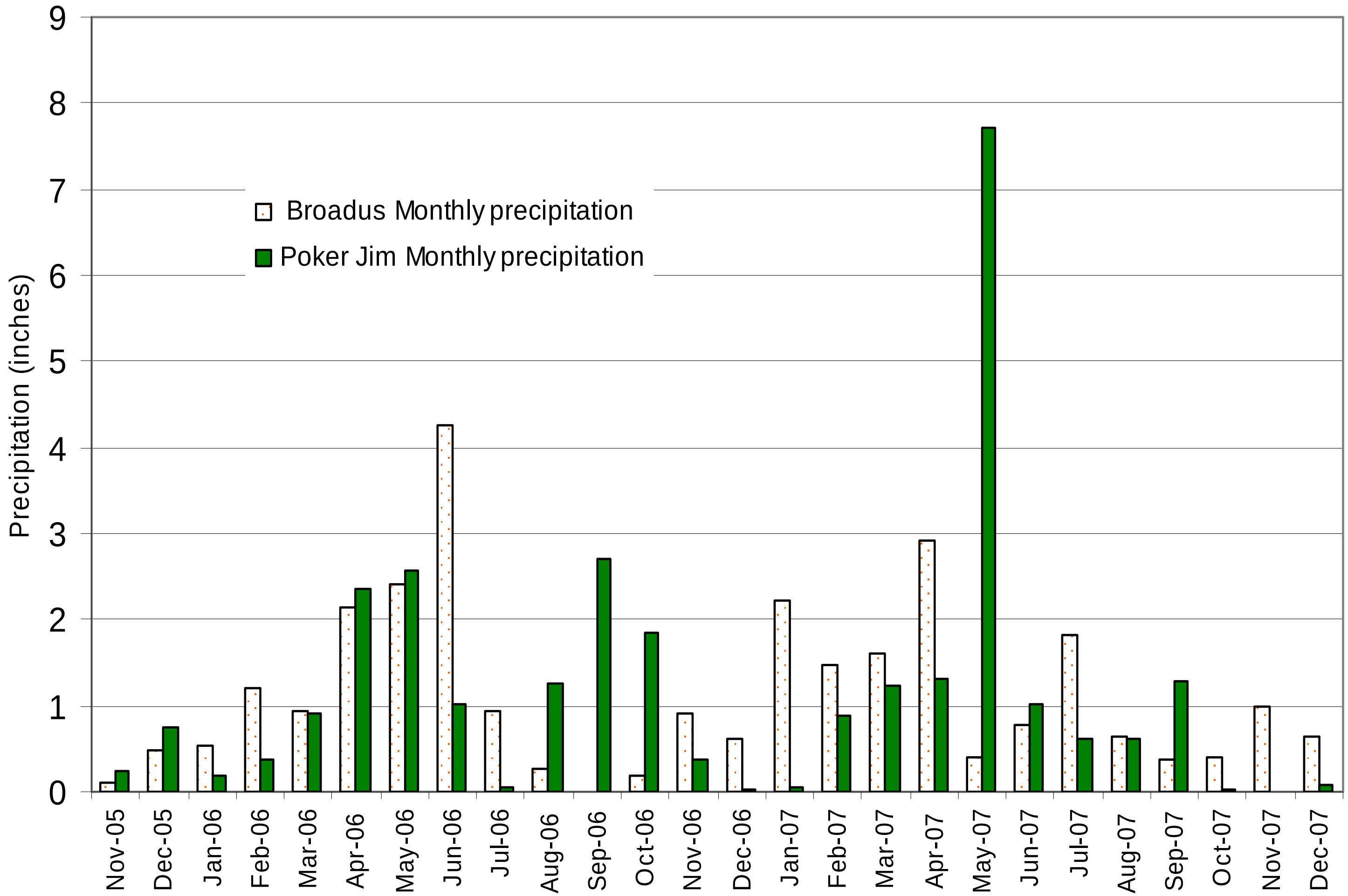

Figure 3. Comparison of Broadus and Poker Jim monthly precipitation totals. Monthly precipitation is collected near the town of Broadus and near Poker Jim lookout. The Poker Jim station is located about 45 miles southwest of the Broadus station. The map location is Township 06S and Range 44E.

Broadus: (Western Regional Climate Center: http://www.wrcc.dri.edu/summary/Climsmemt.html) at Huntley of about 31 inches per year. Evaporation rates at Ashland are estimated to be about 9% higher than at Huntley (U. S. Department of Agriculture Soil Conservation Service, 1974), yielding an estimated annual average free-water-surface evaporation rate for the Ashland Ranger District of 34 inches per year.

Evapotranspiration (ET) is the combined loss to transpiration by plants (prairie and timber) and free-water-surface evaporation and has the potential to remove more water than the annual average precipitation. Estimated potential ET in the Montana Agriculture Potential System for mixed rangeland/timber ranges from 21.9 to 34.4 inches during the period April through September (Jim Bauder, personal communication), far greater than the average annual precipitation in the area of 14 to 18 inches. The actual ET will be less than the potential ET as it is controlled by the available moisture and will vary from year to year. For comparison, a study near Mandan, North Dakota indicated actual ET rates in prairie grasslands of 18 to 19 inches per year, approximately equal to the annual precipitation for that area of 16 to 20 inches per year (Aase and Wight, 1972). Ground-water recharge occurs when precipitation infiltrates below the soil and root zones. Overland flow and ET combine to reduce recharge potential.

Previous Investigations

Numerous geologic, hydrologic and hydrogeologic investigations have been published that include the area in and around the Ashland Ranger District. A complete list is presented in Donato and Wheaton (2004). Of specific interest to this report are studies on the Otter Creek hydrogeology (Cannon, 1982, 1983 and 1985), (Lambing and Ferreira, 1986), (Lee and others, 1981), (McClymonds, 1984), (McClymonds and Moreland, 1988) and (U. S. Bureau of Land Management, 1975); regional hydrogeology (Van Voast and Reiten, 1988) and (Slagle, 1983); general geology (Vuke and others, 2001a,b,c,d), (Flores and others, 1999), (Bass, 1932); channel sandstone units in the Tongue River Member of the Fort Union Formation (Lopez and Heath, 2007); and clinker which represents particularly favorable recharge areas (Heffern and others, 1993).

Acknowledgements

Extensive field work performed by Jody Millett-Larned and Dan Stanley was critical to providing the basic spring data used in this report. Support by the U. S. Department of Agriculture Forest Service, particularly Pat Pierson and Mark Nienow is gratefully acknowledged. Without this support this project could not have moved forward. The careful and thorough review provided by Mark Nienow and Elizabeth Brinck Meredith significantly improved this report.

Methods

Water resources (springs, wells, and perennial reaches of streams) that support land uses of the District were inventoried as part of this project, based in part of the District land map (Custer National Forest, 2000). Inventories represent a one-time documentation of the location, and general character of a site. Far better assessment of water resources and better water-management decision making is supported by long-term ground-water monitoring. Selected sites are now included in the regional ground-water monitoring program which is supported by the U. S. Bureau of Land Management, U. S. D. A. Forest Service and MBMG. Data from these sites are included in annual reports generated as part of that long-term program (Wheaton and others, 2007).

Springs in the Ashland District were inventoried during the 2001 through 2003 field seasons and basic data and descriptions were published in Donato and Wheaton (2004). The details about the springs have been expanded somewhat, updated and included in this report as Appendix A. Locations of inventoried springs are shown on Plate 1. Each year, between 10 and 20 of these springs have been included in a regional ground-water monitoring program (Wheaton and others, 2006, 2007). Appendix B is a current list of monitored springs in the District. Regular monitoring consists of measurements of flow (stopwatch and bucket method), temperature, and specific conductance (measured with a field meter). In addition, any changes in conditions or development of the springs is noted during each site visit. All data were entered into Ground Water Information Center (GWIC) database. Water-quality samples have been collected at some springs during this project and during previous projects by the U. S. Geological Survey. Data from all water samples are included in Appendix C.

A number of short, perennial streams exist in the District. All known streams were inventoried during 2004; these data are listed in Appendix D and the locations shown on Plate 2. One stream is included in the ongoing monitoring and is included in Appendix B. For the purpose of this inventory, streams were defined as any short perennial reaches that had an established flow and channel. Initially, map locations of streams identified by the Forest Service were visited to determine if flow was present. Additional sites were located by talking to ranchers and individuals who had knowledge of surface flow in the District. The stream inventory was done during October and November, 2004. The fall season was chosen to best represent baseflow when spring runoff and summer evapotranspiration had limited impact on the amount of surface flow. The top and bottom of each stream's reach was mapped using a handheld GPS unit. Depending on the length of the reach, one or more measurements of flow were taken. Depending on the size of the stream, flow was measured either with a portable weir, small parshall flume, current velocity meter, or volumetrically by diverting the flow through a pipe and measuring with a bucket and stopwatch. The site of the measurement was mapped with a GPS unit, and pictures were taken noting geology, time, and direction that the picture was taken. All data were entered into GWIC database. Water-quality data from streams in the District are included in Appendix C.

The District personnel provided a list of wells that are located in the District or are located on adjacent private land but provide water for pipelines to grazing allotments in the District. All wells records were checked against GWIC records, and were inventoried in the field. The inventory data are in Appendix E. Water quality data for samples collected from wells is listed in Appendix C. Currently, 11 stock wells are included in the regular monitoring work and are listed in Appendix F.

The GWIC database is available to the public on the internet. The website address is http://mbmggwic.mtech.edu. First-time users will need to create a user identification by following the directions. Once logged on, users can access data for specific ground-water projects such as the Forest Service spring or stream inventory. They can also search for specific wells, springs, and other information by location, name, or GWIC number. After locating the specific site, water level data, hydrographs, or topographic map locations can be viewed.

GEOLOGY

Regional Geological Setting

The Ashland Ranger District is located in the northern part of the Powder River Basin, an elongate N-NW trending sedimentary basin stretching across portions of northeastern Wyoming and southeastern Montana (Figure 4).

The Powder River Basin forms a broad asymmetrical syncline with a gently dipping eastern limb and a more steeply dipping western limb. It is bounded in Montana by Laramide (50-75 my) uplifts – the Bighorn and Pryor Mountains to the west, the Black Hills to the east, and the Miles City Arch to the north (Figure 4). The syncline axis trends N-NW near the basin's western margin. In Montana, the basin shallows toward the north against the southern flank of the Miles City Arch. The structural axis also changes in Montana – trending N-NE and roughly paralleling the Tongue River.

Sediments shed from the adjacent Late Cretaceous-Early Tertiary uplifts were transported and deposited into the basin primarily by fluvial processes. As much as 8,000 ft of Cretaceous and Tertiary sediments have accumulated along the basin axis (Curry, 1971). This was accompanied by tremendous accumulations of peat in nearby low-energy environments such as distal floodplains, abandoned crevasse splays, and swamps.

Stratigraphy

The geologic strata exposed at the surface in the area of the Ashland Ranger District consist almost entirely of the Early Tertiary (Paleocene) Fort Union Formation (Figure 5) (Vuke and others, 2001a,b,c,d). The Fort Union Formation ranges from about 600-2,500-ft thick (Van Gosen, 1996) and is comprised of three geologic units. From

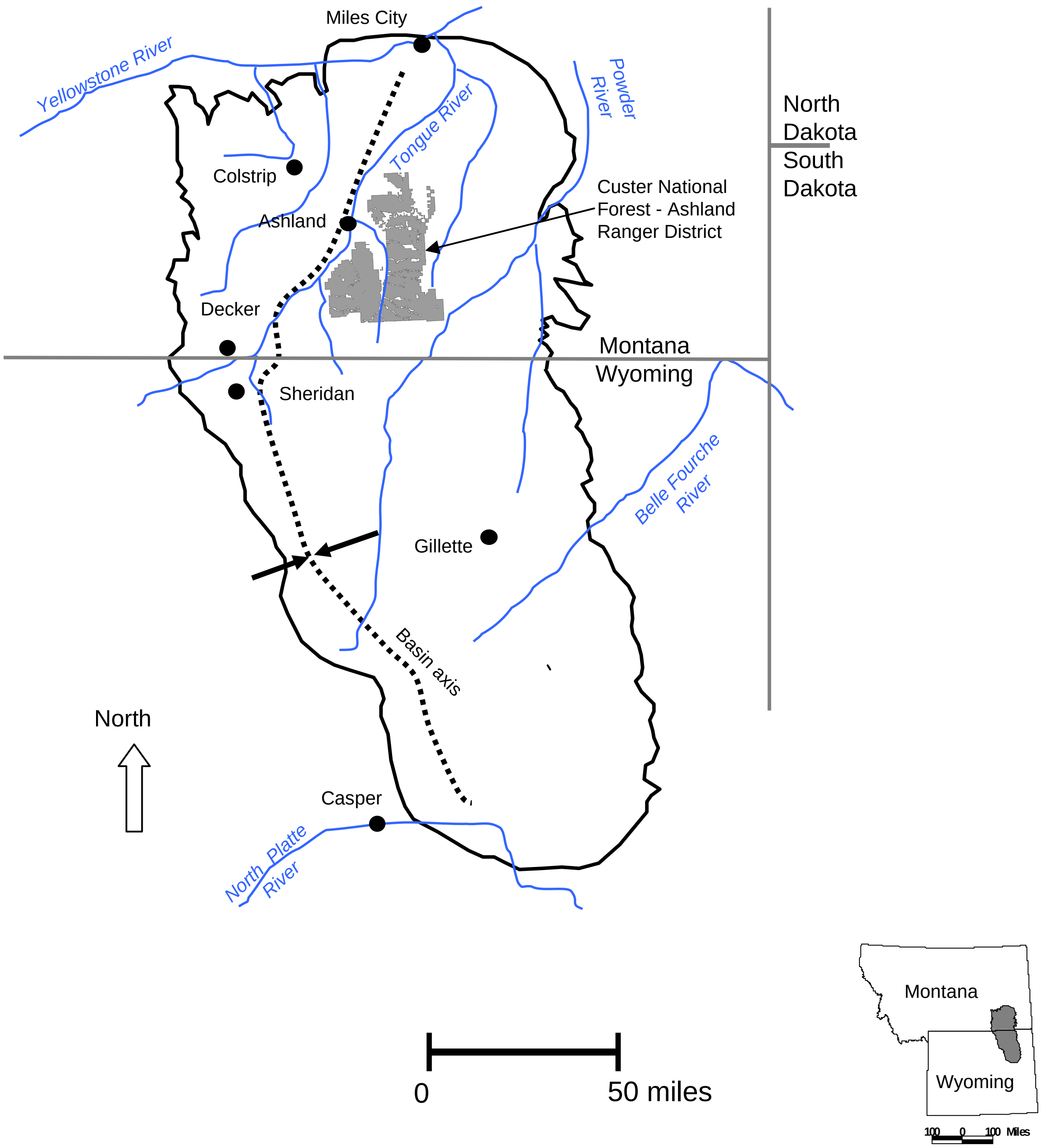

Figure 4. Structural setting for the Powder River Basin in southeastern Montana and northeastern Wyoming. The Ashland Ranger District is in the northern portion of the Powder River Basin.

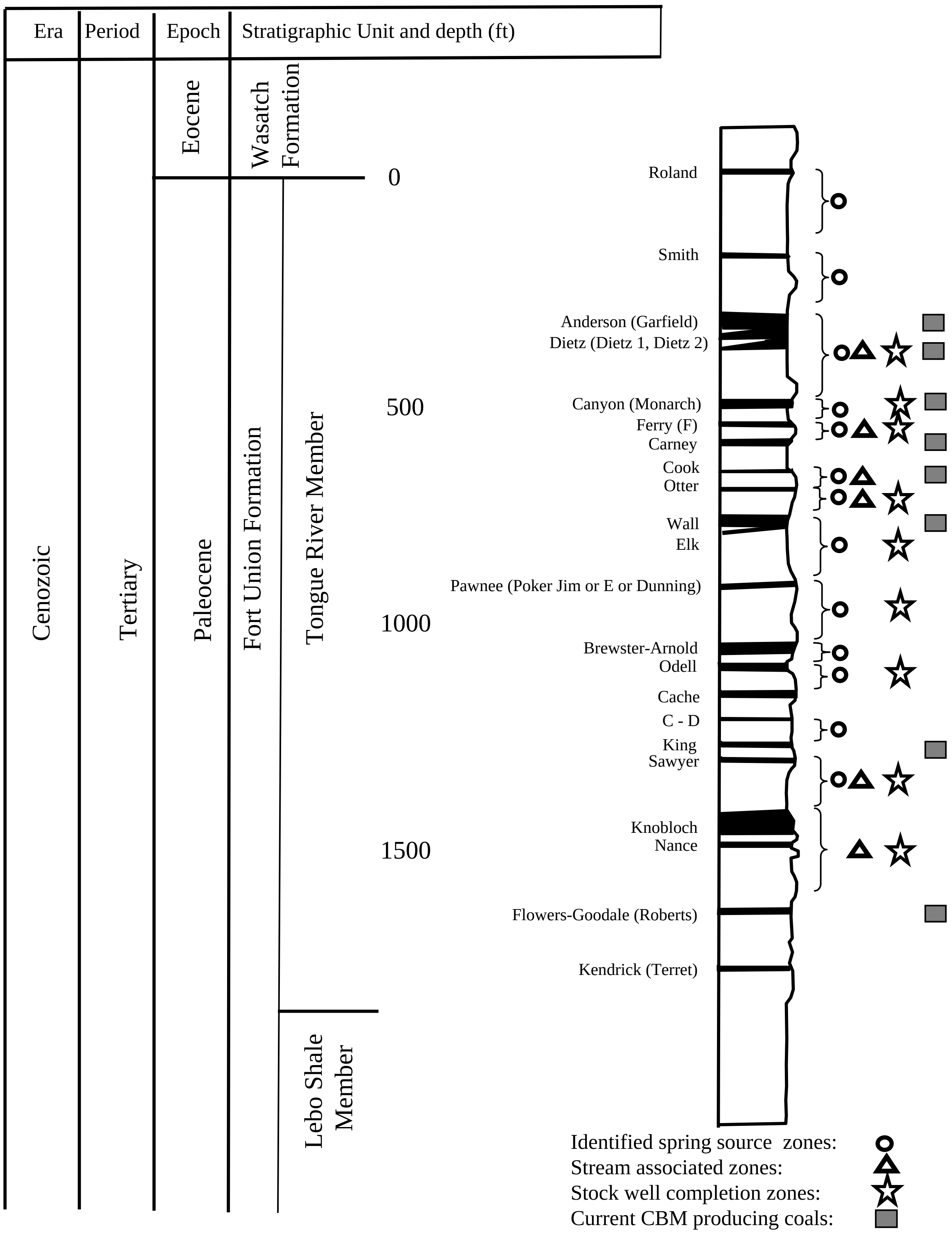

Figure 5. Generalized stratigraphic column for the Ashland Ranger District. Many coal beds have been mapped within the Tongue River Member of the Fort Union Formation. The general relative positions are shown here, with the right edge of the column indicating generally sandy interburden to the right and shale by the line curving to the left. Most coals do not exist across the entire District and the interburden thickness varies considerably. The indicated depths are only approximations. Sources: Matson and Blumer, 1973; McLellan and others, 1990; Law and others, 1979; Fort Union Coal Assessment Team, 1999.

oldest to youngest these are the Tullock Member, Lebo Member (informally referred to as the Lebo Shale), and Tongue River Member. Together they form a thick sequence of interbedded and laterally discontinuous sandstone, siltstone, shale and coal units. Approximately 90% of the study area is covered by outcrops of the Tongue River Member, the youngest of these units. In the north and northeast, present-day streams have eroded through the Tongue River Member exposing the older Lebo Member in some river valleys. The stratigraphically lowest Tullock Member is not exposed.

Recent, north-flowing streams and rivers have eroded and dissected the terrain, exposing the clastic sedimentary units at the surface. Because the topography slopes down to the north, and geologic strata dip to the south, the rocks exposed at the surface are progressively older toward the north (Plate 3). The axis of the Powder River Basin is west of the District, and stratigraphic units dip generally south and west (Figure 4 and Plate 3). Naturally occurring springs are common near coal outcrops. Methane gas present in coal seams (typically referred to as coalbed methane or coalbed natural gas) can also migrate updip if formation pressure is reduced. Coal outcrops can become conduits for the escape of methane and water trapped in those parts of the formations more deeply buried to the south (downdip).

As many as 20 persistent coal beds occur within the Fort Union Formation – most are within the Tongue River Member. Natural coal burning in outcrop results in the formation of clinker – partially baked and fused shales, silts, and sands of nearby strata. Clinker is resistant to erosion and often forms prominent cliffs and caps the higher ridges and plateaus. Clinker zones can be used as stratigraphic marker horizons for mapping coal beds.

Buried paleo-channels up to 100 ft thick and up to 10 or more miles wide have been mapped in the area by Lopez and Heath (2007). These channel, or valley fill, sandstones reflect a dominant drainage to the east-northeast, toward the Paleocene Cannonball Sea. At least 6 stacked channel systems occur in the lower half of the Tongue River Member, suggesting fairly constant paleo-geography during early Tongue River deposition.

The Eocene Wasatch Formation unconformably overlies the Paleocence Fort Union Formation, and outcrops in the southernmost part of the study area (just south of the Custer National Forest boundary), and along some high ridges between Hanging Woman Creek and Otter Creek (Vuke and others, 2001). Quaternary alluvial gravels occupy stream channels and floodplains. Older marine and non-marine sedimentary rocks underlying the Fort Union are not exposed within the study area.

Fox Hills Formation (Cretaceous)

The Fox Hills Formation consists of brownish gray siltstones and sandstones. Sandstones are fine- to medium-grained, commonly coarsening upward and crossbedded.

The lower part of the Formation is comprised of interbedded siltstone and sandstone along with dark-gray shale. The Fox Hills Formation is typically about 100 ft thick.

Hell Creek (Lance) Formation (Cretaceous)

The Hell Creek Formation consists of gray or greenish-gray smectitic, silty mudstone which exhibits a "popcorn" weathering texture. There are secondary cross-bedded and ripple-laminated micaceous channel sandstones in some areas. The upper Hell Creek is characterized by a 25-foot thick cross-bedded channel sandstone. A change from cross-bedded to planar bedded sandstones marks the contact between the Hell Creek Formation and the overlying Fort Union Formation (Tullock Member).

The Lance Formation and the Hell Creek Formation are stratigraphically equivalent, but the Lance consists of thick sandstone beds, whereas the Hell Creek consists of thin sandstone and shale layers. In this paper, the two formations are not distinguished because the location of the contact in the subsurface is not well delineated and the Hell Creek terminology is used.   The Hell Creek Formation is about 700 ft thick.

Fort Union Formation (Tertiary)

Tullock Member

The Tullock Member si the basal member of the Fort Union Formation and consists of light yellow to light brown fine- and medium-grained thin-bedded sandstone and siltstone with minor gray shale. Sandstone units tend to exhibit planar bedding. A few thin coal beds are present. Total thickness of the Tullock is approximately 200-350 ft.

Lebo Member

The Lebo Member consists predominantly of dark gray shale and mudstone with black carbonaceous shale; some lenses of fine-grained sandstone and siltstone; and minor thin, discontinuous, and shaley (or "dirty") coal beds (Vuke and others, 2001). Thickness of the Lebo is between 200 to 300 ft. The Lebo Member effectively acts as an aquitard, separating the hydrogeology of the Tongue River Member from deeper units.

Tongue River Member

The Tongue River Member is the youngest member of the Fort Union Formation and consists of interbedded pale yellow, tan, and orange fine- to medium-grained sandstone, siltstone, and light-yellow to brown mudstone and shale, brown to black carbonaceous shale, and coal beds up to 65 ft thick. Sandstones vary from thin-bedded to massive to cross-bedded. To the north, the Tongue River Member has been removed by erosion. The thickness in the southern portion of the area can be more than 2,000 ft.

Wasatch Formation(Tertiary)

The Wasatch Formation overlies the Fort Union Formation and consists of interbedded siltstones, massive and cross-bedded sandstones, shale, carbonaceous shale, coal, and associated clinker (Vuke and others, 2001). Sandstone units are generally coarser grained and more poorly sorted than those in the Fort Union Formation. They also have a distinctive heavy mineral suite which can be used, in part, for formation identification (Denson and others, 1990). Within the Powder River Basin, most of the important uranium deposits have been found in the lower part of the Wasatch (Denson and others, 1990). The Wasatch Formation is up to 600 ft thick.

Clinker

High ridges are frequently capped by clinker, which resists erosion more than other geologic units in this area. Clinker is often brightly colored (red, pink, orange, yellow) – metamorphosed sedimentary rock which has been partially melted, baked, and fused from burning near-surface coal beds. Therefore, clinker is not a single stratigraphic unit, but can occupy the stratigraphic position of any coal bed that happened to burn. Clinker can form collapse breccias which fill the voids left from burned out underlying coal layers. Clinker beds as thick as 200 ft have been reported, and the clinker thickness is thought to be closely related to the original thickness of the burned coal bed (Heffern and Coates, 2004).

Alluvium

Alluvial material deposited along stream channels, floodplains, and terraces consists of gravels, sands, silts, and clays. The chief constituents are quartzite, chert, igneous rocks, and clinker. In this area, alluvium is generally less than about 15-ft thick.

Mineral Resources

The primary proven mineral resources of the Ashland District of the Custer National Forest are coal and gravel. There is moderate potential for both conventional and unconventional oil and gas accumulations. There are no known or indicated metallic mineral deposits (Van Gosen, 1996). A detailed review of the mineral resources of the Ashland District of the Custer National Forest is provided by Van Gosen (1996).

Coal

Although coal seams are present in all 3 members of the Fort Union Formation and to a lesser extent the Wasatch Formation, the most economically important coal beds are in the Tongue River Member. Outcrop areas of selected coal seams present in the District are shown on Plate 1. Coals of the Tullock and Lebo Members are generally thin and lenticular. Thus, the top of the Lebo Member represents the lower limit, or base, of the primary coal-bearing sequence (Plate 3).

At least twenty persistent coal beds have been identified in the Tongue River Member within the District. The uppermost is the Anderson-Dietz which correlates with the Wyodak in Wyoming; the lowest is the Terret (Figure 5). Major coal-bed outcrops along with their relative stratigraphic position are shown in Plate 3, which includes a north-south cross section, an east-west cross section, and a southwest-northeast cross section. The cross sections illustrate the overall structure of the basin and position of some of the major coal beds within the District.

Coal is present throughout the District, with an estimated 42 billion short tons of non-leased federal coal available to a depth of 3,000 ft (Van Gosen, 1996). Strippable deposits are those that can be economically mined by removing the overburden material. Strippable deposits as identified and described by Van Gosen (1996) and Matson and others (1973) cover more than 30% of the area. The largest strippable deposit is the Ashland deposit, which includes the Otter Creek tracts owned by the State of Montana. In the Ashland field, the Knobloch coal bed reaches a thickness of up to 65 ft.

The coal is mainly classified as lignite A to subbituminous B based on heat of combustion values ranging from 5,881 to 9,662 Btu per pound for 140 samples tested (Van Gosen, 1996). It is generally low in sulfur (<0.4%) and ash (3-6%) content, similar to other Powder River Basin coals.

Gravel

Gravel is used for local road aggregate. Clinker is mined and crushed as a primary source for gravel, giving local roads their typical reddish color. It is abundant and easily accessible at many locations.

Oil and gas

Fifty-three oil and gas exploration wells have been drilled within the District boundary. None have resulted in the discovery of oil or gas reserves. There are several oil and gas fields outside the District. Nearby gas fields include Liscom Creek to the north (T1N,R45E) and Pumpkin Creek to the northeast (T1S, R49E). The nearest oil fields are 20-35 miles to the east-southeast, the largest being the Bell Creek oil field.

Coalbed methane (CBM) development is possible for deep (deeper than about 500 ft) coal seams in the District. Van Voast (2003) identified “moderate” potential for the Knobloch coal seam in the southern portion of the District – mainly south of US highway 212. Potential CBM from other, deeper seams has not been assessed. However, based upon increased depth of burial and seam thickness, it is reasonable to expect the southern portion of the District to present the best opportunities.

GROUND-WATER RESOURCES

Overview of the Hydrogeology of the Study Area

The overview of ground-water resources in the area of the Ashland Ranger District is based on previous research (Cannon, 1982, 1983 and 1985; Slagle, 1983) and data collected as part of this study. Data for springs in the District are available in GWIC (http://mbmggwic.mtech.edu/) and inventory data are presented in Appendix A. Data for streams that were inventoried as part of this study are presented in Appendix D. Basic data for wells in the District that have been inventoried are presented in Appendix E.

Aquifers within the Ashland Ranger District include sandstone units, coal beds, clinker and alluvium along streams. Two generalized types of flow systems have been described within the Fort Union (Van Voast and Reiten, 1988; Slagle, 1983): a deep system of aquifers, primarily recharged in Wyoming and along the edges of the PRB in Montana, flows toward the Yellowstone River; local flow systems where shallow aquifers are primarily recharged within a watershed with flow directions controlled by topography. In most areas, these flow systems are geochemically distinct, with Na^{+} and HCO_3^{-} ions dominating the water quality of deep systems and Mg^{2+}, Ca^{2+} and SO_4^{2-} more prevalent in the shallower systems.

Regionally, recharge occurs primarily along the edges of the PRB in areas of outcrop and along alluvial reaches where streams cross coal or sandstone subcrops. Clinker-capped ridges likely are important areas of recharge throughout the Powder River Basin. In the Fort Union Formation, vertical flow is limited by numerous low-permeability shale units. Ground water slowly seeps through the shale layers and adds some water to deeper aquifers over most of the area. Recharge in the Ashland Ranger District is limited to localized flow systems recharged on clinker capped ridges.

Ground-water discharge occurs where aquifers outcrop along hillsides and beneath alluvium. Generally, discharge areas are on the northern end of flow systems. Discharge forms springs and provides baseflow to streams. Ground water is also discharged to wells that supply water for stock and domestic uses. Within the District, coal beds and sandstone units in the Tongue River Member are the main aquifers that supply water to wells. Alluvium is utilized to a lesser extent due to the limited areas where sufficient thickness exists.

Understanding generalized directions of ground-water flow and vertical gradients between aquifers is important for water management. Ground-water flow is perpendicular to equipotential lines, which define the potentiometric surface. Estimated potentiometric surfaces for aquifers of the Fox Hills, Tullock, a typical sandstone near the base of the Tongue River Member, the Knobloch coal, and the Canyon coal are shown on figures 6, 7, and 8. The number of wells in the project area is not sufficient to generate accurate potentiometric surface maps for these aquifers. The potentiometric surface for the Fox Hills Formation in this area (Figure 6) was developed from well data and a potentiometric surface presented by Slagle (1983). For each of the other aquifers on

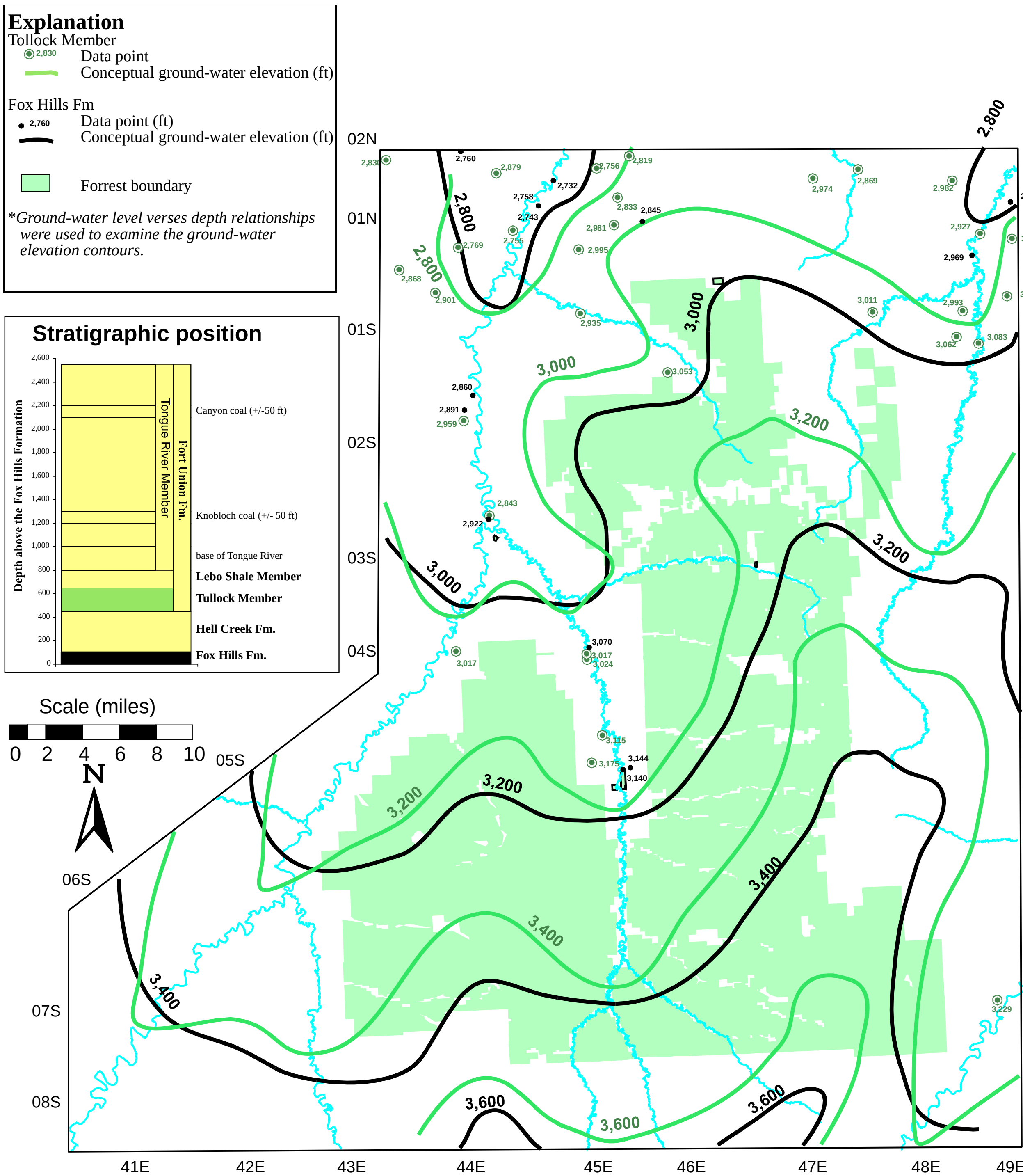

Figure 6. Conceptual ground-water altitudes for the Tullock Member and the Fox Hills Formation.

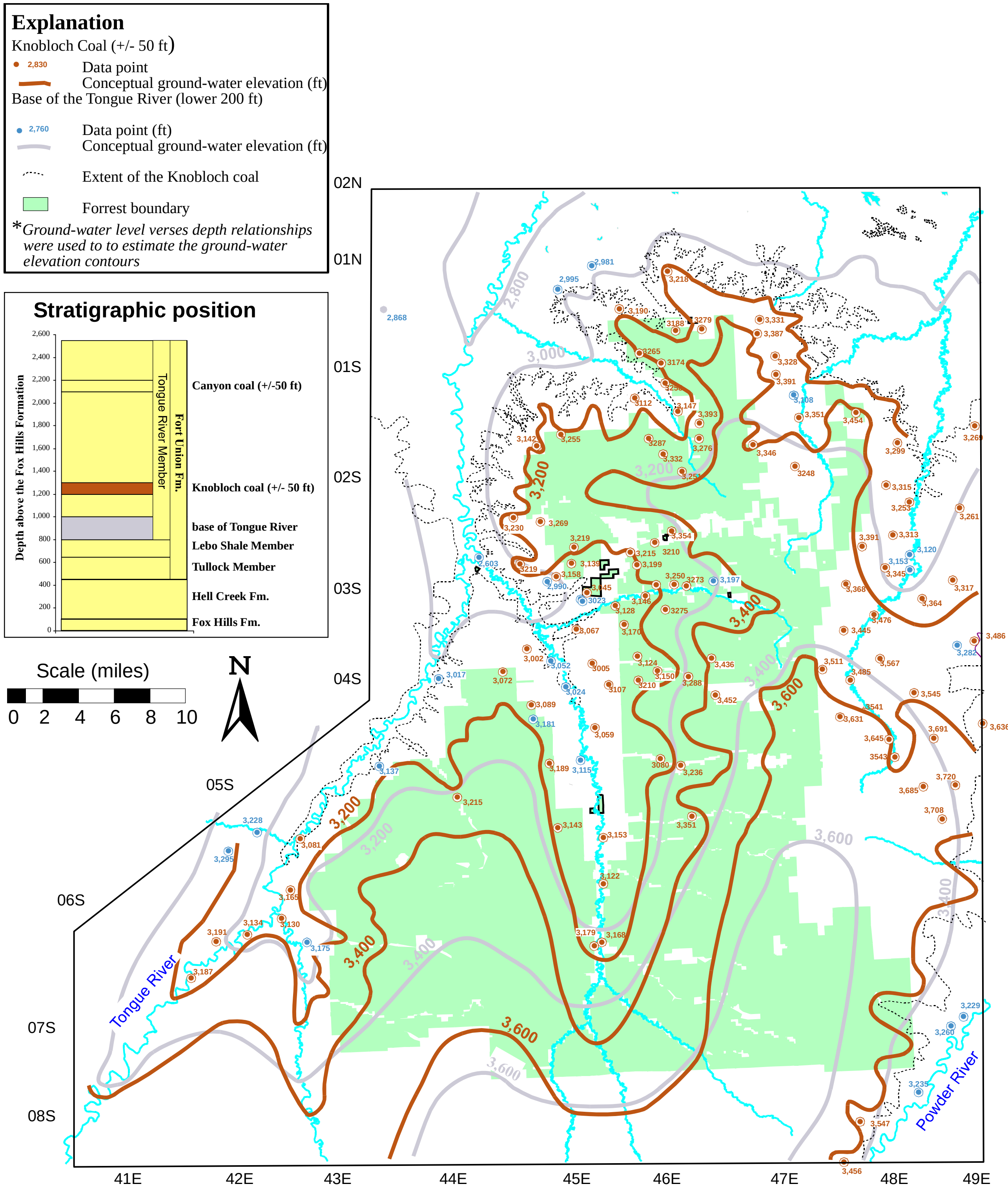

Figure 7. Conceptual ground-water altitudes for aquifers near the base of the Tongue River Member and for the Knobloch coal.

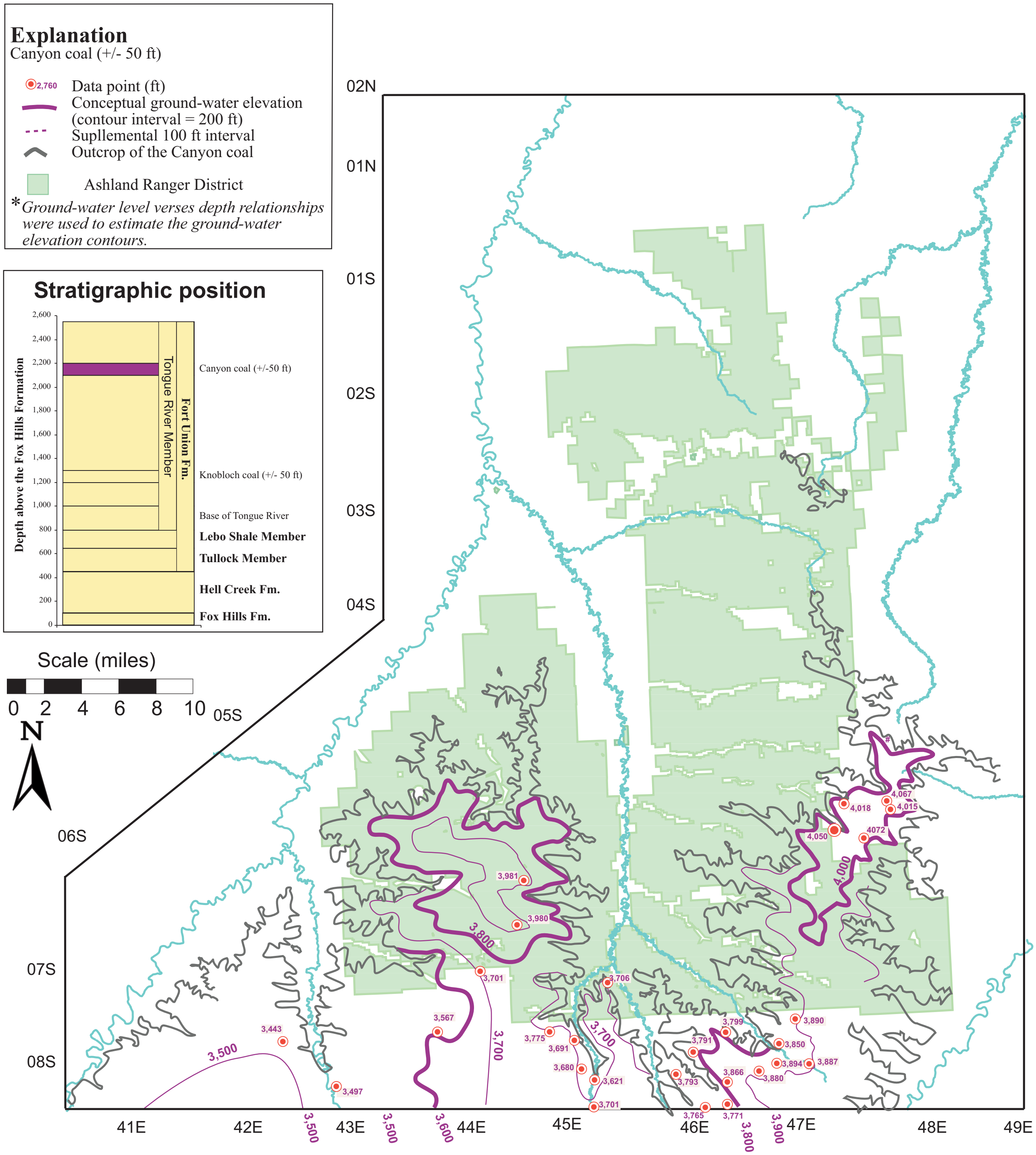

Figure 8. Conceptual ground-water altitudes for the Canyon coal.

figures 6, 7, and 8, a relationship was developed between the water level and well depth for the Fox Hills Formation and water level and well depth for selected wells. Using the established relationship, water levels were estimated for each aquifer over the entire area and contoured to generate the potentiometric maps. At locations where the water level in a well is known, the estimated potentiometric surface is generally within about +/- 50 ft.

Aquifers

Fox Hills and Hell Creek formations

The Fox Hills and Hell Creek formations underlie the entire District (Plate 3). The Fox Hills and Hell Creek formations contain sandstones that are productive aquifers in areas north of the District. Reported discharge rates from these wells are typically between 10 gallons per minute (gpm) and 15 gpm (GWIC). However, due to drilling depths necessary to reach these units, no well records indicate completions in these aquifers within the District (GWIC).

The potentiometric surface is the altitude to which water will rise in a well completed in that specific aquifer and is shown on Figure 6. Ground-water flows are perpendicular to equal-potentiometric lines (contours) on the potentiometric surface and movement is from higher to lower altitudes. Ground water in the Fox Hills flows generally north, with some topographic control near major streams such as the Tongue River. The gradient of the estimated potentiometric surface is about 15 ft per mile. The potentiometric surface for the Hell Creek Formation is expected to be very similar to that of The Fox Hills, but at slightly higher elevations due to the higher stratigraphic position of the Hell Creek relative to the Fox Hills Formation.

Based on samples collected from wells outside the District, water chemistry in these formations is dominated by ions of Na^{+}, HCO_3^{-} and SO_4^{2-}. The total dissolved solids concentrations range from 400 mg/L to 5,000 mg/L and average about 1,500 mg/L (GWIC).

Fort Union Formation

Tullock Member

The Tullock Member is not identified as the source of water for wells within the District, however it is identified in GWIC as the source for 2,905 stock and domestic wells in the PRB in Montana. These wells are located north of the District, but several are near the District boundary (Figure 6). Typical discharge rates for wells completed in the Tullock are between 10 gpm and 15 gpm (GWIC).

The Tullock Member is 300 ft to 500 ft thick and consists predominantly of sandstone and shale (Plate 3). Based on the estimated potentiometric surface (Figure 6) ground-water flow is generally northward. Most recharge to the Tullock occurs well outside the District in areas of outcrop along the margins of the PRB. Additional recharge probably occurs by limited vertical leakage from the overlying geologic units. Discharge occurs well outside the District, along outcrops and where the Tullock subcrops beneath alluvial fill associated with stream valleys such as the Tongue River. Based on calculations of river baseflow, the Tongue River receives about 13 cubic ft per second (cfs) of baseflow from the Tullock Member between the Brandenburg Bridge and Miles City (Woods, 1981; Vuke and others, 2001a; Vuke and others, 2001b).

Water quality in the Tullock Member is similar to that found in other deeper aquifers, and is dominated by ions of Na^+, HCO_3^- and SO_4^{2-}. Total dissolved solids concentrations range from 400 mg/L to 5,000 mg/L and average about 1,500 mg/L (GWIC).

Lebo Shale

The Lebo Shale is not an aquifer, but rather is a regional aquitard. It effectively separates flow systems in the Tongue River Member from those in the deeper aquifers. It is an important consideration in ground-water resources because it will limit potential vertical migration of impacts between those systems due to its role as an aquitard.

Tongue River Member

The majority of ground water used in the District to support livestock and wildlife is obtained from springs and wells completed in sandstone and coals of the Tongue River Member. For the entire PRB in Montana, the Ground-Water Information Center (GWIC) identifies 2,779 stock and domestic wells that are completed in the Tongue River Member. Within the study area, 34 stock water wells were inventoried (Appendix E). The typical discharge rates for these wells are between 5 and 15 gpm.

Drilling logs from the MBMG monitoring wells installed during the past 3 years indicate that on average, less than 40 percent of the Tongue River Member is composed of potential aquifer material (of the 8,649 ft drilled at 16 sites, 25 percent sandstone and 14 percent coal). The remainder is siltstone and shale having low hydraulic conductivity values that cannot transmit significant quantities of water. The sandstone has a wide range of hydraulic conductivity values due to grain size, sorting, and cement that fills the pore spaces.

Coal seams in the Tongue River Member are important aquifers in southeastern Montana because they are more laterally continuous than sandstone units. It is the ability to transmit water and extensive nature of the coal seams that make them the targets for stock and domestic well drilling. Areas of outcrop and subcrop beneath alluvium and colluvium provide springs for livestock and wildlife and baseflow to streams. Sandstone units are also used as aquifers, though to a lesser degree than coal.

Recharge to Tongue River Member aquifers occurs both as regional recharge along the margins of the PRB and locally along clinker-capped ridges. The proportion of each recharge source is not known.

The estimated potentiometric surfaces for sandstones near the base of the Tongue River Member and for the Knobloch Coal are shown in Figure 7. The estimated potentiometric surface for the Canyon Coal is shown in Figure 8. No single sandstone unit is present under the entire study area, rather there are a series of discontinuous sands such as the channel sands mapped by Lopez and Heath (2007). The estimated potentiometric surface for sandstone shown on Figure 7 represents average conditions for those units near the base of the Tongue River Member. Within an individual channel-sandstone unit, ground-water flow would be controlled by boundary conditions and follow the orientation of the sand bodies - generally north and northeast. In Figure 7, ground water in both the coal and sandstone aquifers flows generally northward, with more topographical control in the shallower coal aquifer. Generally, in the Ashland Ranger District, the ground-water gradient near the base of the Tongue River Member is between 15 and 50 ft/mile, while in the Knobloch Coal it is between 30 and 80 ft/mile.

In most areas, there is a downward vertical gradient which supports leakage from shallower to deeper aquifers. However, in several small areas, such as in T6S, R42E in the southwest part of the map in Figure 7, the vertical gradient is upward. Due to this gradient, there are a number of flowing wells completed in the deeper sandstone units along the Tongue River near the community of Birney.

Due to the structure of the basin (Plate 3), the upper portion of the Tongue River Member is exposed in the topographically high areas in the southern part of the District. The estimated potentiometric surface for the Canyon Coal (Figure 8) shows what is considered to be typical flow pattern for these shallow units. Some ground-water originates to the south and flows into the District. This is locally augmented by recharge on ridges such as in T6S, R44E.

The potentiometric surface, measured at individual wells at regular intervals (static water level) shows how the aquifers respond to long-term weather patterns and other stresses such as pumping. Water levels in the Tongue River Member measured at the Liscom well (Figure 9) show declining trends during 2002 and 2005 through 2006 with recovery during intervening years and in 2007. These water-level trends may correlate with annual precipitation patterns, which would indicate some degree of local recharge is reaching this aquifer. Water levels at the Tooley Creek well show several drops of 30 ft or more (Figure 10). These correspond to times when the measurement was made while the well was being pumped. Recovered water levels, measured between times of pumping, indicate a slight long-term decline in water levels which may reflect the current drought conditions.

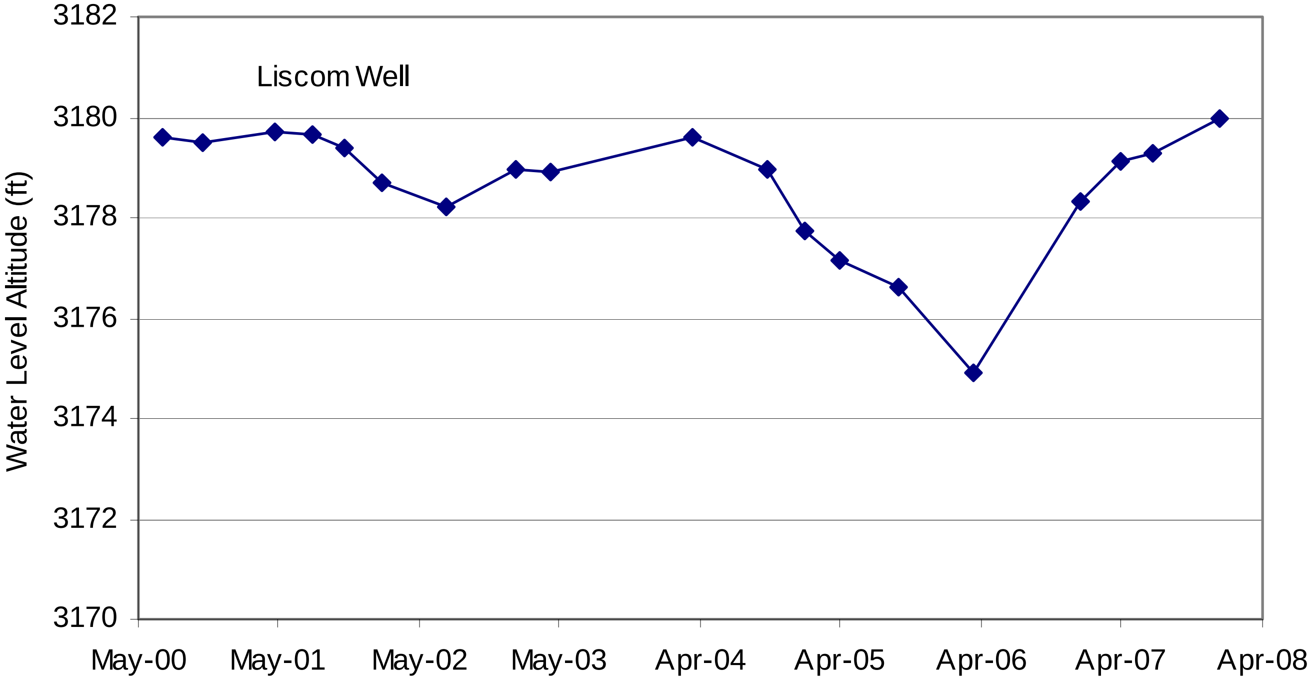

Figure 9. Hydrograph for sandstone aquifer at the Liscom well (GWIC M:94661) which is completed in the Tongue River Member of the Fort Union Formation. Map location is Township 01S Range 46E.

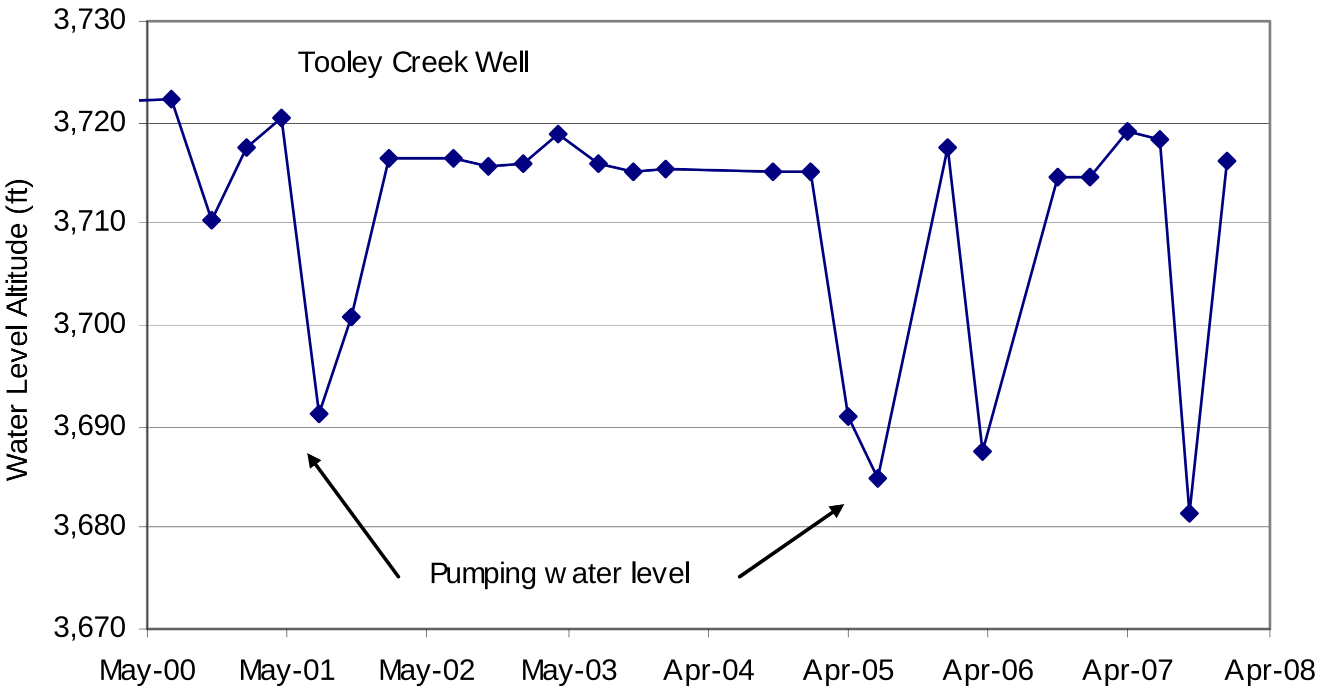

Figure 10. Hydrograph for sandstone aquifer at Tooley Creek well (GWIC M:105007). The 30 foot drops in water levels correspond to the times when the pump was turned on. The overall slight long-term decline in water levels may reflect the current drought conditions. Map location is Township 07S Range 45E.

South of the Ashland Ranger District at monitoring site CBM03-11, water levels in 3 coal beds are measured (Figure 11). The data indicate a downward vertical gradient between the Anderson and Canyon coals. Only the Dietz coal shows a long-term trend, which in this case is one of declining water level.

Temporal changes in water levels and an example of upward vertical gradient between bedrock and alluvial aquifers are demonstrated on figures 12 and 13. A sandstone above the Knobloch Coal subcrops in the alluvium. Ground-water levels in the sandstone aquifer are at a higher altitude than those in the alluvium, therefore ground water is discharging from the sandstone to recharge the alluvium. In each successive, deeper bedrock aquifer the water levels are higher than those in the overlying unit. Temporal changes in water levels indicate a degree of connection between the alluvium and the bedrock aquifers (Figure 13).

Ground water in the Tongue River Member aquifers discharges above the Lebo Shale to springs and streams. The Lebo Shale outcrop area is well north of the Ashland Ranger District (Vuke and others, 2001a). A relatively minor amount of the ground water in the District is intercepted by water wells. That portion of ground water discharged to streams is either lost as evapotranspiration or leaves the area as stream flow. The Tongue River receives approximately 23 cubic ft per second (cfs) of ground-water discharge from the Tongue River Member between the Tongue River Dam and the Brandenburg bridge (Woods, 1981; Vuke and others, 2001a; Vuke and others, 2001b).

Hydraulic conductivity is a measure of the ability of an aquifer to transmit water and is determined in the field by means of aquifer testing. A review of available aquifer test results (54 tests) for Tongue River Member aquifers indicate hydraulic conductivity values in sandstone units have a geometric mean of 0.2 ft/day (Wheaton and Metesh, 2002). Aquifer thicknesses averaged 36 ft and reached a maximum of 110 ft for units tested. The geometric mean for hydraulic conductivity from 370 tests in coal is 1.1 ft/day (Wheaton and Metesh, 2002). Average thickness of tested coal seams is 27 ft and the maximum is 96 ft. Due to extensive lateral continuity, and generally higher hydraulic conductivity as compared to sandstone, coal seams are the primary target for water well completions in that portion of the Powder River Basin that lies in Montana.

Variation in water quality along flow paths in Tongue River Member aquifers has been documented by Van Voast and Reiten (1988). Generally, water quality in recharge areas is dominated by ions of Ca^{2+}, Mg^{2+} and HCO_3^-. Sulfate concentration increases with depth as does the total dissolved solids (TDS). Contact with shale results in increased Na^+ concentrations and decreased Ca^{2+} and Mg^{2+} concentrations. In deeper systems, SO_4^{2-} is removed by bacteria and the water quality is dominated by ions of Na^+ and HCO_3^-. For example, springs that are located proximate to the recharge area, such as Cow Creek Spring, have water quality dominated by Mg^{2+}, Ca^{2+}, and HCO_3^- with low TDS concentrations. Coalbed methane-production water is from the deeper Na^+ and HCO_3^- dominated systems and is expected to have a moderate TDS concentration (approximately 570 to 2,000 milligrams per liter (mg/L); (Wheaton and others, 2005). Plate 4 shows water quality from springs and wells within the District boundaries.

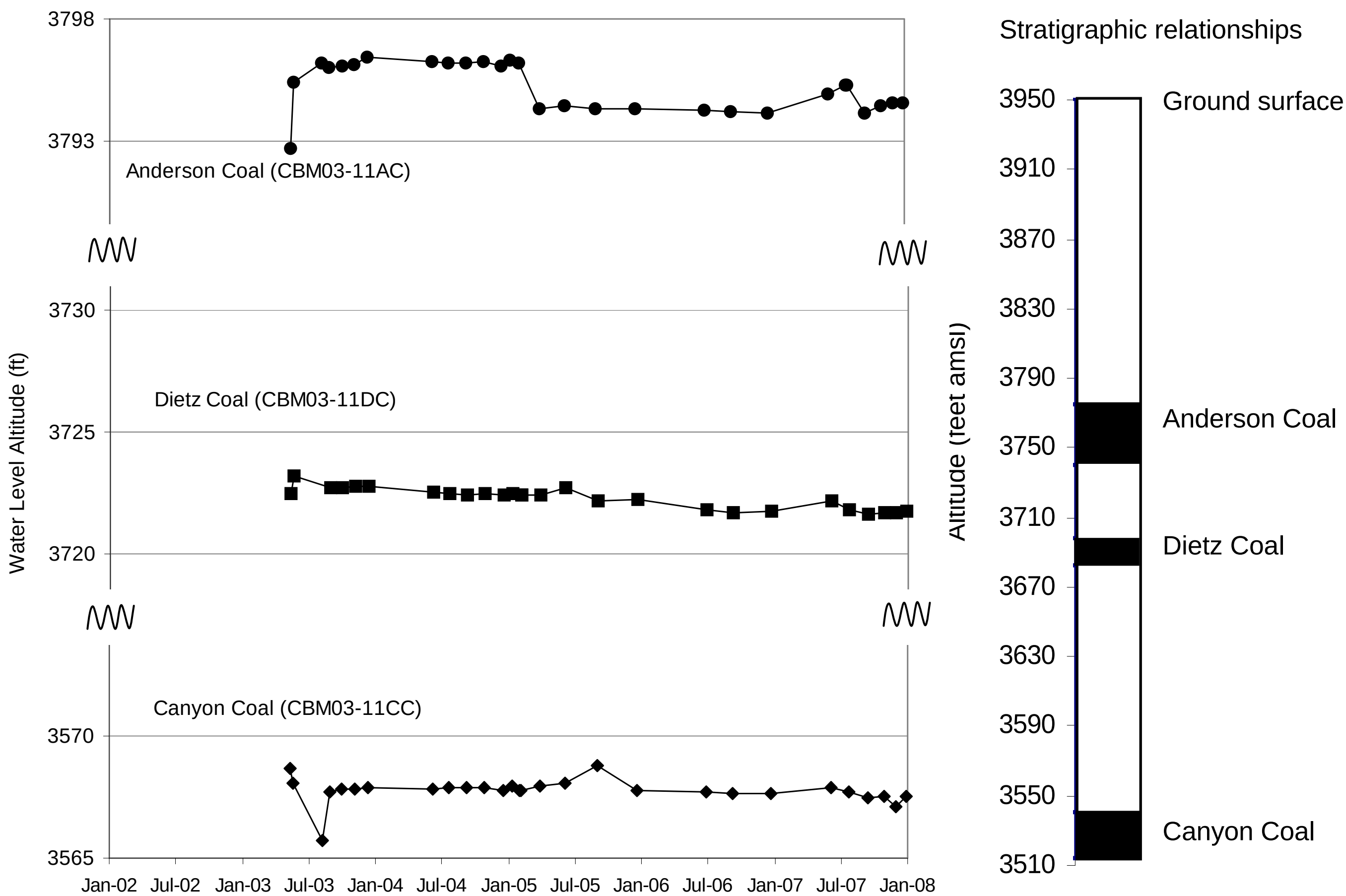

Figure 11. Hydrograph for Anderson, Dietz and Canyon coals at the CBM03-11 site. A downward hydraulic gradient is evident between the coal beds at this site. Map location is Township 08S Range 44E. (GWIC M:203705, M:203707, M:203708)

Note: The vertical scales of the stratigraphic relationship and the hydrograph are different.
The Y axis scale is broken to show better hydrograph detail.

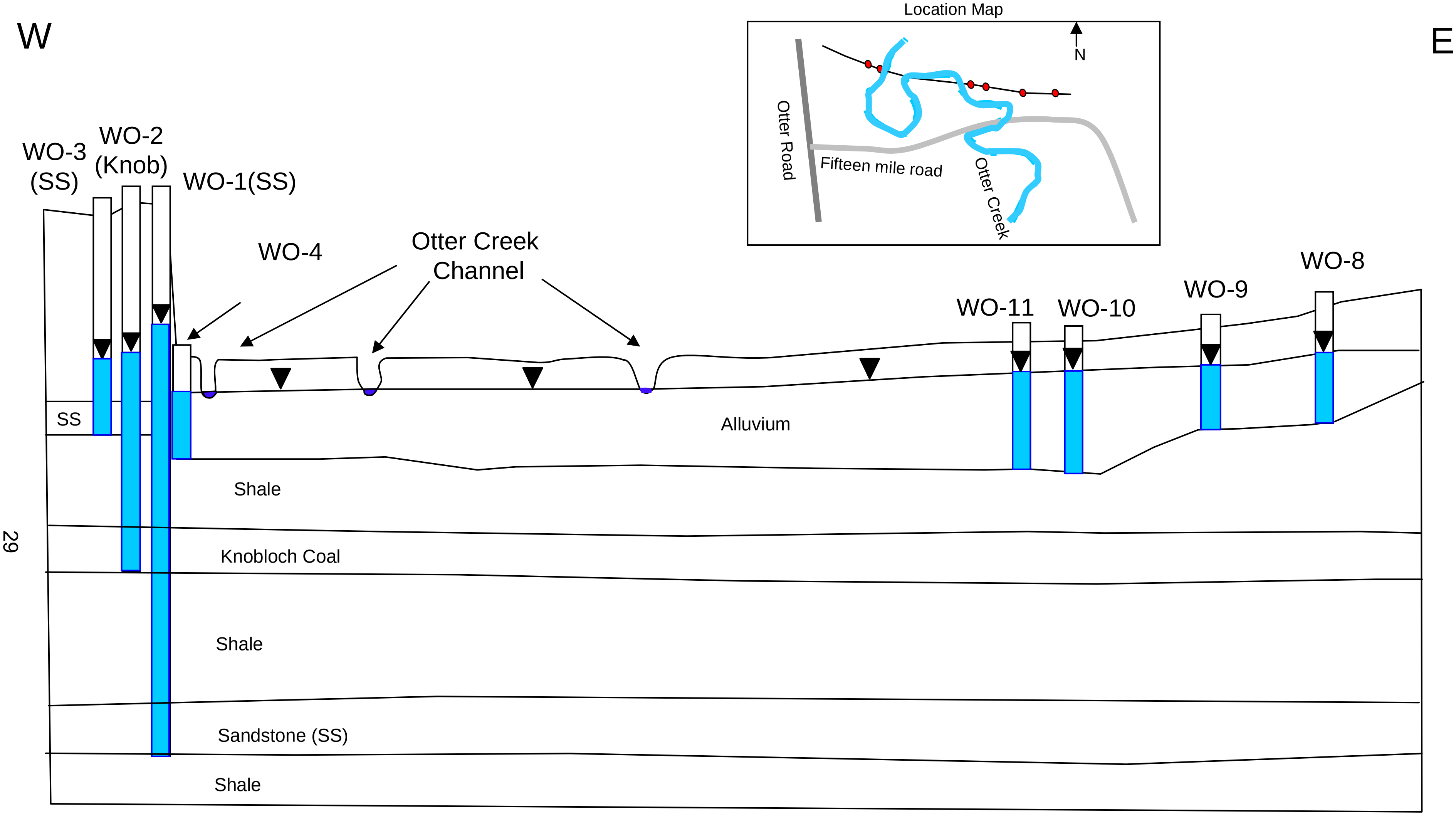

Figure 12. Geologic cross section for Otter Creek alluvial and bedrock wells located in T05S R45E sec 23 near well WO-1. Water levels in the alluvium are lower than the underlying bedrock aquifers. The water levels in the bedrock wells completed in stratigraphically deeper units are higher than those in shallower units. The water levels for this cross section were taken in February 2007. Vertical exaggeration is 9.6:1. (Modified from Cannon, 1985)

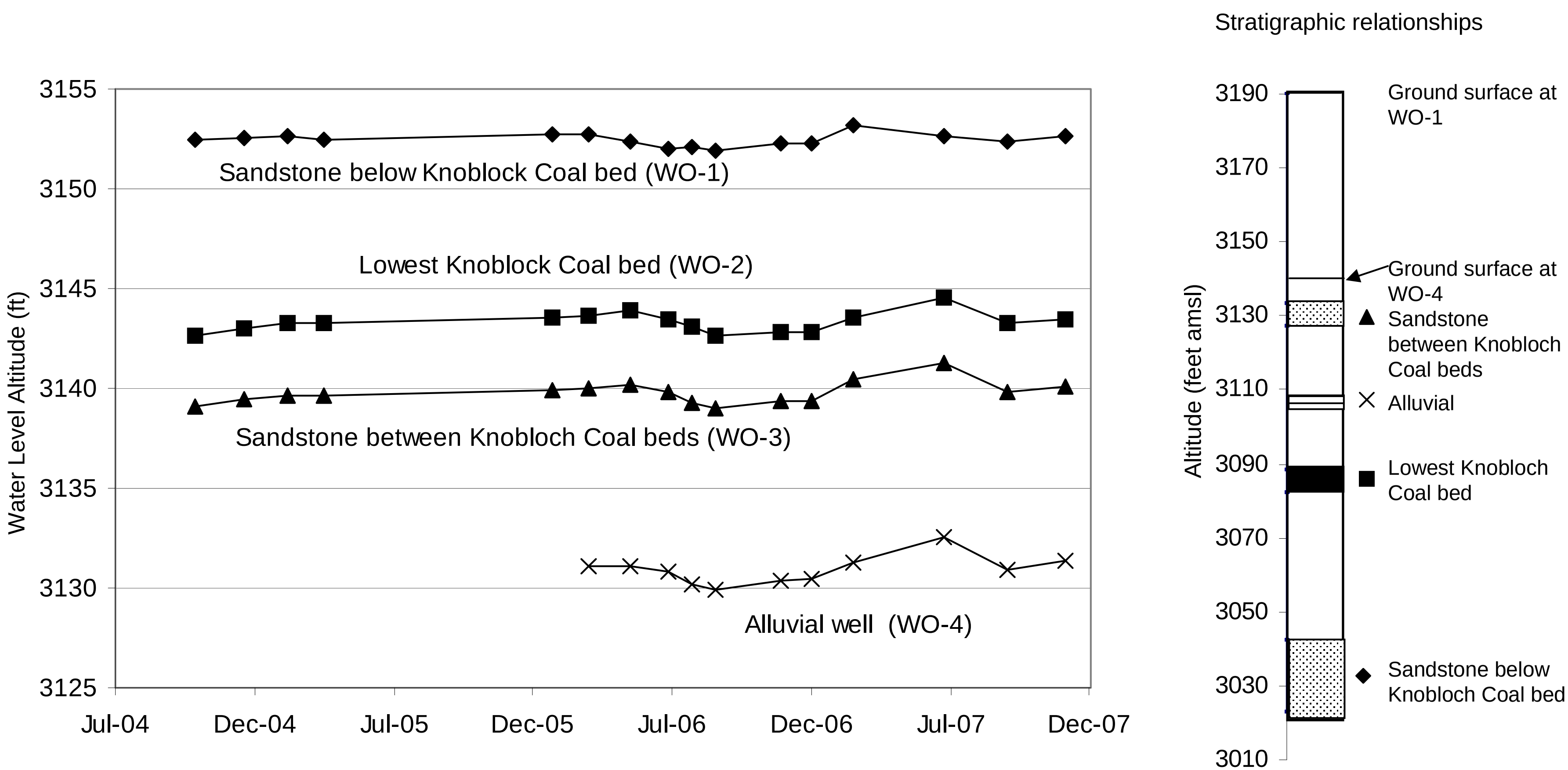

Figure 13. Hydrographs for sandstone and Knobloch Coal near well WO-1 along Otter Creek. Bedrock aquifers at the Otter creek area have an upward vertical gradient, flowing wells are common in the area. The alluvial well appears to show the general seasonal water year cycle. Map location is Township 05S Range 45E. (GWIC M:7780, M:7781, M:7782, M:7783)

Note: The vertical scales of the stratigraphic relationship and the hydrograph are different.

Clinker

Clinker areas allow precipitation to infiltrate and either form clinker aquifers or seep downward recharging underlying aquifers. Clinker springs are a common feature in the District and provide important water sources in topographically high areas.

Alluvium

Water supplies have been developed as springs and wells in the alluvium of the Tongue River, and to a lesser degree in the Powder River and in tributary valleys. Perennial streams exist where saturated alluvium discharges to the channel providing baseflow. Springs form where the slope of the valley floor is steeper than that of the alluvial water table and intersects saturated material. Wheaton and Donato (2004) reported springs in the District with alluvial sources. However, the small area where alluvial aquifers are present within the District limits their usefulness as water resources.

In the Ashland Ranger District, productive alluvium generally consists of clinker gravel from adjacent hills. Alluvial aquifers are recharged directly by local precipitation or by discharge from bedrock aquifers that subcrop in the alluvial fill. The water table (or potentiometric surface) of alluvial aquifers follows the local topography and ground water flows down the valley beneath and/or adjacent to the stream channel.

Alluvial aquifers respond very rapidly to weather and transpiration, typically showing annual cycles. Data from monitoring wells WO-8, 9 and 10 along Otter Creek indicate rising water levels during the fall and winter months and decreasing water levels during the spring and summer (Figure 14).

The geometric mean hydraulic conductivity values from 206 aquifer tests for alluvium across the PRB in Montana is 61 ft/day (Wheaton and Metesh, 2002). Saturated thickness for alluvium, reported from tests, average 17 ft and reach a maximum of 50 ft.

Springs

A total of 409 springs in the Ashland Ranger District were visited and inventoried during 2002 and 2003. Locations and descriptions are contained in Donato and Wheaton (2004). Of the 409 springs, 284 had measurable discharge, ranging from 0.01 up to 15 gpm. Springs were assigned to stratigraphic intervals based on the nearest overlying coal bed, shown on Figure 5.

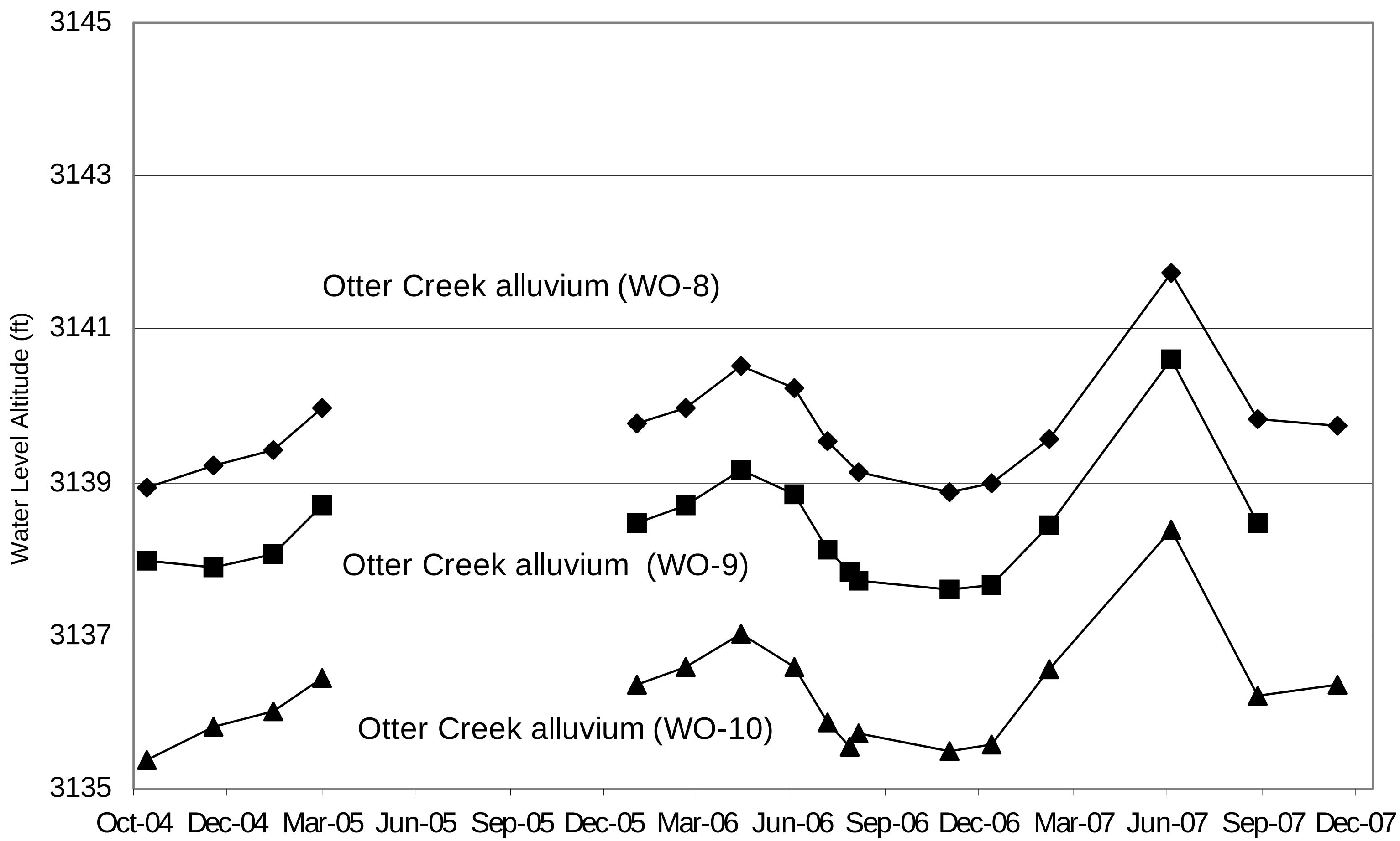

Figure 14. Hydrographs for Otter Creek alluvial wells near WO-10. Water-level trends in the alluvium at the Otter Creek site probably relate to weather patterns. The alluvial aquifer appears to receive recharge from the bedrock aquifers in the area, based on the upward vertical gradient. Map location is Township 05S Range 45E. (GWIC M:7770, M:7772, M:7775)

Occurrence of springs

Springs typically issue from porous clinkers, sandstones and coalbeds near their contacts with underlying mudstone or shale units along hillside outcrops or by the intersection of the water table with the land surface. Commonly, the sources of the springs are obscured by alluvial or colluvial deposits.

The District contains some of the highest elevations in southeastern Montana. High areas tend to receive more precipitation, and many high ridges in the District are capped with clinker. These areas likely are the source for local recharge for many of the springs in the District. Valleys separate many springs from the regional flow systems and therefore discharge from those springs likely represents local recharge. Also, springs that show strong seasonal fluctuations in discharge rates probably reflect local flow systems. Springs that are stratigraphically low and that show minimal seasonal fluctuations are more likely discharge areas for regional flow systems. Some combination of local and regional flow system may actually be the most common explanation for spring occurrence in the District.

To assess geologic distribution of water, the study area was divided into five hydrologic units. Following topographically high ridges, the area was divided into a series of tributaries (Plate 5). In the following discussion, only those springs that had measurable flow are considered.

Water quantity

Spring discharge can be a result of discharge from a local ground-water flow system (precipitation falling within the immediate watershed boundaries) or a regional ground-water flow system (precipitation falling outside the watershed and traveling some distance in the aquifer to reach the discharge point at an outcrop), or some combination of these. Local flow systems tend to respond much faster to weather patterns (dry periods or heavy rainfall) and are susceptible to impacts only in the immediate area.

Correlation between precipitation events and spring discharge rates is a useful tool to distinguish regional and local ground-water flow systems. In local flow systems, precipitation can reach the spring quickly, causing an increase in flow. In regional flow systems, water may travel for several to thousands of years and therefore discharge rates from regional springs fluctuate very little. For all springs in the District, the correlation between precipitation and spring discharge is based on short periods of record. This relationship will be better defined through long-term monitoring.

A total of 62 springs had a discharge rate of 1 gpm or greater during the 2002-2003 inventory. During the inventory, total spring flow was 257 gpm from the 284 flowing springs in the District. The stratigraphic intervals associated with springs are indicated on Figure 5.

Springs were divided into four categories based on the geologic material comprising the associated aquifer: alluvium, bedrock, clinker and unknown. During the inventory field work, the source lithology (sandstone, coal, alluvium, clinker, and colluvium) for each spring was identified where possible. These data are listed in Appendix A. There is some uncertainty in lithology identification because source areas were typically not visible and lithology was often inferred from surrounding exposures. In many sites the source material could not be identified and is left blank in Appendix A. The spring count and cumulative flow for each category is shown on Figure 15. By far, the greatest number of springs and the largest total flow is associated with bedrock springs. This is not surprising since alluvium and clinker have much smaller areal distributions than Tongue River Member bedrock. In addition, alluvium is recharged by a combination of bedrock discharge and, to a lesser extent by direct infiltration of precipitation. Because of the influence of bedrock discharge to alluvium, the alluvial springs are included in figures 16 and 17 in the nearest overlying stratigraphic interval of the spring location.

Both spring occurrence and flow are fairly evenly dispersed throughout the area of the District (Plate 5). The total number of springs and the cumulative discharge per associated coal unit is shown on Figure 16. The associated coal units are shown with brackets on Figure 5 and each includes the named coal and sandstone underburden. The Cook Coal is associated with the most springs (60), and the Anderson Coal zone is associated with the greatest cumulative flow (107.2 gpm from 57 springs).

As shown on Figure 17, the average discharge per spring is largest for the Anderson/Dietz zone (1.9 gpm). Those springs associated with the Otter and Sawyer coals have average discharge rates of about 1 gpm. The Smith and the Brewster-Arnold coals are associated with the smallest average discharge rates (0.1 gpm) but each unit only represents 1 spring (Figure 16).

By far, more springs and the largest spring discharges are associated with the stratigraphically higher units, which include beds from the Pawnee coal up to the Anderson/Dietz coal zone (figures 5 and 16). Springs are located along outcrop areas of the associated coal bed or underlying sandstone, and the pattern of spring locations approximately follows the coal outcrops shown on Plate 1. Individual coal beds are not typically continuous across the entire area of the District. Anderson/Dietz coal zones springs are most common in the southwest area of the District, Canyon coal springs occur throughout the southern area, springs associated with the Ferry coal occur in the northern area of the District, those associated with the Cook coal occur in the central area, and Pawnee springs occur in the central and northern areas.

On Plate 5, the area with the largest total area and the largest volume of spring discharge (165.6 gpm in area 2) is located within the heart of the District draining Otter and Home Creek watershed. Within this area the most productive geologic unit is the combined Anderson and Dietz. The combined units in the Anderson coal zone produce about 59.1 gpm. Also in this area the Cook and Pawnee stratigraphic units produce large quantities of water at 28.2 and 21.8 gpm respectively.

Areas 1, 4, and 5 produce lower total quantities of 21.9, 27.6, and 31.5 gpm per area, respectively. The most productive units in areas 4 and 5 are the Anderson and Dietz. The most productive interval in area is the Pawnee. Lastly, area 3 which is the

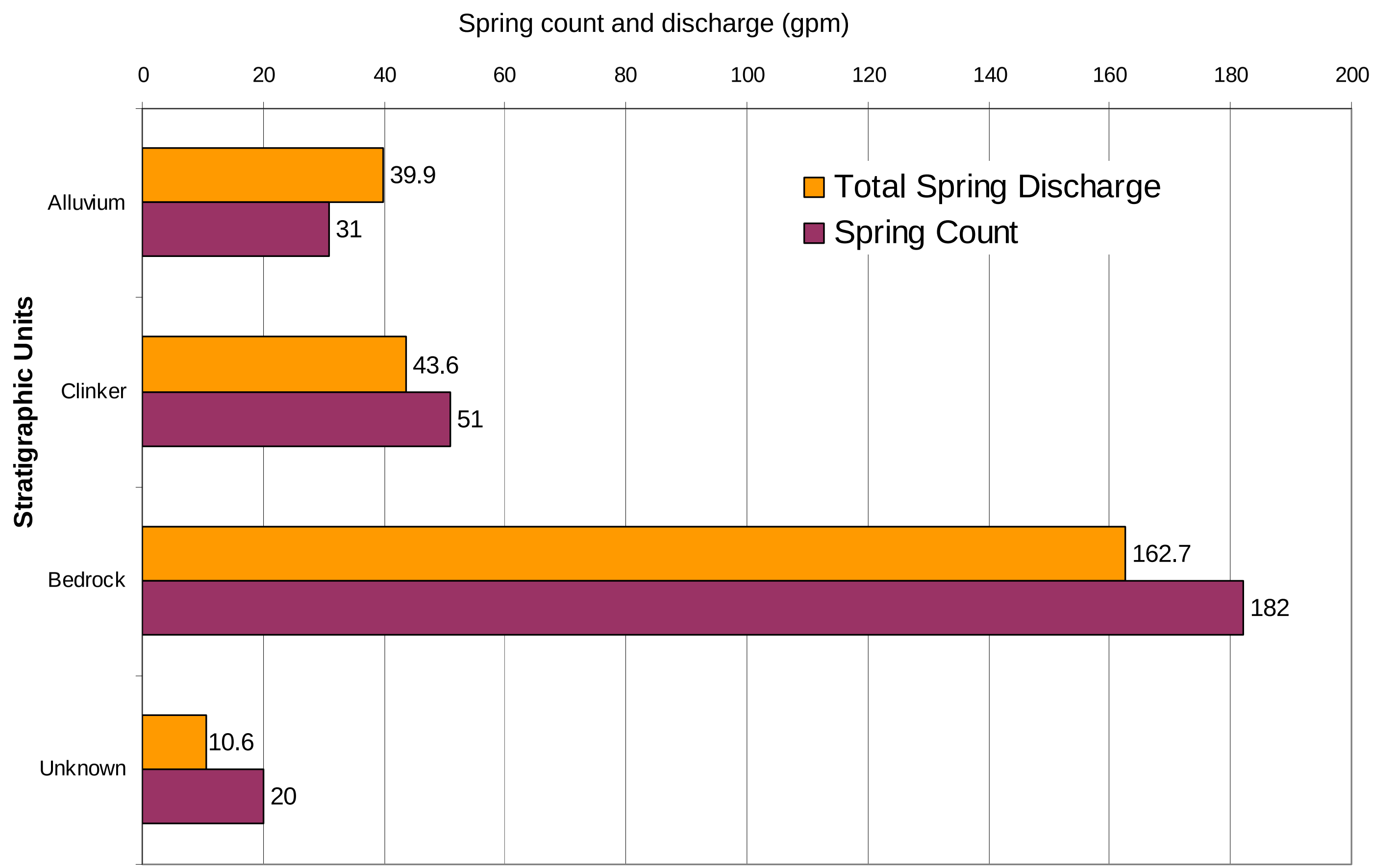

Figure 15. Total number of springs and cumulative discharge for stratigraphic units suggest that most springs and the greatest cumulative flow is associated with bedrock sources.

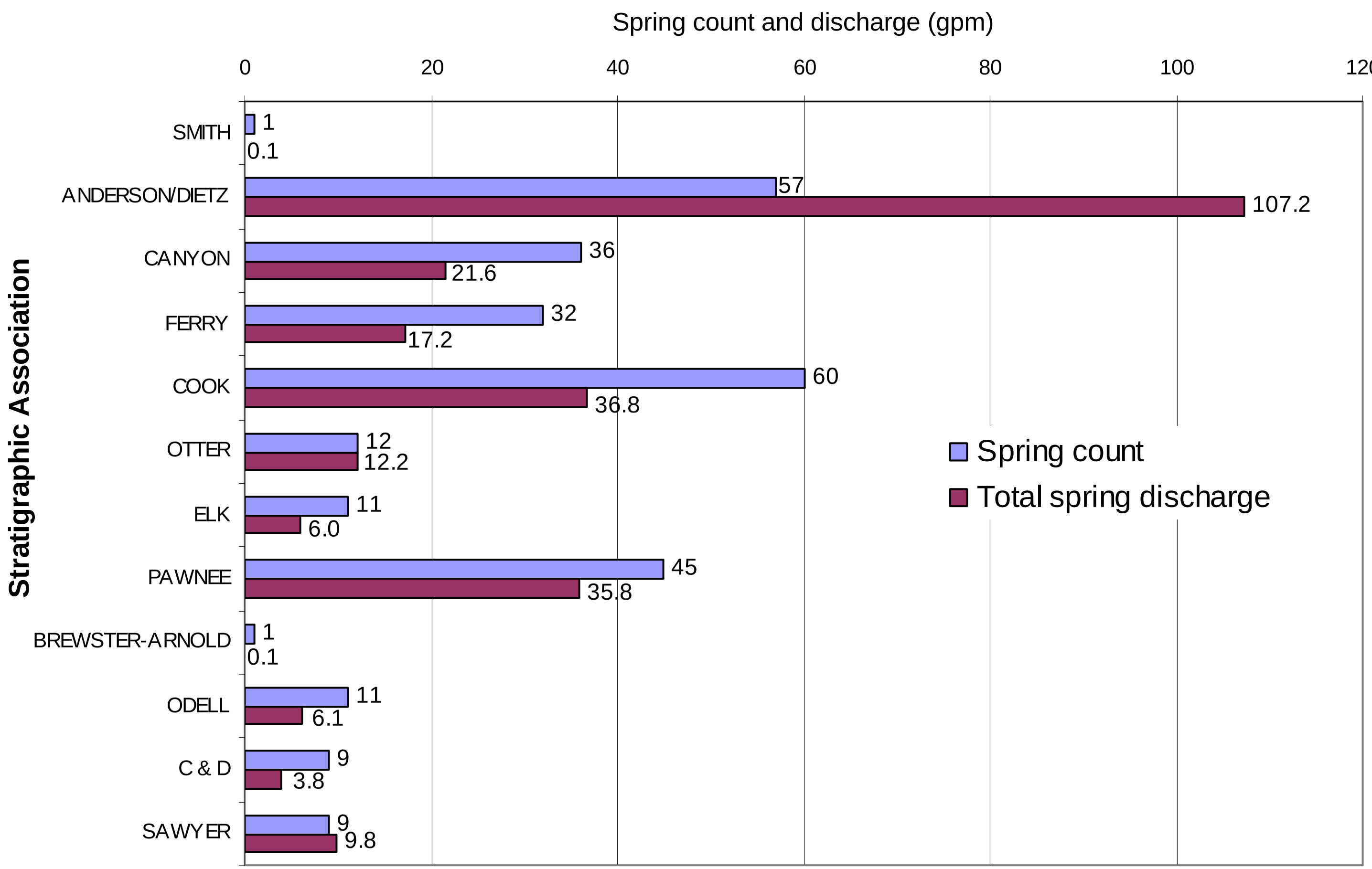

Figure 16. Total number of springs and cumulative discharge for individual coal bed association suggests the Cook coal supplies the most springs and the Anderson/Dietz coals have the greatest cumulative flow.

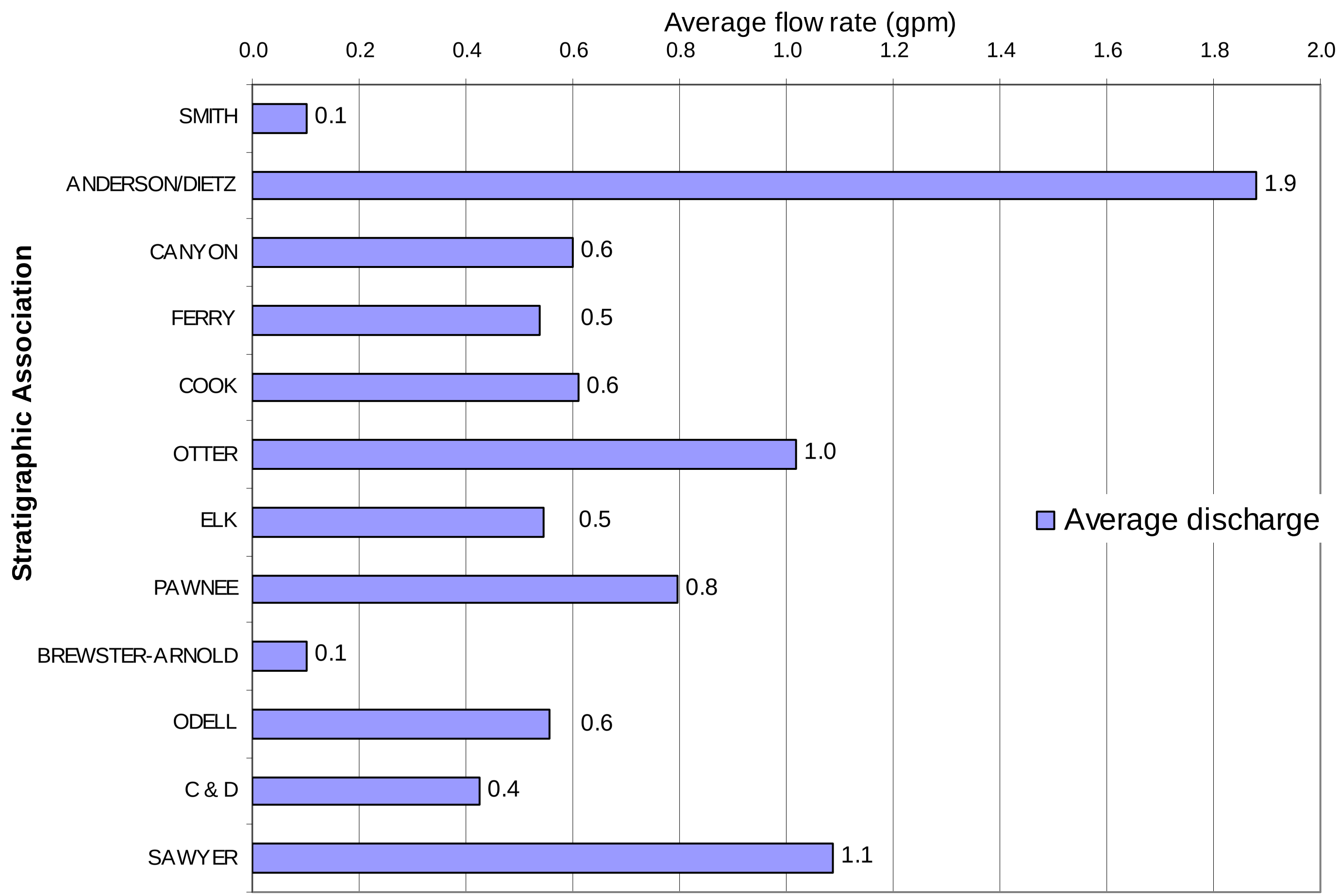

Figure 17. Average spring discharge rates for individual coal bed associations. Springs associated with stratigraphic intervals that include the Anderson/Dietz coal zone and underburden have the greatest average flow rates.

smallest watershed produces 10.1 gpm. In this area the Canyon and Cook are the most productive units both producing 4.2 gpm.

Spring-discharge hydrographs for sites that represent different areas of the District and different stratigraphic associations are presented in figures 18 through 23. In the northern part of the District, the North Bidwell Spring (GWIC ID: 198819) shows small seasonal variations (Figure 18). This spring is sourced in the clinker of the Ferry coal. This spring no doubt receives some local recharge, but the steady flow rates and lack of correlation with precipitation patterns (figures 2 and 3) indicate a strong component of regional flow.

Lemonade Spring (GWIC ID: 198766) (Figure 19), in the north-central part of the District, is sourced in the Ferry underburden and shows fairly stable flow rates indicative of regional flow recharge. However, while North Bidwell Spring flow has decreased slightly since 2004, Lemonade Spring has actually increased, especially during 2007. A large wildfire in this area during 2004 may have altered the recharge pattern, reducing transpiration and allowing a greater percentage of precipitation to recharge the ground water. The reduced transpiration, coupled with the wet spring of 2007, probably explains the increased flow and demonstrates the influence of local recharge at this site.

The source for North Fork Spring (GWIC ID: 205010; Figure 20) is the Canyon Coal underburden. It is in the north-central part of the flow area and shows moderate fluctuations over the period of record. Flow from this spring did not increase in response to the spring, 2007 precipitation and is therefore considered to be dominated by regional recharge.

In the south-central part of the District, an unnamed spring on lower Cow Creek (GWIC ID: 197395) shows some seasonality prior to 2007, and then a strong increase in flow rate (Figure 21). There had also been a large wildfire in this area, but a number of years prior to the increase in flow. The increase in flow is likely the result of the combination of reduced transpiration demand and the high precipitation received in the spring of 2007 (figures 2 and 3). The source of this spring is sandstone beneath the Otter coal and the spring is located topographically low in the watershed. Topographically high in the same watershed, and recharged by clinker of the Anderson coal, the Cow Creek Spring (GWIC ID: 7909) shows strong seasonal fluctuations over this short duration of record (Figure 22). This spring is the water supply source for the Fort Howes workstation.

In the southern part of the District, Alkali Spring (GWIC ID: 197452) is sourced from the Otter coal (Figure 23). This spring is a discharge point for the regional flow system, plus it receives some local recharge. The spring-flow graph for this spring correlates with the precipitation shown in figures 2 and 3, indicating local recharge.

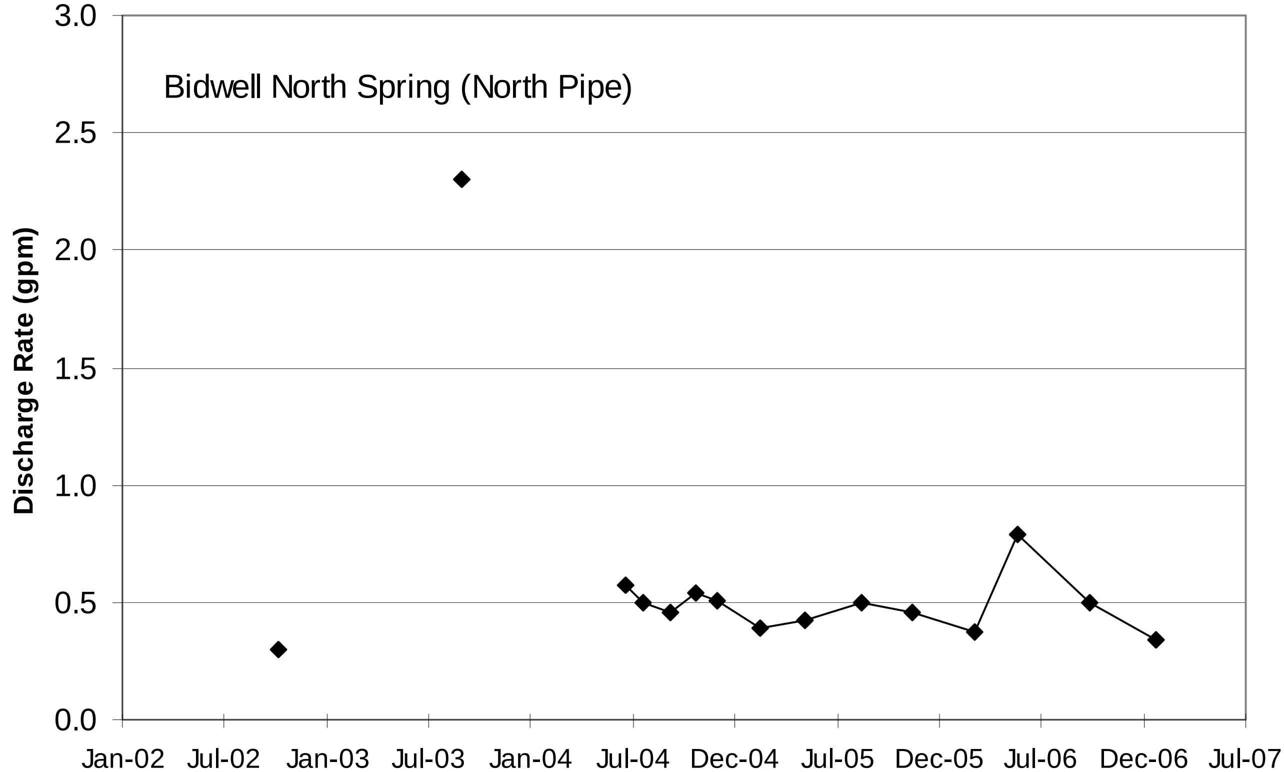

Figure 18. Hydrograph for Bidwell North Spring. The Bidwell Spring (GWIC as M:198819) appears to be locally recharged by a flow system below the Canyon and Ferry coal beds. The spring discharge rate is about 0.5 gpm. The isolated high discharge in 2003 may represent a precipitation event. Map location is Township 02S Range 47E.

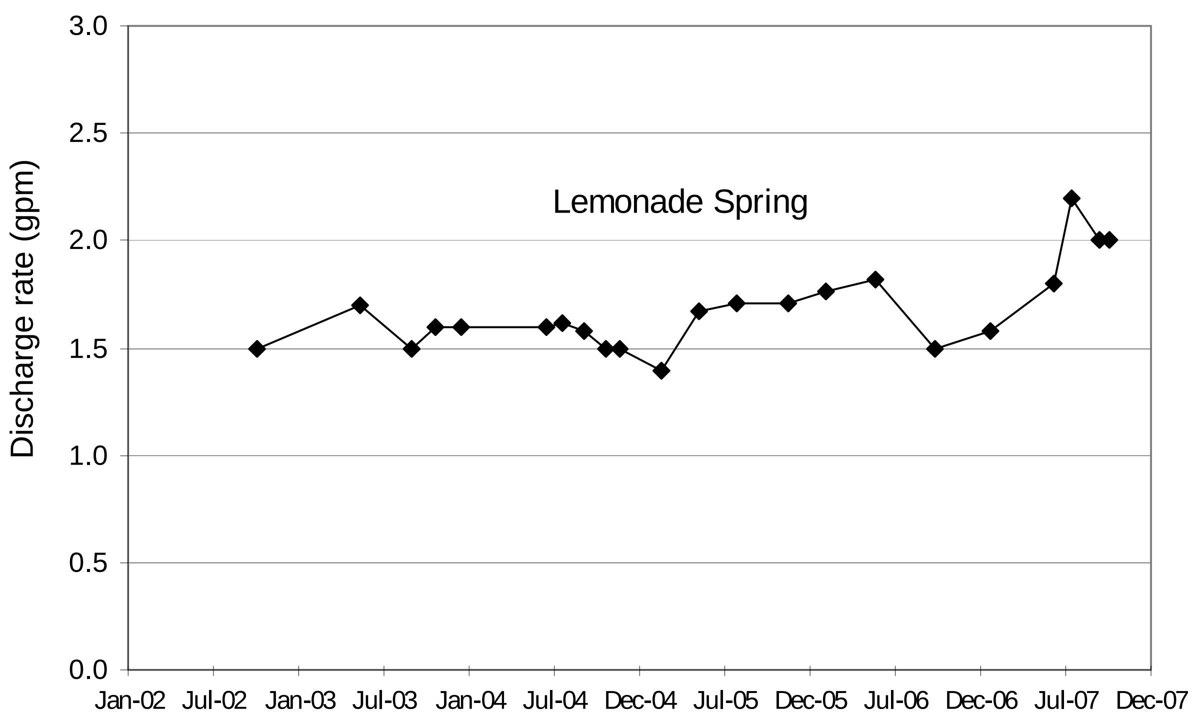

Figure 19. Hydrograph for Lemonade Spring. Lemonade Spring (GWIC M:198766) appears to be locally recharged by the Canyon and Ferry coal beds. The spring has an average discharge of 1.7 gpm. Map location is Township 03S Range 47E.

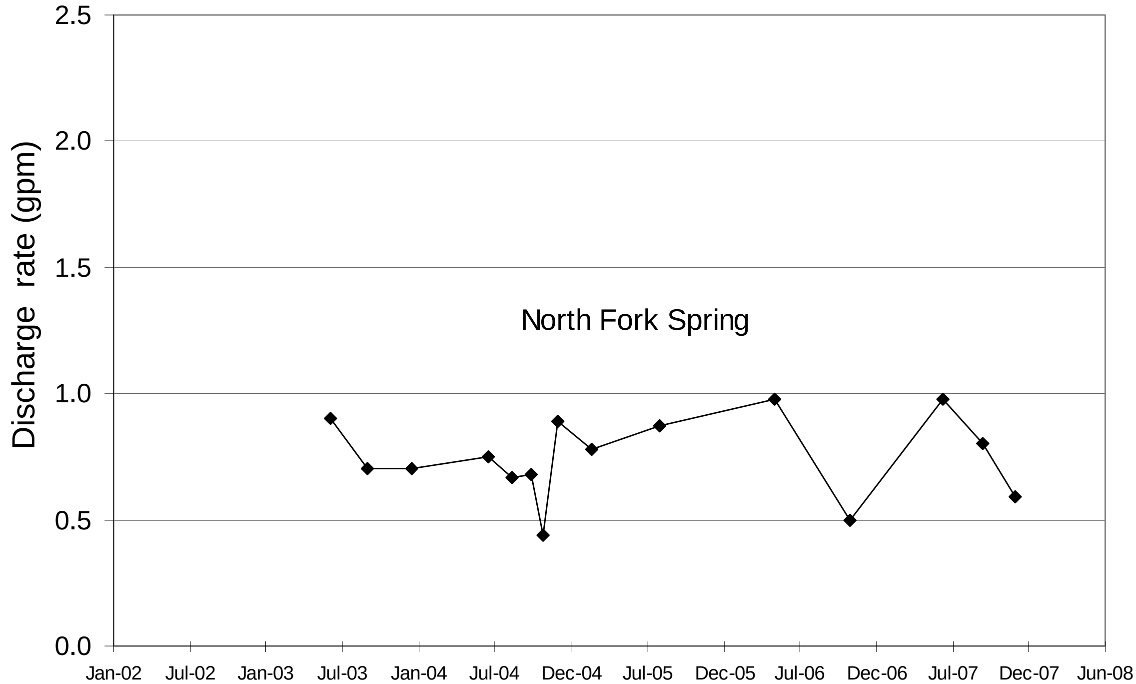

Figure 20. Hydrograph for North Fork Spring. The North Fork spring (GWIC M: 205010) appears to be locally recharged by the Canyon Coal aquifer. The spring discharges less than 1 gpm. Map location is Township 06S Range 48E.

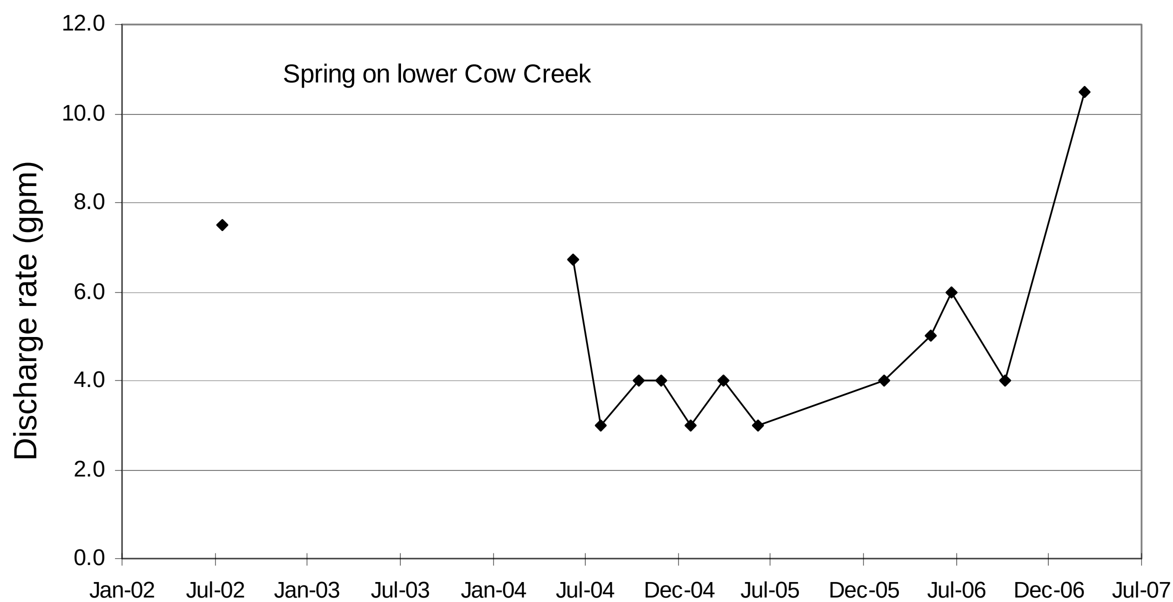

Figure 21. Hydrograph for spring on lower Cow Creek (GWIC M:197395). This spring is locally recharged by the sandstone above the Cook coal bed. The average discharge rate is about 5 gpm. Map location is Township 06S Range 45E.

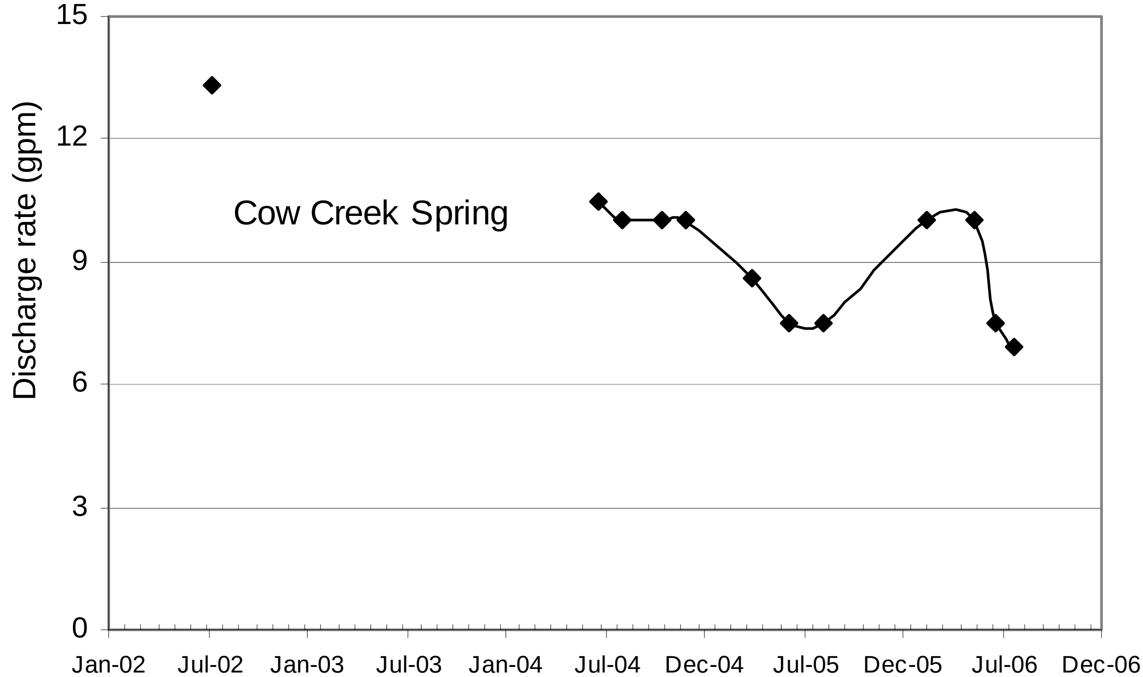

Figure 22. Hydrograph for Cow Creek Spring. Cow Creek spring (GWIC M:7909) appears to be locally recharged by the clinker ridge above the spring. The spring discharges about 7 gpm. Map location is Township 06S Range 45E.

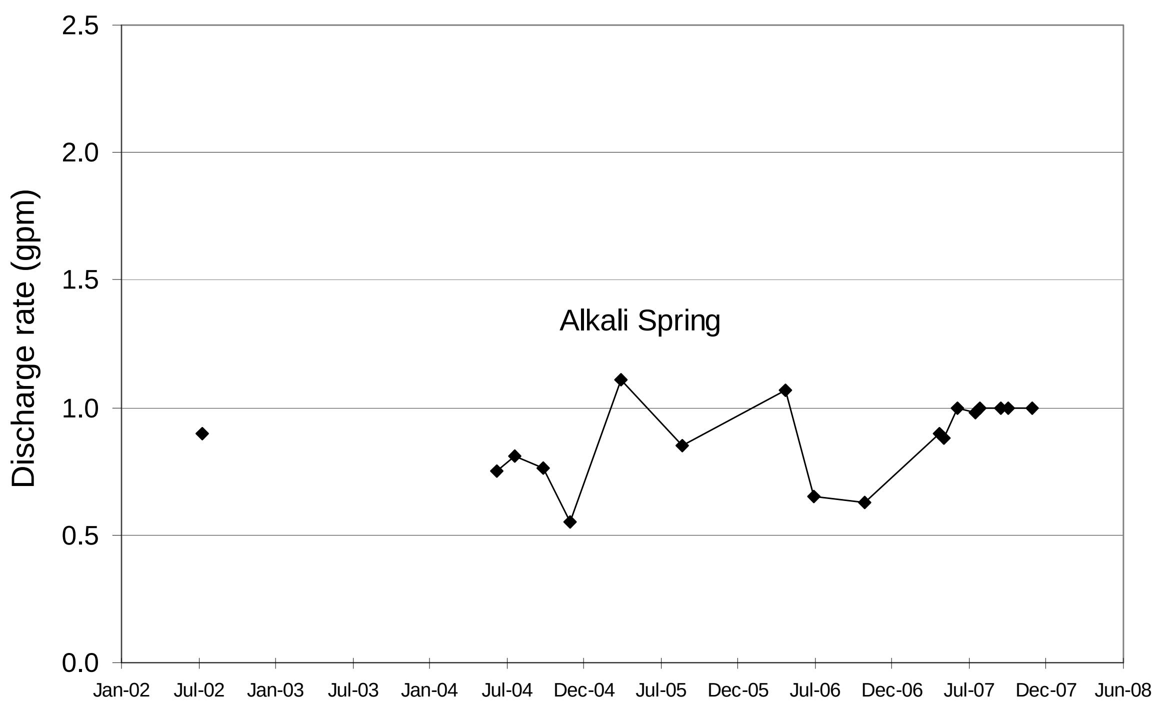

Figure 23. Hydrograph for Alkali Spring. This spring (GWIC M:197452) appears to be a combination of local and regional recharge associated with the Cook coal aquifer. The spring discharges at about 0.9 gpm. Map location is Township 07S Range 46E.

Water quality

Those springs with the lowest TDS contents (as indicated by low specific-conductance values measured at all inventoried springs and listed in Appendix A) are usually associated with clinker beds high in the stratigraphic section. Those with the highest TDS appear to be springs that have the longest flow paths from recharge areas, perhaps of regional scale. The TDS concentration in sampled springs ranged from 267 to 4,997 mg/l. The ratio of Na^+ to $Ca^{2+}$and Mg^{2+}, the sodium adsorption ratio (SAR), values for the springs ranged from 0.4 to 31.4.

Water-quality samples for laboratory analysis were collected from 29 springs between 1974 and 2007 (Appendix C). The water in sampled springs and wells mainly contained Na^+, Mg^{2+}, and SO_4^{2-} ions. There is a general water quality trend related to recharge altitude. The aquifers topographically higher receive relatively fresh recharge from precipitation. This water then follows flow paths into deeper aquifers undergoing chemical changes along the way to become more concentrated in Na^+, Mg^{2+} and SO_4^{2-} ions. Locally recharged springs generally have lower TDS concentrations, composed of Mg, $Ca^{2+}$and SO_4^{2-} ions. Regional springs generally have higher TDS with higher concentrations of Na^+, SO_4^{2-} and HCO_3^-.

Coalbed methane is held in the coal by water pressure. Therefore, CBM development does not typically occur near outcrop areas because the water pressure is naturally reduced by seepage from the outcrop. Also, the water quality in local flow systems is dissimilar to that associated with CBM producing areas. Coalbed-methane production water is dominated by ions of Na^+ and HCO_3^-, with little or no SO_4^{2-}. Water quality in local flow systems in southeastern Montana is typically dominated by ions of Mg, Ca^{2+} and SO_4^{2-}. Magnesium, Ca^{2+} and HCO_3^- can be the dominant ions very near the recharge area where SO_4^{2-} has not yet gone into solution. Water-quality data are used as one tool to distinguish regional and local ground-water flow systems.

Inventoried Streams

All identified streams in the District were visited and documented during the fall season, 2004. For the purpose of this study, streams were defined as reaches where water flowed in the thalweg for a distance of about 100 ft or more during the fall baseflow period. All inventory data are presented in Appendix D and the sites are shown on Plate 2.

Perennial stream flow

The only streams in or adjacent to the district that are perennial throughout their entire reach are: 1) the Tongue River, which drains the western and northern areas of the District; 2) the Powder River which drains the eastern part of the District; and 3) Otter

Creek, a tributary to the Tongue River which roughly splits the southern part of the District from south to north. Several streams such as Cow Creek, Horse Creek, Stocker Branch, Timber Creek and others contain short segments of perennial flow. The length of these segments is dependent on the volume of ground water discharging to the channel and losses to receiving ground water and evapotranspiration along the channel. The segments range in length from a few ft to a mile or more. Most of the District stream channels, however, are ephemeral and carry water only during spring runoff or during periods of prolonged precipitation. During this inventory there was measurable stream flow in 25 stream segments representing 19 different creeks in the District.

Stream flow is normally presented in terms of cubic ft per second. However, gallons per minute (gpm) was chosen as the unit for flow rates in the following discussion to stay consistent and more easily comparable with the spring and well discussions in this report.

Water quantity

Stream flows typically have greater seasonal variations than do either ground-water levels or spring discharge rates, which are a reflection of ground water discharge. Gaining streams receive ground water discharge and all streams receive runoff from storm events. Stream flows are decreased by evaporation from the stream surface, transpiration from phreatophytes in the riparian zone, irrigation withdrawals, and consumption such as by cattle and wildlife.

The cumulative stream flow inventoried in the District between October 12, 2004 and November 19, 2004 was 399 gpm. The inventory was conducted after the first killing frost of fall and at times when there had been no recent precipitation in order to capture baseflow conditions. Precipitation records (Figure 2) indicate that 2004 was a dry year among numerous years of drought. Due to the lack of precipitation, the Fall, 2004 inventory is likely to represent lower than normal flow conditions in the District. The greatest volume of flow was in the southern part of the District, with decreasing flow in streams located to the north. This stream-flow pattern is consistent with discharge areas of the northward flowing regional ground-water flow systems described earlier.

During the fall of 2004, only Cow Creek and Otter Creek had flow for extended or multiple reaches. All other streams inventoried in the District appeared to have a single point or short reach of gaining flow. Then decreasing flow with distance until the thalweg was dry.

Perennial flow was measured along an upper and along a lower section of Cow Creek (subsections 11 and 13 on Plate 2). Cow Creek Reservoir, an earthen-dam reservoir, is located near the head of the upper reach, a short distance below the complex of springs which include Cow Creek Spring. The springs contribute a cumulative discharge of approximately 16.5 gpm, of which approximately 7 gpm is diverted to Ft. Howes for public water supply. Flow, specific conductance and water temperature were measured at 14 stream inventory sites along Cow Creek.

Near the upper end of Cow Creek, the flow into the reservoir from the springs was 11.2 gpm during this inventory. This spring issues from clinker of the Dietz coal. Below the reservoir, the flow continued at about that same rate for nearly 1.5 miles before decreasing and ending in a damp thalweg. The channel was dry for another mile, at which point flow began seeping from the alluvium. Flow in this lower reach was continuous for less than one mile. Maximum measured flow in both the upper and lower reach was 13.5 gpm. Between the Cow Creek spring and the lower reach, baseflow to the creek could come from the Canyon and Otter coal beds and interburden sandstone units. Loss from the stream occurs to the alluvium, evapotranspiration and cattle.

Cow Creek is a tributary to Otter Creek, which is on private land. Detailed field work for Otter Creek was not included in this study. Cannon (1985) provided a detailed analysis of ground-water discharge to Otter Creek and concluded that between 15 Mile Creek and the Tongue River at Ashland, bedrock discharge added an annual average of 140,270 cubic ft per day (728 gpm) to the flow of the creek. This ground water flows from the Knobloch coal and underlying and overlying sandstone units.

As part of the current study, four flow measurements of Otter Creek plus data from the USGS gauging station near Ashland for October 13, 2004, indicate increasing flow south of Taylor Creek and then little change downstream to Ashland. The maximum flow was 135 gpm at Otter Creek site 1B (Appendix D and Plate 2). The farthest downstream flow rate measured was 44 gpm at the USGS gauging station near Ashland. The increasing baseflow described by Cannon (1985) was not apparent in this single set of measurements. However, a one-time set of measurements would not be expected to provide a detailed evaluation.

A permanent gauging station has been established on East Fork Hanging Woman Creek (subsection 6 on Plate 2). Stream flow measurements are recorded by a data logger at a v-notch weir (Figure 24). High flow rates during the spring indicate snow melt and runoff from spring storms and correlate well with precipitation at the Poker Jim meteorological station. Low flows during the summer and fall reflect the drier period of the year and the effect of transpiration during the growing season.

Water quality

Samples for laboratory analysis were not collected at Cow Creek, but specific conductance (SC) values, an approximation of TDS, give an indication of changes in water quality along the stream (Appendix D). The lowest SC value measured was near the Cow Creek spring, where the upper perennial reach begins. Here the SC value was 433 uS/cm^2. Downstream from this point the SC values in Cow Creek steadily increase (Figure 25). The highest value measured was 1244 uS/cm^2, near the end of the lower perennial reach. The increase in SC is likely the result of dissolution of available salts in the alluvial system, concentration by transpiration along the riparian zone during the summer, and possibly addition of bedrock discharge to the flow.

Three samples have been collected at the East Fork Weir for laboratory analysis during 2006 and 2007 (Appendix C and Plate 4). The SAR has ranged from 2.0 to 2.5

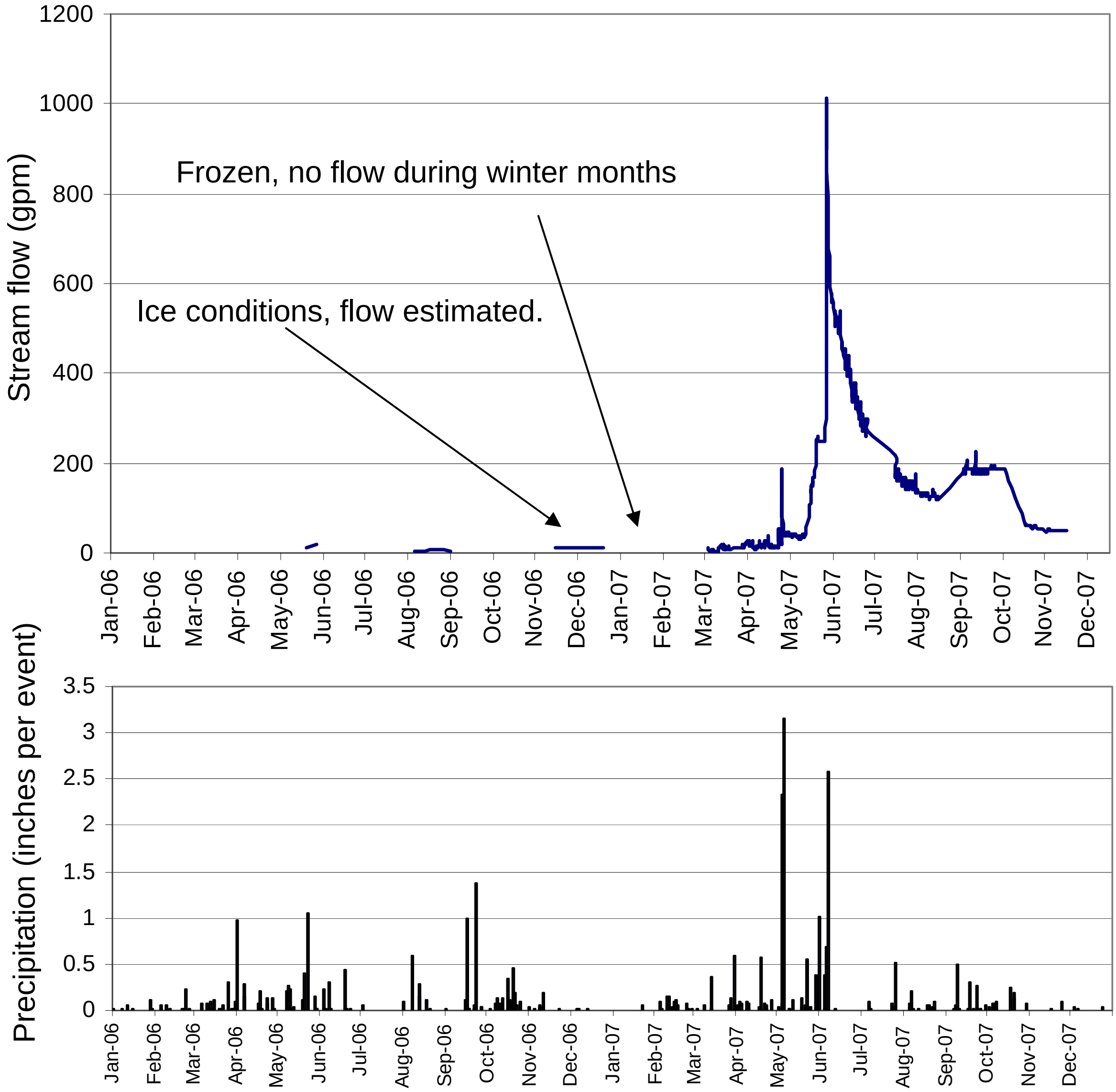

Figure 24. Hydrograph and precipitation data for East Fork Hanging Woman Creek M:223877. The relationship between surface flow, and the timing and magnitude of precipitation events is demonstrated by these data. Precipitation data are from the Poker Jim meteorological station. A series of significant rain events occurred during the spring and early summer, 2007 before the large flow event at the weir.

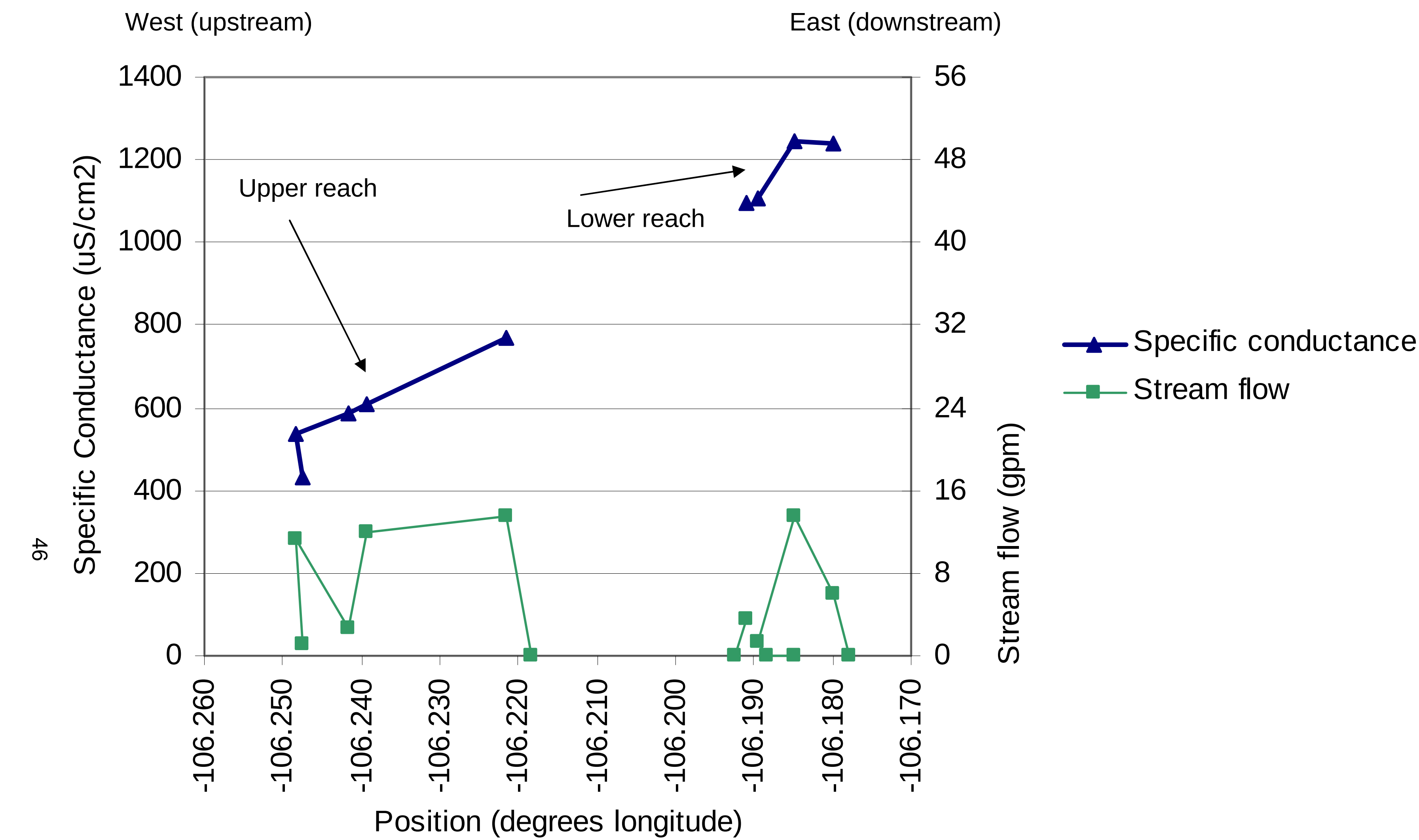

Figure 25. Specific conductance values measured in Cow Creek during October, 2004, increase downstream. The maximum flow rates in both the upper and lower reaches change little with distance downstream. The lower flow rates in each reach may be due to more water moving through the subsurface where the transmissivity of the alluvial aquifer is higher. The locations corresponds to section 11 on Plate 2.

with TDS concentrations of 855 to 1,155 mg/L. Specific conductance reflects the TDS concentration and is measured regularly at this site (Figure 26). During this period of record, SC shows a direct correlation with flow, increasing as the flow increases. This may be the result of soil salts being flushed during runoff after rain storms.

Data from six samples collected during the 1970's and 1980's by the USGS from Otter Creek between Fort Howes and Ashland are listed in Appendix C. The SAR values in Otter Creek range from 4.1 to 7.3. The TDS concentrations range from 1,569 to 4,085 mg/L. Data from a series of stream samples collected in October, 1977 (Plate 4) show an increase in Na^+ and SO_4^{2-} in the middle site (O-10S). The increase in Na^+ may reflect discharge from the Knobloch coal to the alluvium reaching the stream. The Na^+ concentration in the Knobloch coal is high, 1,027 mg/L in a nearby well (Newell Pipeline well, Appendix C).

Inventoried Wells

Thirty-four stock wells were inventoried within the project area (Appendix E). Lithologic records for these wells are missing or incomplete, so specific stratigraphic intervals and aquifer descriptions could be assigned to only a few. Of the inventoried wells, 10 are completed in alluvium and the other 24 are completed in the Tongue River Member.

Water quantity

Wells completed in the alluvium range in depth from 16 to 50 ft. The thickness of saturated alluvium in each of these wells ranges from 3 ft to 28 ft. As the wells may not have been drilled to the bottom of the alluvial material, the saturated thicknesses in the wells does not necessarily represent the total saturation of alluvium, but rather a minimum needed in order to obtain the desired pumping rates. The pumping rate is on record for only one of the alluvial wells, and none could be measured during inventory. The one reported pumping rate was 5 gpm.

Bedrock wells are interpreted to have been completed in the Tongue River Member at reported depths from 50 to 540 ft. Total drilled depths are not available for several wells, but it is unlikely that they would have been drilled deeper than the Tongue River Member. Lithologic logs are available for 10 of the wells and these indicate completions in sandstone and/or coal aquifers. Reported well yields range from 5 to 15 gpm and average nearly 10 gpm.

Water quality

Water-quality samples have been collected from four pipeline wells (Appendix C). Generally, the water in these sampled wells is dominated by Na^+, HCO_3^- and SO_4^{2-} ions, indicative of regional sources. The SAR values for the pipeline wells ranged from

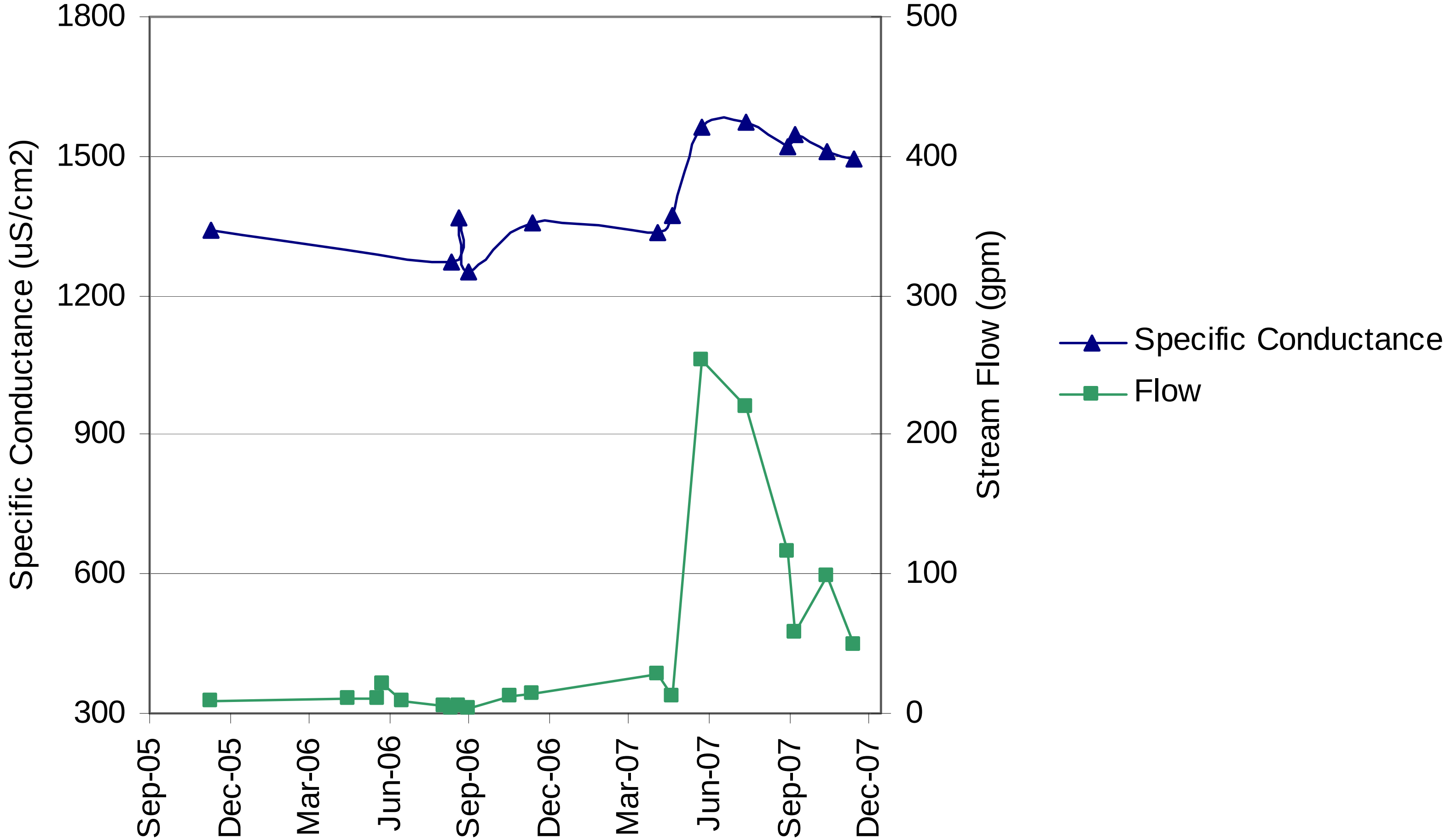

Figure 26. Specific conductance in the East Fork Hanging Woman Creek at site M:223877 generally increase with to increasing flow. Map location is Township 06S Range 43E.

14.6 to 64.1. The TDS concentration for the pipeline wells ranged from 1,053 to 2,873 mg/l.

Water quality from the Tooley Creek well, completed in sandstone above the Canyon Coal, is dominated by Na^+ cations and nearly equal concentrations of HCO_3^- and SO_4^{2-} anions in terms of milliequivalents per liter (meq/L) with a TDS concentration of 1,612 mg/L. Water from the Skinner Gulch pipeline well, completed beneath the Pawnee Coal, has a higher TDS concentration (2,873 mg/L) and is dominated by ions of Na^+ and SO_4^{2-} indicating this well is completed in an area of the aquifer with fresher or younger water that has not reached the sulfate reduction zone. The Newell pipeline well is completed in the Knobloch Coal. Water quality from this well is similar to the typical signature for coalbed methane produced water (Van Voast, 2003). Sodium and HCO_3^- are the dominant ions, SO_4^{2-} concentration is low due to its reduction and the SAR is 64. Water quality from the East Fork pipeline well, which is completed in coal and sandstone beneath the Knobloch Coal, is similar with Na^+ and HCO_3^- as the dominant ions, and low SO_4^{2-} concentration. Water quality from coal aquifers that is dominated by Na^+ and HCO_3 and low in SO_4^{2-} indicates areas where CBM can be expected to occur.

WATER SUPPLIES AND USES

Sufficient data are not available to develop a complete water budget for the Ashland Ranger District. However, some aspects of water inputs and water uses that can be estimated and discussed are summarized in Table 1. Water input to the study area includes precipitation, stream inflow and ground-water inflow. Water uses and outflows from the District include evaporation and transpiration (ET), consumptive uses such as stock water, stream outflow and ground-water outflow.

Based on an estimated average annual precipitation in the District of 16-inches per year, approximately 580,000 acre-ft of water falls each year in the form of rain and snow over the entire area of the District (435,000 acres). Averaged over one year, this is equal to an average flow rate of about 360,000 gpm. The rate of rainfall during an actual storm event is of course much greater. For example, a rainfall event totaling 0.5 inches over the entire District for a 24-hour period is falling at a rate of about 4 million gpm.

There is no stream flow entering the study area. The longest perennial reach is Otter Creek, which originates within the southern part of the study area and flows out of the study area to the north. Additional water input to the District is ground water in the regional flow systems entering the District from the south. However, for Tongue River Member aquifers, the ground-water outflow from the District is equal to the ground-water inflow to the District, plus recharge, less loss from the ground-water. In order for ground-water recharge to be part of the bedrock outflow from the District it would need to seep vertically to about the depth of the Knobloch Coal (Plate 3). Otherwise it is lost at the outcrop areas. For the purpose of this discussion, ground-water inflow and outflow in bedrock aquifers are assumed to be equal, less the loss of ground water within the

Table 1. Estimated water sources and uses for the Ashland Ranger District, Custer National Forest

	Amount (ac-ft/year)	Annual averge flow rate (gpm)	Comments
Sources and inputs			
Precipitation	580,000	360,000	Based on estimated average annual precipitation of 16 in/yr
Ground-water inflow	Unknown		Regional aquifers primarily recharged outside District boundary
Uses and outflows			
Otter Creek	800	600	Based on USGS data for period 1973-2006
Springs	340	260	Based on inventories during 2001-2003
Streams	520	400	Based on inventories during 2004.
Livestock (June - October)	200	120	21,815 annimals at 20 gal per day for 150 days, from wells and springs
Ground-water outflow	Unknown		Regional aquifer inflow less regional aquifer discharge in District
Evapotranspiration	~578,000	~358,000	Estimated, based on the above values

Sources:

Precipitation: Spatial Climate Analysis Service (SCAS) at Oregon State University (OSU) (http://www.prism.oregonstate.edu/products/matrix.phtml)

Otter Creek - http://waterdata.usgs.gov/mt/nwis/uv/?site_no=06307740&PARAmeter_cd=00060,00065,00010

Springs - Donato and Wheaton, 2004

Livestock - personal communication, Mark Nienow, Forest Service

District which is included as spring and stream flow, and water pumped from wells. Some recharge to the alluvial aquifers occurs from precipitation and spring discharge and no doubt a portion flows from the District in these shallow systems.

Total flow measured during spring inventories in the District was about 260 gpm. The total measured stream flow was just over 1,000 gpm, which includes the average annual flow for Otter Creek (USGS data for the period 1973 through 2006). Therefore the combined average annual surface flow from the District is estimated to be about 1,260 gpm.

Ground-water pumping rates are not documented for wells that supply the District. However, consumption rates can be estimated based on the number of cattle being watered. In the Ashland Ranger District, 21,815 head of cattle typically graze from June through October. Estimating 20 gallons per day per head for 150 days, the annual consumption by cattle is about 65 million gallons during the grazing season. As shown in Table 1, this volume, averaged over a period of 1 year, is equal to 120 gpm.

The majority of the water that falls as precipitation in the District is lost to ET. As there are only a few small areas of reservoirs, springs and streams, free-water surface evaporation accounts for a very small percentage of this loss. Evaporation from soil and transpiration are the primary consumptive water use in the District, with transpiration most likely accounting for most of that loss. Using this estimate, over the area of the District (435,000 acres) the annual loss to ET may be approximately equal to the annual average precipitation rate of about 16 inches of water per year and little regional ground-water recharge is expected to occur.

VULNERABILITY TO COALBED-METHANE DEVELOPMENT

If CBM production occurs in or near the Ashland Ranger District, the quantity of water available at some springs, streams and wells will be reduced due to the removal of large quantities of ground water by CBM wells. Those water supplies that obtain a portion of their water from coal beds that are developed for CBM will be most vulnerable to impacts. Little effect is expected in wells or springs that do not get at least some of their water from the coal seams. Because annular seals are not required in the state of Montana, all wells that penetrate saturated coals, even if they are not screened within the coal, are vulnerable. Donato and Wheaton (2004) listed the sources of water for springs in the District and discussed the likelihood of springs being impacted by possible coalbed methane or coal mining development. An updated version of that spring inventory list is included in this report as Appendix A. Water wells, such as the pipeline wells listed in Appendix E, are also susceptible to impacts, if they are completed in, or penetrate, a saturated coal bed subject to CBM development, and are within the areal extent of related drawdown.

Both CBM production and coal mines are known to disrupt ground-water flow, but differing development methods characteristic of each type can create differing impacts. In the case of coal mining, wells, springs and streams having local sources of recharge may be the most vulnerable to nearby development, while those fed by more regional recharge are of less concern. Regional flows characterize deeper aquifers, typically farther from areas of shallow overburden that are potential mine areas. In the case of CBM development, sources of water fed by the regional flow systems will be the most vulnerable. Methane does not occur in local flow systems because of the attendant oxidizing conditions and presence of SO_4^{2-}. Gas production will be more remote from recharge areas, tapping deeper aquifers where chemically reducing conditions encourage the stability and growth of methanogenic bacteria and where increased water pressure holds the methane in place. As such, the water sources that are vulnerable to impacts from CBM development will be different than those that are vulnerable to impacts from coal mining. This analysis looks only at vulnerability to impacts from CBM development. A similar analysis could be done for coal mining and would produce much different results than those presented here.

Off-District CBM development that may impact District ground-water resources is most likely to occur to the south, southwest or to a somewhat lesser degree east of the District (Van Voast and Thale, 2001). Springs, streams and wells located in those areas are of greatest concern for impact due to off-District development.

The areas and the coal beds that may eventually be developed for coalbed methane within the District boundary or adjacent to it cannot currently be specifically defined, and it is the area of development that will determine the potential for impacts on the District. In the event that flow from springs or streams, or discharge from wells is reduced or eliminated as a result of CBM production, replacement water supplies will be necessary to maintain the current activities and land uses in the District. The water supplies that are most susceptible to future impacts were identified so that appropriate monitoring programs can be designed. All sites listed in appendices A, D and E were evaluated, based on an assumed development scenario.

For the purpose of this assessment, the area of anticipated CBM development was based on the boundaries presented by Van Voast and Thale (2001). Within these general boundaries, areas where coal seams occur at depths greater than 300 ft and at least 3 miles from their nearest point of outcrop were considered as having development potential. Coal thickness, which may affect potential development, was not considered in this assessment. Note that the projected level of development is based solely on the criteria above, and not on economic factors such as the quantity of methane, distance to pipelines, etc. Neither does it take into account surface land use restrictions. For each coal bed that is associated with water supplies in the District (Figure 5), the outcrop area, the assumed CBM-development area, and the water supply sites (springs, perennial stream reaches and wells) were compared on a map. Ground-water flow directions for this assessment were based on figures 7 and 8.

The water supplies were then assessed based on the following criteria. The radius of impact from CBM development was assumed to be 5 miles from the edge of the potential production area (Wheaton and Metesh, 2002 and U. S. Bureau of Land Management, 2003). Water supplies that come from coal beds have the greatest chance of being reduced by CBM production. For sites where the source lithology was not known, the nearest overlying coal bed was assumed to be the source aquifer. The source lithology for some sites is identified as clinker, but the water has specific conductance (SC) values greater than 1,500 uS/cm^2. Water flowing through clinker should have a low TDS and therefore a low SC. Because bedrock aquifers typically have a higher SC value, clinker sites with SC values greater than about 1,500 uS/cm^2 were deemed to have an unknown contribution from bedrock and were included as coal source lithologies.

Water-supply sites that lie within 5 miles of the assumed development area and were identified or assumed to receive water from coal were assigned an impact-potential value of 2 (appendices A, D and E). An impact-potential value of 2 indicates sites that have a likelihood of being impacted if CBM development reaches the maximum extent used in this assessment. These sites should be monitored closely during development of CBM in or near the District. Those sites which are located within 5 miles of the southwest, south, and southeast District boundaries and which were rated as 2 would be the highest priority for monitoring impacts from off-District CBM development (Plate 6).

Water-supply sites that lie within 5 miles of the assumed development area but do not receive water directly from coal beds were assigned an impact-potential value of 1 (appendices A, D and E). These sites include sandstone units beneath the coal bed and alluvial springs or perennial streams below the coal outcrop.

Water-supply sites located further than 5 miles from the assumed development area, or that were not located within the ground-water flow paths intersected by CBM development area were not assigned an impact-potential value.

Water-supply sites with impact-potential values of 1 or 2 are shown on Plate 6. Twenty-four springs were assigned a value of 2, and 17 springs were assigned a value of 1. Of the 25 stream reaches inventoried, 5 were assigned a value of 2 and 2 were assigned a value of 1. Three wells were assigned a value of 2 and 15 were assigned a value of 1. This assessment was based on an assumed CBM development scenario which reflects the maximum aerial extent likely to occur in and around the District. Actual impacts to water supplies will vary from this assessment and will depend upon the stratigraphic intervals developed for CBM and the areal extent of that development. Monitoring of springs, wells and streams should be based on anticipated CBM development.

If CBM production occurs outside the District but not within the District, impacts to water supplies in the District will be limited to those shown on Plate 6 that are within about 5 miles of development. CBM development is most likely to occur along the southern edge of the District, with less potential for development along the western and eastern edges.

ONGOING WORK

Of the springs in the District that were inventoried previously, approximately 20 that cover the southern and eastern areas were chosen to monitor on a quarterly basis (Appendix B). Some springs outside the forest are also monitored on a quarterly basis. The monitoring consists of a volumetric (stopwatch – bucket method) measurement of flow; and temperature and specific conductance are measured with a field meter. Any changes in site conditions are noted. In addition to the springs, a weir and recorder is used to monitor stream flow on East Fork Hanging Woman Creek. A recording weather station has been installed near Poker Jim lookout. The monitoring network is reviewed and changed annually in accordance with new data and needs.

Regional monitoring wells surrounding and within the forest are visited and measured on a monthly, quarterly or semi-annual schedule depending on their distance to current CBM development. Those wells within the District are listed in Appendix F. Regular monitoring consists of measuring the static water level of monitoring wells. Water quality samples are collected semi-annually from selected wells, spring, and one stream to help identify possible impacts from CBM development and produced-water management.

CONCLUSIONS

The Ashland Ranger District of the Custer National Forest (District) is located in southeastern Montana and includes an area of approximately 435,000 acres. The forest is managed by the Ashland Ranger District located in Ashland, Montana. The District lies within the Powder River Basin which includes mineable coal deposits and reserves of coalbed methane (CBM). Currently there are no active coal mines or CBM development within the forest boundaries. Both coal mining and CBM development can remove large quantities of ground water from aquifers. Livestock and wildlife in the forest are dependent on ground water supplies and therefore, understanding the ground-water resources and potential impacts that future energy development might have is critical for resource managers.

Water supplies occur naturally and have been developed from sandstone units, coal beds, clinker and alluvium along streams within the Ashland Ranger District. There are two generalized types of flow systems within the Fort Union Formation: a deep system of aquifers, recharged primarily in Wyoming and along the edges of the PRB in Montana with flow toward the Yellowstone River; and local flow systems where shallow aquifers are primarily recharged within a watershed with flow directions controlled by topography.

Recharge occurs in areas of outcrop and along streams reaches where coal or sandstone subcrops to the alluvium. Clinker-capped ridges likely are important areas of recharge throughout the Powder River Basin. Recharge in the Ashland Ranger District is limited to localized flow systems recharged on clinker capped ridges.

Discharge occurs where aquifers crop out along hillsides and beneath alluvium. Generally, discharge areas are on the northern end of flow systems. Discharge forms springs and provides baseflow to streams. The largest number of springs and largest volume of spring discharge is associated with the stratigraphic interval extending from the Pawnee coal up to the Anderson/Dietz coal zone. Ground water is also discharged to wells that supply water for stock and domestic uses. This water comes primarily from coal beds and sandstone units in the Tongue River Member.

Under an assumed scenario of maximum CBM development in the District, 24 of the 284 springs with measurable flow were identified as being most susceptible to impact, and 17 additional springs were of concern. Of the 25 stream reaches inventoried, 5 appear to be susceptible to impact and 2 more require careful monitoring in the event of CBM development. Nineteen wells should be monitored if development occurs, of which 3 are considered most vulnerable to impact. This assessment was based on an assumed CBM development scenario reflective of the maximum aerial extent likely to be developed in and around the District. Actual impacts to water supplies will vary from this assessment and will be dependent upon the specific stratigraphic intervals and actual areal extent of CBM development. Monitoring of springs, wells and streams should be based on proposed CBM drilling plans.

If CBM production occurs outside the District but not within the District, impacts to water supplies in the District will be limited to those that are within about 5 miles of development. CBM development is most likely to occur along the southern edge of the District, with less potential for development along the western and eastern edges.

Future monitoring should be based on anticipated needs and adjusted as CBM production approaches the District boundaries. Continued monitoring will assist with decision making, identification of impacts (and lack of impacts), and overall better water management regardless of whether or not coalbed methane is eventually developed on the Ashland Ranger District lands.

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Appendix A. Basic data for inventoried springs in the Ashland Ranger District

GWIC ID	Spring Name	Township	Range	Section	Tract	Longitude	Latitude	Altitude (feet)	USGS Quadrangle
204995	SPUKE SPRING	01S	46E	10	DDAC	-106.02895	45.75729	3490	HAYES POINT
205025	PRIMROSE SPRING	01S	46E	11	CDDD	-106.01668	45.75601	3595	HAYES POINT
199638	SHEERING PIN SPRING	01S	46E	12	CBBB	-106.00558	45.76209	3420	HAYES POINT
199636		01S	46E	13	BBCA	-106.00400	45.74784	3580	BEAVER CREEK SCHOOL
204992	LITTLE WONDER SPRING	01S	46E	15	BBBD	-106.04449	45.75285	3305	HAYES POINT
204994	DEVAULT SPRING	01S	46E	16	BADC	-106.05901	45.75252	3250	HAYES POINT
204987	SAWMILL SPRING	01S	46E	23	DABB	-106.01079	45.73249	3390	BEAVER CREEK SCHOOL
199633	WONDER SPRING	01S	46E	24	ACAD	-105.99079	45.73638	3820	STACEY
199635	SURPRISE SPRING	01S	46E	24	BAAA	-105.99659	45.74043	3840	STACEY
204993	NORTH SARTIN SPRING	01S	46E	25	BBDB	-105.98589	45.72155	3650	STACEY
199614	SCHILLER SPRING	01S	46E	31	DCCC	-106.09766	45.69973	3260	BEAVER CREEK SCHOOL
199610	SARTIN DRAW SPRING	01S	46E	36	BBDA	-106.00272	45.70948	3480	BEAVER CREEK SCHOOL
199639		01S	47E	6	BABA	-105.97852	45.78348	3540	NORTH STACEY SCHOOL
199640	RED SHALE SPRING	01S	47E	6	DABB	-105.97100	45.77690	3600	NORTH STACEY SCHOOL
199641	LISCOM MOUNTAIN SPRING	01S	47E	18	ACAA	-105.97027	45.75136	3620	NORTH STACEY SCHOOL
199643	LISCOM BUTTE SPRING	01S	47E	18	DACD	-105.96892	45.74582	3820	STACEY
199632	SARTIN DRAW SPRING	01S	47E	30	BDAC	-105.97745	45.72173	3740	STACEY
199611	NORTH STACEY SPRING	01S	47E	32	CCAC	-105.96116	45.70062	3660	STACEY
205072	BRIDGE CREEK SPRING	01S	48E	30	CDCD	-105.85381	45.71388	3375	ELK RIDGE
205060		02S	45E	3	DBBB	-106.15940	45.68905	3390	COOK CREEK RESERVOIR
205061	JO SPRING	02S	45E	4	ABCD	-106.17985	45.69362	3520	COOK CREEK RESERVOIR
205062		02S	45E	4	CADB	-106.18346	45.68702	3440	COOK CREEK RESERVOIR
205063	BRINGOFF SPRING	02S	45E	9	BCBC	-106.19029	45.67731	3515	COOK CREEK RESERVOIR
205065	CLIFF SPRING	02S	45E	11	DADD	-106.13382	45.67212	3570	COOK CREEK RESERVOIR
198849	ASH CREEK 1 SPRING	02S	45E	12	CDAB	-106.12073	45.67020	3490	BEAVER CREEK SCHOOL
198851	ASH CREEK 2 SPRING	02S	45E	12	ACCC	-106.11837	45.67475	3460	BEAVER CREEK SCHOOL
198853	MAIN ASH SPRING	02S	45E	12	ABDA	-106.11609	45.68007	3390	BEAVER CREEK SCHOOL
205059	CUTBANK SPRING	02S	45E	16	AAAC	-106.17208	45.66591	3640	COOK CREEK RESERVOIR
205058	COOK SPRING	02S	45E	21	ADDB	-106.17324	45.64719	3590	COOK CREEK RESERVOIR
205064		02S	45E	21	BCAA	-106.18661	45.64912	3600	COOK CREEK RESERVOIR
199623	DAILY SPRING	02S	45E	23	DDAB	-106.13144	45.64169	3680	COOK CREEK RESERVOIR
199594	PROVOST SPRING	02S	45E	25	BBCA	-106.10934	45.63683	3540	BEAVER CREEK SCHOOL
204989	GENTRY SPRING	02S	45E	26	BDAC	-106.14211	45.63742	3625	COOK CREEK RESERVOIR
197843	COAL CREEK SPRING	02S	45E	33	CADA	-106.18198	45.61530	3340	WILLOW CROSSING
199620	WEST FORK 1 SPRING	02S	45E	35	BBCD	-106.14792	45.62168	3540	WILLOW CROSSING
199621	WEST FORK 2 SPRING	02S	45E	35	BCAA	-106.14701	45.62070	3520	WILLOW CROSSING
199605	BOTTOM CRIB SPRING	02S	46E	1	DABA	-105.98591	45.68883	3560	STACEY
199619		02S	46E	5	CDCA	-106.07861	45.68323	3410	BEAVER CREEK SCHOOL
199617		02S	46E	8	BBDA	-106.08094	45.67933	3460	BEAVER CREEK SCHOOL

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GWIC ID	Spring Name	Township	Range	Section	Tract	Longitude	Latitude	Altitude (feet)	USGS Quadrangle
199618		02S	46E	8	BABC	-106.08009	45.67999	3460	BEAVER CREEK SCHOOL
7247	MAXWELL SPRING	02S	46E	10	DBAD	-106.02932	45.67246	3470	BEAVER CREEK SCHOOL
199603	STRAIGHT CREEK SPRING	02S	46E	12	ADCA	-105.98603	45.67573	3520	STACEY
199600		02S	46E	13	BACD	-105.99662	45.66381	3520	STACEY
204990	SHEEP CREEK 2 SPRING	02S	46E	13	BDCC	-105.99785	45.66040	3520	STACEY
199597	UPPER BEAVER CREEK SPRING	02S	46E	14	BDAD	-106.01363	45.66194	3495	BEAVER CREEK SCHOOL
204932	LOWER BEAVER CREEK SPRING	02S	46E	14	BDAD	-106.01360	45.66228	3505	BEAVER CREEK SCHOOL
204986	DEER CREEK 2 SPRING	02S	46E	16	BDDD	-106.05472	45.65964	3550	BEAVER CREEK SCHOOL
204988	CABIN SPRING	02S	46E	17	CDDB	-106.07802	45.65384	3860	BEAVER CREEK SCHOOL
7246	CABIN CREEK SPRING	02S	46E	17	BBAA	-106.08165	45.66714	3590	BEAVER CREEK SCHOOL
199609		02S	46E	17	ADAC	-106.06626	45.66213	3605	BEAVER CREEK SCHOOL
199616	UPPER CABIN CREEK SPRING	02S	46E	17	BBDA	-106.08042	45.66652	3610	BEAVER CREEK SCHOOL
204983	PASTURE SPRING	02S	46E	20	DDCD	-106.06784	45.63905	3665	BEAVER CREEK SCHOOL
199622	DEER CREEK SPRING	02S	46E	21	BDAB	-106.05595	45.64898	3700	BEAVER CREEK SCHOOL
7249	DARLING DRAW SPRING	02S	46E	22	DBDB	-106.03131	45.64314	3960	BEAVER CREEK SCHOOL
199598	MAXWELL CREEK SPRING	02S	46E	22	AAAB	-106.02604	45.65189	3490	BEAVER CREEK SCHOOL
204985	FUNNEL DRAW SPRING	02S	46E	23	ADCB	-106.00798	45.64642	3740	BEAVER CREEK SCHOOL
198777	EAST FORK SPRING	02S	46E	25	ACBA	-105.99103	45.63373	3890	STACEY
204980	SECTION 26 SPRING	02S	46E	26	DBBC	-106.01046	45.63073	3660	BEAVER CREEK SCHOOL
204984	HORSEHEAD SPRING	02S	46E	28	BBAD	-106.06085	45.63705	3660	BEAVER CREEK SCHOOL
204981	DARLING DRAW SLUMP 1 SPRING	02S	46E	28	DAAD	-106.04556	45.63065	3570	BEAVER CREEK SCHOOL
204982	CORAL CREEK SPRING	02S	46E	29	BADA	-106.07635	45.63558	3620	BEAVER CREEK SCHOOL
204973	BARREL SPRING	02S	46E	36	DACD	-105.98594	45.61305	3660	HOME CREEK BUTTE
199602		02S	47E	17	ABDD	-105.94893	45.66510	3790	STACEY
199601		02S	47E	18	CCAD	-105.97795	45.65585	3560	STACEY
204991	SHEEP CREEK 1 SPRING	02S	47E	18	BBCD	-105.98151	45.66491	3670	STACEY
7253	HOLIDAY SPRING	02S	47E	19	CDDB	-105.97421	45.63929	3975	STACEY
198817	BIDWELL SPRING SOUTH PIPE	02S	47E	19	CCCC	-105.96278	45.64039	3895	STACEY
198819	BIDWELL SPRING NORTH PIPE	02S	47E	19	CCCC	-105.96278	45.64039	3895	STACEY
198810		02S	47E	30	BBDD	-105.97770	45.63469	3990	STACEY
198821	SUTTON SPRING TOP PIPE	02S	47E	30	ADCA	-105.96544	45.63215	4000	STACEY
198822	SUTTON SPRING BOTTOM PIPE	02S	47E	30	ADCA	-105.96544	45.63215	3900	STACEY
199624	THOMAS SPRING	02S	47E	30	DCDA	-105.96795	45.62502	3920	STACEY
205070	BUCKBERRY SPRING	02S	48E	6	CBBC	-105.86001	45.68978	3570	ELK RIDGE
205071	ELK RIDGE SPRING	02S	48E	8	BBDC	-105.83580	45.68030	3795	ELK RIDGE
205067	CAMERON SPRING	02S	48E	17	ABDC	-105.82500	45.66559	3600	ELK RIDGE
205068	CAMERON RESERVOIR SPRING	02S	48E	17	ADDA	-105.81860	45.66310	3490	ELK RIDGE
205069		02S	48E	17	DADA	-105.81892	45.65803	3550	ELK RIDGE
205066	MANNING SPRING	02S	48E	31	ABDC	-105.84666	45.62155	3660	SAMUELSON RANCH

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GWIC ID	Spring Name	Township	Range	Section	Tract	Longitude	Latitude	Altitude (feet)	USGS Quadrangle
204963	NECESSITY 2 SPRING	03S	46E	2	ABBB	-106.01204	45.60864	3575	COLEMAN DRAW
7405	PASS SPRING	03S	46E	4	CDBB	-106.05812	45.59717	3490	COLEMAN DRAW
204959	PASS RESERVOIR SPRING	03S	46E	4	BDDC	-106.05515	45.60112	3480	COLEMAN DRAW
204997	RANDEL SPRING	03S	46E	5	CABA	-106.07743	45.60051	3320	COLEMAN DRAW
204960	SAND SPRING	03S	46E	10	DCBC	-106.03151	45.58191	3340	COLEMAN DRAW
204961	GILPATRICK SPRING	03S	46E	13	BBBB	-106.00090	45.57833	3410	COLEMAN DRAW
204962	NEW GILPATRICK SPRING	03S	46E	14	DDBB	-106.00672	45.57674	3385	COLEMAN DRAW
199612	GASKILL SPRING	03S	46E	17	AABA	-106.06606	45.57903	3290	COLEMAN DRAW
7418	COAL BANK SPRING	03S	46E	18	BDAD	-106.09590	45.57397	3220	COLEMAN DRAW
204979	UD SPRING SPRING	03S	46E	31	AADC	-106.08645	45.53275	3320	COLEMAN DRAW
204996	BEAR DEN SPRING	03S	46E	33	CCBA	-106.06180	45.52440	3400	COLEMAN DRAW
204977	JELLISON SPRING	03S	46E	34	BDBA	-106.03772	45.53136	3770	COLEMAN DRAW
7422	STAFFORD SPRING	03S	46E	34	DDDC	-106.02506	45.52163	3460	COLEMAN DRAW
199700	STAFFORD #1	03S	46E	34	DDDC	-106.02515	45.52138	3460	COLEMAN DRAW
204975	SCHOOLMARM SPRING	03S	46E	36	BBAA	-105.99696	45.53527	3595	HOME CREEK BUTTE
199606	FISH POND SPRING	03S	47E	5	DBDA	-105.94660	45.59841	3870	HOME CREEK BUTTE
199607	LOWER HANSON SPRING	03S	47E	5	DABA	-105.94423	45.60052	3920	HOME CREEK BUTTE
199608	UPPER HANSON SPRING	03S	47E	5	DABA	-105.94369	45.60173	3980	HOME CREEK BUTTE
204966	PAIN SPRING	03S	47E	5	BBAC	-105.95812	45.60767	4020	HOME CREEK BUTTE
204965	BULL FROG SPRING	03S	47E	6	CCCC	-105.98123	45.59424	3670	HOME CREEK BUTTE
198811	FRARY SPRING	03S	47E	7	AADC	-105.96308	45.59050	3680	HOME CREEK BUTTE
204964	WILBUR SPRING	03S	47E	7	BACB	-105.97551	45.59156	3665	HOME CREEK BUTTE
198812		03S	47E	8	ADCB	-105.94524	45.58732	3840	HOME CREEK BUTTE
197841	UPPER CABIN SPRING	03S	47E	9	CCDB	-105.93713	45.57929	3920	HOME CREEK BUTTE
198813	EAST SPRING	03S	47E	9	BCAA	-105.93619	45.58923	3950	HOME CREEK BUTTE
205057	CAIN SPRING	03S	47E	12	CDCA	-105.87319	45.58161	3710	SAMUELSON RANCH
197838	LOGGING CREEK SPRING	03S	47E	15	DDAA	-105.89970	45.56830	3930	HOME CREEK BUTTE
197839		03S	47E	15	DADD	-105.89940	45.56890	3970	HOME CREEK BUTTE
197738	FLY CREEK 1 SPRING	03S	47E	16	AAAA	-105.92060	45.57810	3980	HOME CREEK BUTTE
197842	CABIN SPRING	03S	47E	17	BCDD	-105.95580	45.57262	3650	HOME CREEK BUTTE
204967	CABIN 2 SPRING	03S	47E	17	BDBC	-105.95522	45.57415	3660	HOME CREEK BUTTE
197711	HIGHWAY 212 SPRING	03S	47E	21	DDCC	-105.92360	45.55140	3620	HOME CREEK BUTTE
197735	FLY CREEK 2 SPRING	03S	47E	21	BBCC	-105.93860	45.56220	3720	HOME CREEK BUTTE
197840	LOGGING SPRING	03S	47E	22	BAAD	-105.90991	45.56317	3875	HOME CREEK BUTTE
204974	LOGGING CREEK 3 SPRING	03S	47E	22	BCCA	-105.91213	45.56381	3890	HOME CREEK BUTTE
197710	HOUGHLAN SPRING	03S	47E	23	CAAA	-105.88830	45.55720	3750	HOME CREEK BUTTE
198766	LEMONADE SPRING	03S	47E	28	ACAA	-105.92551	45.54553	3635	HOME CREEK BUTTE
199625		03S	47E	28	ABAB	-105.92643	45.55024	3615	HOME CREEK BUTTE
199627	WESCO SPRING	03S	47E	28	BCAA	-105.93880	45.54571	3595	HOME CREEK BUTTE

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GWIC ID	Spring Name	Township	Range	Section	Tract	Longitude	Latitude	Altitude (feet)	USGS Quadrangle
199626		03S	47E	29	ADBD	-105.94272	45.54531	3585	HOME CREEK BUTTE
199628	LITTLE TOBIN SPRING	03S	47E	29	DCBD	-105.94861	45.53766	3685	HOME CREEK BUTTE
204976	PRIVATE SPRING	03S	47E	31	BBAD	-105.97239	45.52656	3710	HOME CREEK BUTTE
198798	KING CREEK SPRING	04S	44E	23	DACC	-106.25995	45.47362	3340	GREEN CREEK
7565	PASS SPRING	04S	44E	24	ABBB	-106.24330	45.48278	3540	KING MOUNTAIN
205012	MCKELVEY SPRING	04S	44E	35	DCBA	-106.26617	45.45348	3530	GREEN CREEK
198793		04S	44E	36	ACDB	-106.24168	45.44867	3680	KING MOUNTAIN
198967		04S	45E	30	AADA	-106.21333	45.46623	3320	KING MOUNTAIN
198969		04S	45E	30	AADA	-106.21381	45.46606	3330	KING MOUNTAIN
7598	GENE CREEK SPRING	04S	45E	30	DDBB	-106.21723	45.45786	3460	KING MOUNTAIN
205056	CAPRA SPRING	04S	45E	32	CADD	-106.20635	45.44262	3385	KING MOUNTAIN
204978	TUCKER SPRING	04S	46E	3	BBBA	-106.05100	45.52126	3425	COLEMAN DRAW
199694	HARRIET 2 SPRING	04S	46E	14	BBBD	-106.03083	45.49066	3380	YAGER BUTTE
199695	HARRIET 1 SPRING	04S	46E	15	ADCC	-106.03679	45.48544	3405	YAGER BUTTE
205020	POTHOLE SPRING	04S	46E	17	ACAA	-106.07895	45.48846	3320	YAGER BUTTE
205007	DD SPRING	04S	46E	22	CBAA	-106.05015	45.47040	3660	YAGER BUTTE
199697		04S	46E	22	DABB	-106.03670	45.47033	3550	YAGER BUTTE
205008	MCBRIDE SPRING	04S	46E	22	BDBD	-106.04536	45.47304	3560	YAGER BUTTE
199696		04S	46E	23	CBCB	-106.03120	45.46829	3590	YAGER BUTTE
199667		04S	46E	23	ABBA	-106.01951	45.47706	3550	YAGER BUTTE
199665	WATT DRAW 1 SPRING	04S	46E	24	CCCC	-106.01083	45.46436	3640	YAGER BUTTE
199666		04S	46E	26	AACA	-106.01490	45.46096	3690	YAGER BUTTE
199677		04S	46E	27	BABC	-106.04940	45.46214	3540	YAGER BUTTE
7606	MINERAL YAGER SPR ING	04S	46E	28	DAAB	-106.05491	45.45578	3480	YAGER BUTTE
204998	COAL BANK SPRING	04S	46E	28	BACD	-106.06635	45.46000	3560	YAGER BUTTE
7607	COAL CREEK SPRING	04S	46E	29	CBBD	-106.09195	45.45504	3340	YAGER BUTTE
199673	OTTESEN SPRING	04S	46E	29	BABD	-106.08590	45.46230	3440	YAGER BUTTE
199649		04S	46E	31	ABBB	-106.10235	45.44880	3320	YAGER BUTTE
199654		04S	46E	33	BDCC	-106.06737	45.44152	3310	YAGER BUTTE
199676	ERICKSON SPRING	04S	46E	35	BADA	-106.02263	45.44706	3660	YAGER BUTTE
199653	SPIKE CAMP SPRING	04S	46E	36	BCDB	-106.00746	45.44338	3510	YAGER BUTTE
199668	OLE SPRING	04S	46E	36	ADBA	-105.99415	45.44506	3555	THREEMILE BUTTES
197707	FEAR SPRING	04S	47E	4	CCBA	-105.94690	45.51060	3920	HOME CREEK BUTTE
197709	BUFFALO HEAD SPRING	04S	47E	5	DBBC	-105.95780	45.51250	3780	HOME CREEK BUTTE
197708		04S	47E	8	ABBB	-105.95890	45.50670	3660	HOME CREEK BUTTE
199595	DOONAN GULCH SPRING	04S	47E	10	BACD	-105.92052	45.50343	3940	HOME CREEK BUTTE
198862	KNUDSON SPRING	04S	47E	11	CBAC	-105.90399	45.49860	3745	THREEMILE BUTTES
198888	LOWER KNUDSON SPRING	04S	47E	11	CDBC	-105.90153	45.49501	3700	THREEMILE BUTTES
199596	KNUDSON 2 SPRING	04S	47E	14	BBBB	-105.90724	45.49232	3730	THREEMILE BUTTES

Appendix A. Basic data for inventoried springs in the Ashland Ranger District

GWIC ID	Spring Name	Township	Range	Section	Tract	Longitude	Latitude	Altitude (feet)	USGS Quadrangle
199690	MCCLENNAN 2 SPRING	04S	47E	21	DCAC	-105.93607	45.46593	3690	THREEMILE BUTTES
198890		04S	47E	22	AACA	-105.91064	45.47597	3980	THREEMILE BUTTES
198889	DOONAN SPRING	04S	47E	23	ABAA	-105.89380	45.47791	3830	THREEMILE BUTTES
199679	SKINNER GULCH 2 SPRING	04S	47E	26	ABCA	-105.89925	45.46166	3990	THREEMILE BUTTES
199680	SKINNER GULCH 1 SPRING	04S	47E	26	BCCD	-105.89647	45.45682	3870	THREEMILE BUTTES
199691		04S	47E	27	DABB	-105.91238	45.45583	3890	THREEMILE BUTTES
199693	MCCLENNAN 1 SPRING	04S	47E	28	BBAA	-105.94555	45.46297	3720	THREEMILE BUTTES
199699		04S	47E	28	AADA	-105.93009	45.46113	3715	THREEMILE BUTTES
199687	BLUE BORE SPRING	04S	47E	30	CCBC	-105.97000	45.45280	3650	THREEMILE BUTTES
199698		04S	47E	31	BDAD	-105.98167	45.44405	3550	THREEMILE BUTTES
199669	ABBOTT SPRING	04S	47E	33	CCBA	-105.94810	45.43799	3735	THREEMILE BUTTES
199670	JOE SPRING	04S	47E	33	CCDA	-105.94636	45.43595	3695	THREEMILE BUTTES
204947		05S	43E	13	CBAC	-106.37543	45.40023	3530	BIRNEY DAY SCHOOL
204940		05S	43E	26	BDCA	-106.39605	45.37854	3350	BIRNEY DAY SCHOOL
204939		05S	43E	27	BACA	-106.41233	45.37466	3340	BROWNS MOUNTAIN
204938		05S	43E	28	ADDC	-106.42085	45.37332	3335	BROWNS MOUNTAIN
205013	TWIN SPRING	05S	44E	1	CADD	-106.24491	45.42938	3970	KING MOUNTAIN
197726	GOOD SPRING	05S	44E	1	BBBC	-106.25390	45.43810	3720	GREEN CREEK
198789		05S	44E	1	BBCD	-106.25298	45.43674	3750	GREEN CREEK
197878	EAST FORK 2 SPRING	05S	44E	10	AADD	-106.27489	45.42229	3490	GREEN CREEK
197879	EAST FORK 1 SPRING	05S	44E	10	ADCB	-106.27920	45.41950	3430	GREEN CREEK
204948		05S	44E	20	ABDC	-106.32312	45.39272	3470	GREEN CREEK
197733	BRIAN 1 SPRING	05S	44E	24	BADD	-106.24440	45.39280	3950	KING MOUNTAIN
197609	PERRY (NEW) SPRING	05S	44E	25	DCDC	-106.24144	45.36675	3710	FORT HOWES
197720	PERRY (OLD) SPRING	05S	44E	25	DDCC	-106.23970	45.36690	3680	FORT HOWES
197861	- PERRY SPRING	05S	44E	25	DDBB	-106.23699	45.36780	3600	FORT HOWES
197880	HAY CREEK SPRING	05S	44E	27	ADCA	-106.27914	45.37496	3470	POKER JIM BUTTE
205032	GREEN CREEK 2 SPRING	05S	44E	29	BDCD	-106.33180	45.37449	3875	POKER JIM BUTTE
205028	UPPER GREEN CREEK SUMP SPRING	05S	44E	30	ACCC	-106.34778	45.37451	3830	POKER JIM BUTTE
197544		05S	44E	33	CCAA	-106.31280	45.35440	3860	POKER JIM BUTTE
197513		05S	44E	34	AAAC	-106.27839	45.36470	3540	POKER JIM BUTTE
197722		05S	44E	35	AAAA	-106.25780	45.36580	3895	POKER JIM BUTTE
205002	OLD ROAD SPRING	05S	44E	35	BDAC	-106.26865	45.36155	3660	POKER JIM BUTTE
205003	LOWER BIG SPRING	05S	44E	35	BBAD	-106.27308	45.35462	3635	POKER JIM BUTTE
197717	BUTCH SPRING	05S	44E	36	ADDC	-106.23688	45.35952	3720	FORT HOWES
7757	CHROMO SPRING	05S	45E	6	DABC	-106.21811	45.42940	3420	KING MOUNTAIN
197872	BADGET SPRING	05S	45E	7	DDBC	-106.21679	45.41168	3420	KING MOUNTAIN
197873		05S	45E	8	CCDD	-106.21038	45.41042	3365	KING MOUNTAIN
197846	BRIAN 3 SPRING	05S	45E	8	CBAC	-106.21179	45.41594	3390	KING MOUNTAIN

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GWIC ID	Spring Name	Township	Range	Section	Tract	Longitude	Latitude	Altitude (feet)	USGS Quadrangle
7766	LITTLE BRIAN SPRING	05S	45E	18	ACAA	-106.21860	45.40661	3435	KING MOUNTAIN
7767	LOWER BRIAN 2 SPRING	05S	45E	18	AACC	-106.21769	45.40665	3425	KING MOUNTAIN
7769	UPPER BRIAN SPRING	05S	45E	18	BDBD	-106.22605	45.40448	3590	KING MOUNTAIN
7788	PAGET 2 SPRING	05S	45E	29	DAAB	-106.19652	45.37294	3370	FORT HOWES
197859	FIRST SPRING	05S	45E	29	BDDD	-106.20548	45.37437	3395	FORT HOWES
197862	PRONGHORN SPRING	05S	45E	29	CCCC	-106.21339	45.36651	3450	FORT HOWES
197860	LOWER PERRY	05S	45E	30	CACC	-106.22862	45.37007	3550	FORT HOWES
199645	DUNNING SPRING	05S	45E	33	AADA	-106.17426	45.36380	3290	FORT HOWES
199646		05S	45E	33	AADB	-106.17651	45.36325	3310	FORT HOWES
199647		05S	45E	33	AACD	-106.17789	45.36292	3310	FORT HOWES
199644		05S	45E	34	BBBA	-106.17272	45.36513	3285	FORT HOWES
199648		05S	45E	34	BBAA	-106.17010	45.36517	3255	FORT HOWES
7795	COOMBE SPRING	05S	46E	9	CBCC	-106.05177	45.41318	3420	YAGER BUTTE
199684		05S	46E	10	DABD	-106.03519	45.41489	3420	YAGER BUTTE
199686	MIDDLE CREEK SPRING	05S	46E	12	DAAC	-105.99281	45.41467	3540	THREEMILE BUTTES
198768	FIFTEEN MILE SPRING	05S	46E	16	CADB	-106.06452	45.39980	3600	YAGER BUTTE
7796	WILEY USE SPRING	05S	46E	20	ABAC	-106.08089	45.39274	3370	YAGER BUTTE
205026	JACOBS SPRING	05S	46E	24	CACC	-106.00574	45.38364	3495	YAGER BUTTE
7800	SMITH SPRING	05S	46E	27	CADA	-106.04250	45.37998	3395	YAGER BUTTE
199658	- OVERALL SPRING	05S	46E	29	DDAB	-106.07471	45.36879	3325	GOODSPEED BUTTE
199659		05S	46E	34	AADD	-106.03220	45.36202	3450	GOODSPEED BUTTE
199661	PIERCE SPRING	05S	46E	35	ADAC	-106.01399	45.36029	3570	GOODSPEED BUTTE
199662		05S	46E	36	BCCB	-106.00973	45.35990	3630	GOODSPEED BUTTE
199663	ELK CREEK SPRING	05S	46E	36	DBDB	-105.99830	45.35635	3550	PHILLIPS BUTTE
197704	QUEBBEMAN SPRING	05S	47E	2	DDDB	-105.88920	45.42175	3995	THREEMILE BUTTES
199685	POTTER SPRING	05S	47E	7	AADB	-105.97179	45.41854	3620	THREEMILE BUTTES
204999	NO NAME SPRING	05S	47E	9	ADCB	-105.93344	45.41526	3740	THREEMILE BUTTES
199583	TENMILE SPRING	05S	47E	10	BBDA	-105.92389	45.41771	3700	THREEMILE BUTTES
199584	DOTY SPRING	05S	47E	10	DACC	-105.90975	45.41134	3770	THREEMILE BUTTES
197706		05S	47E	11	ABDD	-105.89280	45.41780	4060	THREEMILE BUTTES
205001	COLLINGE SPRING	05S	47E	11	ABCA	-105.89664	45.41794	3950	THREEMILE BUTTES
197607	UPPER FIFTEEN MILE SPRING	05S	47E	16	DCDC	-105.93720	45.39202	3760	THREEMILE BUTTES
197610	MONTGOMERY SPRING	05S	47E	16	CDDC	-105.94102	45.39202	3720	THREEMILE BUTTES
199585	LOWER SPRING CREEK SPRING	05S	47E	17	DABD	-105.95208	45.39758	3720	THREEMILE BUTTES
199586	UPPER SPRING CREEK SPRING	05S	47E	17	DABD	-105.95159	45.39784	3725	THREEMILE BUTTES
199593	DEAD HORSE SPRING	05S	47E	18	BDDD	-105.98122	45.39911	3695	THREEMILE BUTTES
197608	DALZELLS SPRING	05S	47E	21	ABBB	-105.93797	45.39119	3730	THREEMILE BUTTES
199582	MANKAMEYER SPRING	05S	47E	22	DACC	-105.91038	45.38238	3770	THREEMILE BUTTES
205000	MCCOLLUGH SPRING	05S	47E	22	BDAD	-105.91885	45.38635	3805	THREEMILE BUTTES

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205009	ANCHOR SPRING	05S	47E	28	BAAA	-105.94034	45.37645	3775	THREEMILE BUTTES
204935	SCHWIND SPRING	05S	47E	31	DDCD	105.97420	45.34830	3670	PHILLIPS BUTTE
205027	CARL SPRING	05S	47E	31	ADBD	-105.97288	45.35751	3675	PHILLIPS BUTTE
197512	ROUGH PRONG SPRING	06S	43E	1	DDBA	-106.40330	45.34140	3860	BROWNS MOUNTAIN
197509	BLACK EAGLE 1 SPRING	06S	43E	2	DBDC	-106.42720	45.34080	3970	BROWNS MOUNTAIN
197508	BLACK EAGLE 2 SPRING	06S	43E	3	DABC	-106.44220	45.34285	3920	BROWNS MOUNTAIN
204943		06S	43E	10	BDDC	-106.45171	45.32979	3900	BROWNS MOUNTAIN
204944	HACKLEY SPRING	06S	43E	10	BBBB	-106.45902	45.33584	3895	BROWNS MOUNTAIN
197505	TIMBER L SPRING	06S	43E	12	BDBB	-106.40314	45.32646	3890	BROWNS MOUNTAIN
204942		06S	43E	12	DABB	-106.40023	45.32861	3920	BROWNS MOUNTAIN
197516	PRUNE SPRING LOWER	06S	43E	13	AABD	-106.40008	45.32030	3820	BROWNS MOUNTAIN
197517	PRUNE SPRING UPPER	06S	43E	13	AADA	-106.39869	45.32006	3820	BROWNS MOUNTAIN
204941	COTTONWOOD SPRING	06S	43E	14	BBCA	-106.41884	45.31904	3790	BROWNS MOUNTAIN
204950	ROBERTS SPRING	06S	43E	15	ADCD	-106.45119	45.31469	3500	BROWNS MOUNTAIN
197515	TIMBER CREEK SPRING 1	06S	43E	24	AABB	-106.40170	45.30690	3940	BROWNS MOUNTAIN
205075	WILCOX SPRING	06S	43E	27	CCCA	-106.45664	45.28061	3760	BROWNS MOUNTAIN
198985	PASTURE 2 SPRING	06S	43E	34	DDDD	-106.43872	45.26464	3800	BROWNS MOUNTAIN
198986		06S	43E	35	BDCD	-106.43193	45.27218	3980	BROWNS MOUNTAIN
198979	BREWSTER GULCH SPRING	06S	43E	36	DDDC	-106.40032	45.26445	3730	BROWNS MOUNTAIN
198981		06S	43E	36	DCAC	-106.40540	45.26643	3850	BROWNS MOUNTAIN
199630		06S	43E	36	DDDD	-106.39806	45.26471	3760	BROWNS MOUNTAIN
205030	PENN AND PASTURE SPRING	06S	43E	36	BCAC	-106.41489	45.27390	3800	BROWNS MOUNTAIN
204949		06S	44E	2	CBDB	-106.31761	45.34403	3890	POKER JIM BUTTE
197510		06S	44E	7	ACAA	-106.38619	45.33479	3940	BROWNS MOUNTAIN
197511		06S	44E	7	ADCB	-106.38470	45.33390	3920	BROWNS MOUNTAIN
198974		06S	44E	21	DABA	-106.34398	45.30210	3860	POKER JIM BUTTE
204945		06S	44E	21	BCAB	-106.35889	45.30545	3860	POKER JIM BUTTE
204946		06S	44E	21	BCCC	-106.36102	45.30340	3845	POKER JIM BUTTE
198973		06S	44E	24	ACBA	-106.28750	45.30528	4140	POKER JIM BUTTE
205029	WILD HOG 1 SPRING	06S	44E	29	CACC	-106.37627	45.28523	3660	BROWNS MOUNTAIN
205031	JACKSON SPRING	06S	44E	29	ADCD	-106.36528	45.28830	3685	POKER JIM BUTTE
205052	WATER GAPS SPRING	06S	44E	31	ABCD	-106.39073	45.27869	3790	BROWNS MOUNTAIN
205024	WILD HOG 2 SPRING	06S	44E	32	BAAB	-106.37375	45.28007	3720	POKER JIM BUTTE
205023	JACKSON 2 AND JACKSON HOLE SPRING	06S	44E	32	ACAD	-106.36876	45.27635	3790	POKER JIM BUTTE
205022	SQUIRREL SPRING	06S	44E	33	CBDD	-106.35718	45.27060	3905	POKER JIM BUTTE
205021	3XBAR SPRING	06S	44E	34	CDAB	-106.33304	45.26956	3870	POKER JIM BUTTE
197500	EMMA KRAFT SPRING	06S	44E	36	ABAA	-106.28440	45.28117	3890	POKER JIM BUTTE
197504		06S	44E	36	AAAA	-106.27923	45.27923	3870	POKER JIM BUTTE
199590	GATE SPRING	06S	45E	1	CBBD	-106.17717	45.34388	3360	FORT HOWES

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199588	GATE CREEK 2 SPRING	06S	45E	2	DCCA	-106.18850	45.33947	3530	FORT HOWES
199589	ROCK JOB SPRING	06S	45E	3	DADD	-106.19891	45.34201	3770	FORT HOWES
199587	PAGET 1 SPRING	06S	45E	3	CACC	-106.21135	45.34208	3920	FORT HOWES
197606	PADGETT SPRING THREE	06S	45E	4	CDBB	-106.23394	45.34118	3930	FORT HOWES
197603	COIL SPRING	06S	45E	5	ACCD	-106.24940	45.34535	3990	FORT HOWES
197604	LOST SPRING	06S	45E	5	ADCB	-106.24440	45.34610	3980	FORT HOWES
205004	HAGEN 2 SPRING	06S	45E	6	ACDC	-106.26879	45.34499	3830	POKER JIM BUTTE
205006	BIG SPRING	06S	45E	6	AABD	-106.26481	45.35044	3990	POKER JIM BUTTE
205005	HAGEN 1 SPRING	06S	45E	8	CABA	-106.25472	45.33050	4000	POKER JIM BUTTE
197605	PAGET 4 SPRING	06S	45E	9	ACAB	-106.22671	45.33423	3940	FORT HOWES
197715	FIRST CREEK SPRING	06S	45E	9	DDDD	-106.22032	45.32423	4005	FORT HOWES
197712	STAG ROCK 2 SPRING	06S	45E	10	CADA	-106.21030	45.32810	3955	FORT HOWES
197714	STAG ROCK SPRING 2	06S	45E	10	CADB	-106.21060	45.32813	3975	FORT HOWES
197601	STAG ROCK SPRING	06S	45E	11	DBCA	-106.18643	45.32830	3490	FORT HOWES
205094	PEGGY SPRING	06S	45E	11	DADD	-106.17920	45.32728	3450	FORT HOWES
197456		06S	45E	17	DDDD	-106.24046	45.30928	3840	FORT HOWES
198972	COW CREEK 2 SPRING	06S	45E	17	DCBA	-106.24887	45.31186	3910	FORT HOWES
7909	COW CREEK 1 SPRING	06S	45E	20	ABBC	-106.25010	45.30792	3940	FORT HOWES
204931		06S	45E	20	AAAA	-106.24097	45.30846	3835	FORT HOWES
197396		06S	45E	23	CCBC	-106.19810	45.29673	3540	FORT HOWES
197395		06S	45E	23	DCDC	-106.18504	45.29533	3490	FORT HOWES
197459	CY SPRING	06S	45E	27	DCBD	-106.20421	45.28089	3730	FORT HOWES
197498	MORRIS SPRING	06S	45E	31	BABD	-106.27172	45.27867	3830	POKER JIM BUTTE
197471	MOONSHINE SPRING	06S	45E	32	CDAD	-106.25061	45.26720	3930	POKER JIM BUTTE
197469		06S	45E	33	BCBC	-106.23949	45.27533	3690	FORT HOWES
205018	ASH SPRING	06S	46E	2	BADA	-106.06667	45.34915	3640	GOODSPEED BUTTE
199682		06S	46E	3	DCBA	-106.08411	45.33988	3470	GOODSPEED BUTTE
204971	GOODSPEED 2 SPRING	06S	46E	13	DCAC	-106.04492	45.31042	3620	GOODSPEED BUTTE
204972	OLE SPRING	06S	46E	14	BAAD	-106.06858	45.32142	3440	GOODSPEED BUTTE
197602	GUMBO POINT SPRING	06S	46E	18	CBDB	-106.15253	45.31284	3285	FORT HOWES
199567		06S	46E	21	DDCC	-106.10295	45.29427	3710	GOODSPEED BUTTE
199578	DRY GULCH WEST SPRING	06S	46E	22	CCBB	-106.09791	45.29639	3585	GOODSPEED BUTTE
199579	DRY GULCH SOUTH SPRING	06S	46E	22	CCBB	-106.09791	45.29639	3585	GOODSPEED BUTTE
204969	HEDUM 3 SPRING	06S	46E	23	DCCC	-106.06770	45.29463	3900	GOODSPEED BUTTE
204970	GOODSPEED SPRING	06S	46E	24	BBAD	-106.05390	45.30636	3660	GOODSPEED BUTTE
197863	KELTY SPRING	06S	46E	25	CCAB	-106.05409	45.28182	3715	GOODSPEED BUTTE
199568	HEDUM SPRING	06S	46E	26	CDBA	-106.07098	45.28231	3680	GOODSPEED BUTTE
204968	HEDUM 2 SPRING	06S	46E	26	DBBA	-106.06634	45.28558	3710	GOODSPEED BUTTE
204953	FORK SPRING	06S	46E	28	BBBA	-106.11787	45.29323	3610	GOODSPEED BUTTE

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198891	SNELL SPRING	06S	47E	2	DCCC	-105.93025	45.33755	3805	PHILLIPS BUTTE
199660	CANYON SPRING	06S	47E	5	CACA	-105.99701	45.34219	3710	PHILLIPS BUTTE
205017	MUD AND MUD OVERFLOW SPRING	06S	47E	6	CADD	-106.01503	45.34116	3895	GOODSPEED BUTTE
198893	ROCK SPRING	06S	47E	9	BBAC	-105.97833	45.33541	3885	PHILLIPS BUTTE
199566	TWO TROUGH SPRING	06S	47E	14	BDCC	-105.93507	45.31576	3950	PHILLIPS BUTTE
198892	COAL MINE SPRING	06S	47E	15	ABAB	-105.94879	45.32207	3965	PHILLIPS BUTTE
197657		06S	47E	16	CCDA	-105.97772	45.30938	3750	PHILLIPS BUTTE
197663	RED SHALE SPRING	06S	47E	17	DDDD	-105.98341	45.30940	3750	PHILLIPS BUTTE
205019	COAL HOLLOW SPRING	06S	47E	17	BBAD	-105.99865	45.32092	3700	PHILLIPS BUTTE
199655		06S	47E	18	DABB	-106.01915	45.31343	3640	GOODSPEED BUTTE
204951	PIPER DRAW SPRING	06S	47E	19	DACD	-106.01122	45.29899	3775	GOODSPEED BUTTE
205016	SOUTH LYON CREEK SPRING	06S	47E	20	BBAD	-105.99818	45.30734	3700	PHILLIPS BUTTE
199565	UPPER LYON CREEK SPRING	06S	47E	22	ACCA	-105.94925	45.30264	3935	PHILLIPS BUTTE
199569	LYON CREEK SPRING	06S	47E	22	ACCC	-105.95004	45.30200	3920	PHILLIPS BUTTE
199574		06S	47E	25	ABAA	-105.90653	45.29295	4090	PHILLIPS BUTTE
197665	PIERCE SPRING	06S	47E	27	BCBC	-105.96113	45.28866	3900	PHILLIPS BUTTE
199581	MUD TURTLE SPRING	06S	47E	28	DCAB	-105.96914	45.28271	3940	PHILLIPS BUTTE
197864	SHEEP SPRING	06S	47E	31	AAAA	-106.00704	45.27279	3745	GOODSPEED BUTTE
204952	COAL BANK SPRING	06S	47E	31	BBBB	-106.03175	45.27729	3715	GOODSPEED BUTTE
205011	JOE ANDERSON SPRING	06S	47E	34	CABA	-105.95470	45.27145	4030	PHILLIPS BUTTE
197666	MASON PRONG SPRING	06S	47E	36	CDAD	-105.91104	45.26731	4085	PHILLIPS BUTTE
197668	UPPER SKULL SPRING	06S	47E	36	ADCC	-105.90182	45.27223	3935	PHILLIPS BUTTE
197669	UPPER SKULL 2 SPRING	06S	47E	36	ADDD	-105.90085	45.27191	3915	PHILLIPS BUTTE
205010	NORTH FORK SPRING	06S	48E	20	BDCA	-105.87358	45.29962	3950	HODSON FLATS
199570	RED SHALE SPRING	06S	48E	28	CDDD	-105.84813	45.27694	3735	HODSON FLATS
199571		06S	48E	29	ADAC	-105.86124	45.28586	3830	HODSON FLATS
199572	DEAD MAN SPRING	06S	48E	29	BABB	-105.87433	45.29032	3940	HODSON FLATS
199573	WILLOW SPRING	06S	48E	30	DBBA	-105.88789	45.28307	3910	PHILLIPS BUTTE
197670	SKULL SPRING	06S	48E	31	BCAB	-105.89559	45.27114	3900	PHILLIPS BUTTE
197845	MASON SPRING	06S	48E	32	DDAB	-105.86056	45.26427	3710	HODSON FLATS
205014	COAL DRAW SPRING	06S	48E	32	AADA	-105.85892	45.27383	3750	HODSON FLATS
205015	FENCE CORNER SPRING	06S	48E	32	CDBB	-105.87258	45.26503	3725	HODSON FLATS
199631		07S	43E	1	AAAB	-106.40062	45.26416	3720	BROWNS MOUNTAIN
198983		07S	43E	1	CBBB	-106.41689	45.25632	3530	BROWNS MOUNTAIN
204933		07S	43E	1	CBAA	-106.41473	45.25694	3550	BROWNS MOUNTAIN
198984		07S	43E	2	DDAB	-106.42061	45.25301	3495	BROWNS MOUNTAIN
197654		07S	43E	14	DAAB	-106.42071	45.22759	3500	STROUD CREEK
204955	RIMROCK SPRING	07S	43E	15	DADD	-106.43944	45.22497	3635	STROUD CREEK
204956	CLARK DRAW 1 SPRING	07S	43E	24	CADA	-106.40957	45.21106	3765	STROUD CREEK

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GWIC ID	Spring Name	Township	Range	Section	Tract	Longitude	Latitude	Altitude (feet)	USGS Quadrangle
204957	CLARK DRAW 2 SPRING	07S	43E	24	BCAA	-106.41474	45.21624	3670	STROUD CREEK
199629	UPPER BREWSTER SPRING	07S	44E	6	BBBB	-106.39680	45.26569	3770	BROWNS MOUNTAIN
205053	BREWSTER GULCH 2 SPRING	07S	44E	6	DBBD	-106.39140	45.25614	3880	BROWNS MOUNTAIN
205054	BREWSTER GULCH 1 SPRING	07S	44E	6	CDAB	-106.39487	45.25345	3800	BROWNS MOUNTAIN
199558	HOLBROOK DRAW SPRING 2	07S	44E	9	ABAC	-106.34684	45.24862	3780	HAMILTON DRAW
199559	FOSSIL SPRING	07S	44E	9	ADAB	-106.34220	45.24832	3720	HAMILTON DRAW
199560	HOLBROOK DRAW 3 SPRING	07S	44E	9	DABB	-106.34464	45.24439	3755	HAMILTON DRAW
199561		07S	44E	9	DACC	-106.34578	45.24190	3745	HAMILTON DRAW
205045	WASHOUT SPRING	07S	44E	13	DDDD	-106.27999	45.22339	3870	HAMILTON DRAW
204934	BOYCE MEADOW SPRING	07S	44E	13	BBCB	-106.29884	45.23578	3880	HAMILTON DRAW
205048	WOLF SPRING	07S	44E	14	ABBB	-106.30988	45.23756	3880	HAMILTON DRAW
204958	NORTH LEE SPRING	07S	44E	15	CDBA	-106.33362	45.22606	3830	HAMILTON DRAW
204936		07S	44E	17	BCAA	-106.37843	45.23326	3550	STROUD CREEK
204937		07S	44E	17	BDCD	-106.37540	45.23117	3535	STROUD CREEK
204954	STOCKER DRAW SPRING	07S	44E	19	CDCC	-106.39490	45.20897	3715	STROUD CREEK
205049	CHIPMUNK SPRING	07S	44E	21	CCBB	-106.36105	45.21198	3640	HAMILTON DRAW
197394		07S	45E	9	DDDD	-106.21949	45.23750	3645	OTTER
197393		07S	45E	15	ACAA	-106.20450	45.23260	3550	OTTER
205046	TOOLEY CREEK SPRING	07S	45E	18	DCAB	-106.26768	45.22639	3860	HAMILTON DRAW
205047	MARY SPRING	07S	45E	18	DCDD	-106.26533	45.22376	3790	HAMILTON DRAW
197454		07S	45E	26	DCBC	-106.18719	45.19617	3620	OTTER
205050	BECKY SPRING	07S	45E	30	CACD	-106.27410	45.19817	3835	HAMILTON DRAW
8013	HANDLEY SPRING	07S	45E	31	DBCA	-106.26584	45.18524	3850	HAMILTON DRAW
205076	DYNAMITE SPRING	07S	45E	31	CCAB	-106.27679	45.18307	3790	HAMILTON DRAW
197453		07S	45E	36	BACA	-106.17045	45.19144	3870	OTTER
199575	GRIFFIN COULEE SPRING	07S	46E	4	BDBA	-106.11054	45.26066	3495	GOODSPEED BUTTE
199580	WILBER SPRING	07S	46E	9	AADD	-106.09685	45.25088	3630	GOODSPEED BUTTE
205039	SEYMOUR SPRING	07S	46E	12	CACD	-106.04885	45.24336	3695	REANUS CONE
205044	RENI SPRING	07S	46E	14	BDCA	-106.07077	45.23221	3600	REANUS CONE
205077	SCHOOL SECTION SPRING	07S	46E	16	DBDC	-106.10359	45.22710	3470	REANUS CONE
205080	HIGH TRAIL SPRING	07S	46E	23	DDDD	-106.05544	45.21053	3650	REANUS CONE
205079	POLYWOG SPRING	07S	46E	26	CCBB	-106.07479	45.19880	3570	REANUS CONE
205078	REANUS SPRING	07S	46E	27	BBBC	-106.09576	45.20762	3580	REANUS CONE
197452	ALKALI SPRING	07S	46E	31	BACD	-106.15005	45.19141	3470	OTTER
205051	CONE SPRING	07S	46E	33	CBAA	-106.11216	45.18804	3755	REANUS CONE
205074	CHARLIE KRAFT SPRING	07S	46E	35	DACC	-106.05987	45.18408	3730	REANUS CONE
205043	SCHOOL SECTION 36 SPRING	07S	46E	36	BCAB	-106.05136	45.19142	3595	REANUS CONE
199576		07S	47E	2	AACD	-105.92070	45.26121	4100	PHILLIPS BUTTE
197865	SLOUGH GRASS CREEK SPRING	07S	47E	3	BBCB	-105.95458	45.26260	4040	PHILLIPS BUTTE

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GWIC ID	Spring Name	Township	Range	Section	Tract	Longitude	Latitude	Altitude (feet)	USGS Quadrangle
197866	TAYLOR CREEK SAWMILL SPRING	07S	47E	5	BCDC	-106.01131	45.25831	3840	GOODSPEED BUTTE
199577	MAY SPRING	07S	47E	5	ACDA	-105.99905	45.26115	3855	PHILLIPS BUTTE
197867	STANLEY SPRING	07S	47E	6	BABB	-106.02973	45.26426	3735	GOODSPEED BUTTE
197871	YONKEE SPRING	07S	47E	13	DCBB	-105.90343	45.22677	3850	SAYLE
197869	PLUM CREEK CORRAL SPRING	07S	47E	25	DCAD	-105.90375	45.19660	3965	SAYLE
205073	RIZOR SPRING	07S	47E	29	ADBD	-105.99699	45.20469	3890	SAYLE
205042	YONKEE DRAW SPRING	07S	47E	30	BDCC	-106.02980	45.20191	3695	REANUS CONE
205040	LOWER SCHOOL HOUSE SPRING	07S	47E	32	BABD	-106.00766	45.19369	3695	REANUS CONE
205041	SCHOOL HOUSE SPRING	07S	47E	32	BABA	-106.00808	45.19444	3695	REANUS CONE
205093		07S	47E	34	ACCA	-105.94661	45.18850	3970	SAYLE
205036	LOWER MAVERICK SPRING	07S	48E	2	DCCD	-105.80440	45.24687	3615	BLOOM CREEK
205037	STUDINER SPRING	07S	48E	2	DDCA	-105.79990	45.24778	3635	BLOOM CREEK
205035	BOG HOLE SPRING	07S	48E	10	CBAC	-105.83457	45.23818	3520	BLOOM CREEK
205033	BULL 2 SPRING	07S	48E	17	BCDD	-105.87483	45.22508	3755	BLOOM CREEK
205034	WATER GAP SPRING	07S	48E	17	AADB	-105.85939	45.22991	3600	BLOOM CREEK
197870	HAILSTONE SPRING	07S	48E	18	CAAC	-105.88824	45.22349	3840	SAYLE
197868	WOLF DEN SPRING	07S	48E	29	DBCC	-105.86749	45.19265	3730	BLOOM CREEK
205038	PEAYS SPRING	07S	48E	29	DDCC	-105.86221	45.18875	3730	BLOOM CREEK
205055	BOUNDRY SPRING	07S	48E	33	CCDD	-105.85337	45.17491	3850	BLOOM CREEK

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GWIC ID	Inventory Date	Measured Discharge (gpm)	Discharge Notes	Discharge Method	pH	Temperature (Degrees C)	Specific Conductance (umhos/cm @ 25 C)	Source Lithology [1]	Recharge Origin	Nearest overlying coalbed association
204995	5/20/2003		NO FLOW					COAL	MIXED	SAWYER
205025	6/27/2003	0.10		ESTIMATED	7.40	13.9	853	CLINKER	LOCAL	C & D
199638	8/30/2002	0.20		VOLUMETRIC		16.1	2740	SANDSTONE	MIXED	SAWYER
199636	8/30/2002		DRY					SANDSTONE	LOCAL	C & D
204992	5/18/2003	0.20		VOLUMETRIC	7.57	11.4	3511	CLINKER	LOCAL	SAWYER
204994	5/20/2003	0.90		VOLUMETRIC	7.01	9.3	3292	COLLUVIUM	LOCAL	SAWYER
204987	5/16/2003	1.50		VOLUMETRIC	7.23	9.8	2375	ALLUVIUM	LOCAL	SAWYER
199633	8/30/2002	0.10		VOLUMETRIC			2740	SANDSTONE	LOCAL	FERRY
199635	8/30/2002	0.10		VOLUMETRIC		17.1	3060	SANDSTONE	LOCAL	PAWNEE
204993	5/18/2003		NOT MEASURABLE					ALLUVIUM	LOCAL	PAWNEE
199614	10/28/2002	0.30		VOLUMETRIC	7.20	10.0	2512	SILTSTONE	MIXED	SAWYER
199610	10/27/2002	0.04		VOLUMETRIC	6.76	11.1	1905	COAL	LOCAL	C & D
199639	8/30/2002		DRY						LOCAL	C & D
199640	8/30/2002		NO FLOW					CLINKER	LOCAL	C & D
199641	8/30/2002	0.40		VOLUMETRIC		14.2	4367	SANDSTONE	LOCAL	C & D
199643	8/30/2002	0.30		VOLUMETRIC		15.5	2226	COAL	LOCAL	FERRY
199632	8/30/2002	0.20		VOLUMETRIC			4517	COAL	LOCAL	PAWNEE
199611	10/27/2002		DRY						LOCAL	PAWNEE
205072	7/18/2003		NO FLOW					COAL	LOCAL	SAWYER
205060	7/16/2003		NO FLOW					COLLUVIUM	LOCAL	C & D
205061	7/16/2003		NO FLOW					SANDSTONE	LOCAL	C & D
205062	7/16/2003		NO FLOW					ALLUVIUM	LOCAL	C & D
205063	7/16/2003		NO FLOW					COAL	LOCAL	PAWNEE
205065	7/16/2003	1.10		VOLUMETRIC	7.40	11.2	1828	CLINKER	LOCAL	PAWNEE
198849	10/9/2002		NO FLOW						LOCAL	C & D
198851	10/9/2002		NOT MEASURABLE						LOCAL	C & D
198853	10/9/2002		NOT MEASURABLE						LOCAL	SAWYER
205059	7/16/2003	0.80		VOLUMETRIC	6.84	11.6	2694	ALLUVIUM	LOCAL	COOK
205058	7/16/2003	0.30		VOLUMETRIC	7.08	11.5	1162	COLLUVIUM	LOCAL	PAWNEE
205064	7/16/2003		NO FLOW					SANDSTONE	LOCAL	PAWNEE
199623	11/7/2002	0.20		VOLUMETRIC	6.97	9.8	2762	SANDSTONE	LOCAL	COOK
199594	10/9/2002	0.60		VOLUMETRIC	6.99	11.9	2592		LOCAL	PAWNEE
204989	5/17/2003		NO FLOW						LOCAL	COOK
197843	7/24/2002	0.40		VOLUMETRIC			4228	SANDSTONE	MIXED	SAWYER
199620	11/7/2002		NO FLOW					COAL	LOCAL	BREWSTER-ARNOLD
199621	11/7/2002		DRY					SANDSTONE	LOCAL	BREWSTER-ARNOLD
199605	10/21/2002		NO FLOW					ALLUVIUM	LOCAL	PAWNEE
199619	11/6/2002	0.40		VOLUMETRIC	8.97	6.4	2196	CLINKER	LOCAL	C & D
199617	11/6/2002	0.30		VOLUMETRIC	8.82	5.7	3633		LOCAL	C & D

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199618	11/6/2002		NO FLOW						LOCAL	C & D
7247	10/20/2002	0.10		VOLUMETRIC	6.95	9.4	2190	COAL	LOCAL	C & D
199603	10/21/2002	0.10		VOLUMETRIC	7.06	8.5	2303	SANDSTONE	LOCAL	PAWNEE
199600	10/20/2002	1.10		VOLUMETRIC	7.12	10.5	1928		LOCAL	C & D
204990	5/17/2003	0.30		VOLUMETRIC	6.97	10.0	2585	SANDSTONE	LOCAL	PAWNEE
199597	10/20/2002	0.20		VOLUMETRIC	7.59	10.0	2701	ALLUVIUM	LOCAL	C & D
204932	10/20/2002	1.20		VOLUMETRIC		10.3	2364	ALLUVIUM	LOCAL	C & D
204986	5/16/2003	1.10		VOLUMETRIC	7.16	8.9	2343	ALLUVIUM	LOCAL	PAWNEE
204988	5/17/2003		NOT MEASURABLE					COLLUVIUM	LOCAL	FERRY
7246	11/6/2002	0.70		VOLUMETRIC	6.97	8.4	1571	ALLUVIUM	LOCAL	ODELL
199609	10/27/2002	0.20		VOLUMETRIC	7.08	8.0	1584		LOCAL	PAWNEE
199616	11/6/2002		NO FLOW					ALLUVIUM	LOCAL	PAWNEE
204983	5/15/2003	0.30		VOLUMETRIC	6.93	11.9	1619	SANDSTONE	LOCAL	FERRY
199622	11/7/2002	0.30		VOLUMETRIC	6.99	7.7	1505		LOCAL	PAWNEE
7249	10/9/2002	1.30		VOLUMETRIC	7.61	9.1	589	SANDSTONE	LOCAL	FERRY
199598	10/20/2002	0.10		VOLUMETRIC	7.59	6.2	1918		LOCAL	PAWNEE
204985	5/16/2003	0.20		VOLUMETRIC	7.31	8.5	2094	ALLUVIUM	LOCAL	PAWNEE
198777	10/7/2002	0.30		VOLUMETRIC	7.26	10.5	1534	SANDSTONE	LOCAL	FERRY
204980	5/15/2003		DRY					SANDSTONE	LOCAL	PAWNEE
204984	5/15/2003	0.40		VOLUMETRIC	7.02	12.0	2252	SANDSTONE	LOCAL	FERRY
204981	5/15/2003	3.50		VOLUMETRIC	7.31	9.9	2057	ALLUVIUM	LOCAL	PAWNEE
204982	5/15/2003	1.80		VOLUMETRIC	6.96	11.0	2276	ALLUVIUM	LOCAL	PAWNEE
204973	5/13/2003	7.50		VOLUMETRIC	6.95	8.2	1284	ALLUVIUM	LOCAL	PAWNEE
199602	10/21/2002	0.20		VOLUMETRIC	6.76	10.9	1003		LOCAL	FERRY
199601	10/20/2002	1.20		VOLUMETRIC	7.32	9.3	1618	ALLUVIUM	LOCAL	PAWNEE
204991	5/17/2003	0.30		VOLUMETRIC	7.66	11.2	1684	CLINKER	LOCAL	PAWNEE
7253	10/8/2002	0.50		VOLUMETRIC	7.27	9.7	245	CLINKER	LOCAL	FERRY
198817	10/8/2002	0.60		VOLUMETRIC	6.87	10.7	1615	CLINKER	LOCAL	FERRY
198819	10/8/2002	0.30		VOLUMETRIC	7.05	8.7	1447	CLINKER	LOCAL	FERRY
198810	10/7/2002	0.60		VOLUMETRIC	7.35	9.2	1180	COAL	LOCAL	FERRY
198821	10/8/2002	0.70		VOLUMETRIC	7.30	8.9	1914	CLINKER	LOCAL	FERRY
198822	10/8/2002	0.10		VOLUMETRIC	7.90	10.3	1331	CLINKER	LOCAL	FERRY
199624	11/8/2002		DRY						LOCAL	FERRY
205070	7/18/2003	0.40		VOLUMETRIC	6.86	11.9	3610	COLLUVIUM	LOCAL	ODELL
205071	7/18/2003								LOCAL	FERRY
205067	7/17/2003								LOCAL	ODELL
205068	7/17/2003								LOCAL	ODELL
205069	7/17/2003	0.20		VOLUMETRIC		14.8	5300	COAL	LOCAL	ODELL
205066	7/17/2003	0.10		ESTIMATED			3246	COAL	LOCAL	PAWNEE

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204963	4/27/2003		NOT MEASURABLE					ALLUVIUM	LOCAL	PAWNEE
7405	4/27/2003	0.08		VOLUMETRIC	7.38	9.6	5309	COAL	REGIONAL	PAWNEE
204959	4/27/2003	0.10		ESTIMATED				ALLUVIUM	LOCAL	PAWNEE
204997	4/26/2003	5.50		VOLUMETRIC	6.81	13.3	1961	COLLUVIUM	MIXED	SAWYER
204960	4/27/2003		NOT MEASURABLE					COAL	LOCAL	PAWNEE
204961	4/27/2003	0.40		VOLUMETRIC	7.22	12.4	3686	SANDSTONE	LOCAL	PAWNEE
204962	4/27/2003	0.10		VOLUMETRIC	7.16	13.1	1828	SANDSTONE	LOCAL	PAWNEE
199612	10/27/2002	0.30		ESTIMATED	6.99	10.3	5257	COAL	REGIONAL	SAWYER
7418	10/27/2002	0.50		VOLUMETRIC	6.87	11.3	5384	SILTSTONE	REGIONAL	SAWYER
204979	5/15/2003		NOT MEASURABLE					CLINKER	LOCAL	ODELL
204996	5/20/2003	0.90		VOLUMETRIC	7.01	10.6	6242	SANDSTONE	LOCAL	PAWNEE
204977	5/14/2003		NOT MEASURABLE					SANDSTONE	LOCAL	FERRY
7422	11/7/2002	0.40		ESTIMATED		4.6	2576	SANDSTONE	REGIONAL	ODELL
199700	11/7/2002		NOT MEASURABLE						LOCAL	ODELL
204975	5/13/2003	0.10		VOLUMETRIC	7.16	10.0	1258	ALLUVIUM	LOCAL	PAWNEE
199606	10/26/2002	0.06		VOLUMETRIC	7.05	6.1	1775	SILTSTONE	LOCAL	FERRY
199607	10/26/2002		NO FLOW						LOCAL	FERRY
199608	10/26/2002	0.30		VOLUMETRIC	7.78	8.0	1433		LOCAL	FERRY
204966	4/28/2003	0.30		VOLUMETRIC	7.30	7.4	1390	CLINKER	LOCAL	FERRY
204965	4/28/2003	0.10		VOLUMETRIC	7.26	8.9	2293	SANDSTONE	LOCAL	PAWNEE
198811	10/7/2002	1.50		VOLUMETRIC	7.23	11.8	1717	ALLUVIUM	LOCAL	FERRY
204964	4/28/2003	0.40		VOLUMETRIC	6.98	8.6	3073	COLLUVIUM	LOCAL	FERRY
198812	10/7/2002		DRY					SANDSTONE	LOCAL	FERRY
197841	7/24/2002	0.60		VOLUMETRIC		13.5	1516	SANDSTONE	LOCAL	FERRY
198813	10/7/2002	0.80		VOLUMETRIC	7.69	12.2	1334	CLINKER	LOCAL	FERRY
205057	7/15/2003	0.90		VOLUMETRIC	6.56	11.5	2955	COLLUVIUM	LOCAL	PAWNEE
197838	7/23/2002	0.20		VOLUMETRIC		13.8	2034	ALLUVIUM	LOCAL	FERRY
197839	7/24/2002		NOT MEASURABLE			16.5	1546	ALLUVIUM	LOCAL	FERRY
197738	7/24/2002	0.05		VOLUMETRIC		17.7	1824	SANDSTONE	LOCAL	FERRY
197842	7/24/2002	0.40		VOLUMETRIC		16.8	2082	COLLUVIUM	LOCAL	FERRY
204967	4/28/2003		NOT MEASURABLE					COLLUVIUM	LOCAL	FERRY
197711	7/22/2002	0.30		VOLUMETRIC		13.5	3400	ALLUVIUM	LOCAL	FERRY
197735	7/24/2002		NOT MEASURABLE					SANDSTONE	LOCAL	FERRY
197840	7/24/2002	0.40		VOLUMETRIC		19.9	2431	COLLUVIUM	LOCAL	FERRY
204974	5/13/2003	0.50		VOLUMETRIC	6.77	10.5	2794	COLLUVIUM	LOCAL	FERRY
197710	7/22/2002	0.30		VOLUMETRIC		12.2	1643	COLLUVIUM	LOCAL	PAWNEE
198766	10/6/2002	1.50		VOLUMETRIC	6.78	10.0	2114		LOCAL	FERRY
199625	11/7/2002	2.00		ESTIMATED	7.91	2.8	2600	ALLUVIUM	LOCAL	FERRY
199627	11/8/2002		NOT MEASURABLE					SANDSTONE	LOCAL	FERRY

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GWIC ID	Inventory Date	Measured Discharge (gpm)	Discharge Notes	Discharge Method	pH	Temperature (Degrees C)	Specific Conductance (umhos/cm @ 25 C)	Source Lithology [1]	Recharge Origin	Nearest overlying coalbed association
199626	11/8/2002	1.20		VOLUMETRIC	7.12	4.8	3099	SANDSTONE	LOCAL	FERRY
199628	11/9/2002	0.10		VOLUMETRIC	6.70	5.3	2761	SANDSTONE	LOCAL	FERRY
204976	5/13/2003	0.50		VOLUMETRIC	7.11	9.6	2210	SANDSTONE	LOCAL	FERRY
198798	5/9/2002	1.10		VOLUMETRIC		18.5	2728	COLLUVIUM	LOCAL	PAWNEE
7565	5/9/2002		NOT MEASURABLE					SANDSTONE	LOCAL	PAWNEE
205012	6/4/2003	1.30		VOLUMETRIC	7.31	12.3	3032	SANDSTONE	LOCAL	PAWNEE
198793	5/9/2002		NOT MEASURABLE			14.8	1610	CLINKER	LOCAL	WALL
198967	9/5/2002		NO FLOW					COAL	LOCAL	ODELL
198969	9/5/2002		NO FLOW					COAL	LOCAL	ODELL
7598	9/5/2002	0.80		VOLUMETRIC		15.2	1965	SANDSTONE	LOCAL	PAWNEE
205056	7/16/2003		DRY					SANDSTONE	LOCAL	PAWNEE
204978	5/14/2003		NOT MEASURABLE					SANDSTONE	LOCAL	PAWNEE
199694	10/28/2002	0.10		VOLUMETRIC		7.6	2808	SANDSTONE	LOCAL	ODELL
199695	10/28/2002	0.60		VOLUMETRIC		8.7	2537	COAL	LOCAL	PAWNEE
205020	6/23/2003	1.80		VOLUMETRIC	6.90	16.1	3958	COAL	LOCAL	ODELL
205007	6/2/2003	0.20		VOLUMETRIC	6.96	10.7	2525	SANDSTONE	LOCAL	COOK
199697	10/30/2002			VOLUMETRIC					LOCAL	ELK
205008	6/2/2003	0.50		VOLUMETRIC	6.97	13.1	3652	SANDSTONE	LOCAL	ELK
199696	10/30/2002		NOT MEASURABLE					SANDSTONE	LOCAL	COOK
199667	10/4/2002		DRY						LOCAL	ELK
199665	10/3/2002		NO FLOW					COAL	LOCAL	COOK
199666	10/4/2002		NOT MEASURABLE						LOCAL	COOK
199677	10/18/2002		NO FLOW					CLINKER	LOCAL	COOK
7606	10/18/2002	0.30		VOLUMETRIC		11.3	4236	SANDSTONE	MIXED	PAWNEE
204998	5/30/2003	0.06		VOLUMETRIC	6.97		4185	COAL	LOCAL	PAWNEE
7607	10/18/2002	0.10		VOLUMETRIC		11.4	5400		LOCAL	ODELL
199673	10/18/2002		NO FLOW					SANDSTONE	LOCAL	PAWNEE
199649	9/16/2002		NO FLOW					ALLUVIUM	LOCAL	ODELL
199654	9/16/2002							SANDSTONE	LOCAL	ODELL
199676	10/6/2002		NO FLOW					SANDSTONE	LOCAL	COOK
199653	9/16/2002		NO FLOW					ALLUVIUM	LOCAL	PAWNEE
199668	10/6/2002	0.30		VOLUMETRIC		11.7	4146	CLINKER	LOCAL	PAWNEE
197707	7/22/2002	0.40		VOLUMETRIC		15.9	3070	COLLUVIUM	LOCAL	FERRY
197709	7/22/2002	0.10		VOLUMETRIC			2685	SANDSTONE	LOCAL	COOK
197708	7/22/2002		DRY					SANDSTONE	LOCAL	WALL
199595	10/10/2002		NO FLOW					ALLUVIUM	LOCAL	CANYON
198862	10/10/2002	0.80		VOLUMETRIC	7.02	10.5	3193	SANDSTONE	LOCAL	COOK
198888	10/10/2002		DRY					SANDSTONE	LOCAL	WALL
199596	10/10/2002	0.10		VOLUMETRIC	7.14	12.3	3476	ALLUVIUM	LOCAL	COOK

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GWIC ID	Inventory Date	Measured Discharge (gpm)	Discharge Notes	Discharge Method	pH	Temperature (Degrees C)	Specific Conductance (umhos/cm @ 25 C)	Source Lithology [1]	Recharge Origin	Nearest overlying coalbed association
199690	10/27/2002	0.50		VOLUMETRIC		9.1	2693		LOCAL	WALL
198890	10/10/2002		DRY					ALLUVIUM	LOCAL	CANYON
198889	10/10/2002	0.60		VOLUMETRIC	7.37	11.0	2325	SANDSTONE	LOCAL	COOK
199679	10/19/2002	0.70		VOLUMETRIC		9.9	1471		LOCAL	CANYON
199680	10/19/2002	0.70		VOLUMETRIC		13.3	3111		LOCAL	CANYON
199691	10/27/2002		NO FLOW					ALLUVIUM	LOCAL	FERRY
199693	10/27/2002	0.60		VOLUMETRIC		7.2	3431	SANDSTONE	LOCAL	COOK
199699	10/27/2002		NO FLOW					ALLUVIUM	LOCAL	COOK
199687	10/21/2002	0.60		VOLUMETRIC		10.2	2669		LOCAL	COOK
199698	10/26/2002		DRY					CLINKER	LOCAL	PAWNEE
199669	10/6/2002	0.90		VOLUMETRIC		11.2	3092	SANDSTONE	LOCAL	COOK
199670	10/6/2002	0.50		VOLUMETRIC		13.7	3715	SANDSTONE	LOCAL	COOK
204947	4/11/2003		NO FLOW					SANDSTONE	LOCAL	COOK
204940	4/10/2003	0.80		ESTIMATED		8.1	2085	COAL	LOCAL	PAWNEE
204939	4/10/2003	1.90		VOLUMETRIC		10.5	1691	COAL	MIXED	PAWNEE
204938	4/10/2003	1.50		ESTIMATED		7.6	2186	SANDSTONE	MIXED	PAWNEE
205013	6/4/2003	1.10		VOLUMETRIC	7.68	10.8	586	CLINKER	LOCAL	ANDERSON
197726	7/23/2002	1.80		VOLUMETRIC		16.6	1738	ALLUVIUM	LOCAL	COOK
198789	9/5/2002		NOT MEASURABLE			19.2	1642	CLINKER	LOCAL	COOK
197878	8/15/2002		DRY					ALLUVIUM	LOCAL	PAWNEE
197879	8/15/2002	0.90		VOLUMETRIC	7.33	16.6	4015	COLLUVIUM	LOCAL	PAWNEE
204948	4/11/2003	1.00		ESTIMATED		7.4	2454	CLINKER	LOCAL	WALL
197733	7/23/2002	1.50		VOLUMETRIC		9.5	521	ALLUVIUM	LOCAL	ANDERSON/DIETZ
197609	7/23/2002	0.40		VOLUMETRIC		18.4	2060	SANDSTONE	LOCAL	COOK
197720	7/23/2002	0.30		VOLUMETRIC			2238	CLINKER	LOCAL	COOK
197861	8/19/2002	0.10		VOLUMETRIC	7.85	18.9	2366	SANDSTONE	LOCAL	OTTER
197880	8/15/2002	0.30		VOLUMETRIC	7.06	16.8	4735	ALLUVIUM	LOCAL	WALL
205032	6/29/2003	0.80		VOLUMETRIC	6.70	10.8	727	SANDSTONE	LOCAL	ANDERSON/DIETZ
205028	6/28/2003		NOT MEASURABLE					ALLUVIUM	LOCAL	ANDERSON/DIETZ
197544	7/20/2002	0.20		VOLUMETRIC		10.4	441	COLLUVIUM	LOCAL	ANDERSON/DIETZ
197513	7/19/2002	0.30		VOLUMETRIC		16.7	3043	SANDSTONE	LOCAL	OTTER
197722	7/23/2002		DRY						LOCAL	ANDERSON/DIETZ
205002	6/1/2003	0.30		VOLUMETRIC	7.39	12.1	2720	CLINKER	LOCAL	COOK
205003	6/1/2003		NOT MEASURABLE					ALLUVIUM	LOCAL	COOK
197717	7/23/2002	0.90		VOLUMETRIC		16.3	930	COLLUVIUM	LOCAL	CANYON
7757	10/27/2002							ALLUVIUM	LOCAL	PAWNEE
197872	8/16/2002	0.40		VOLUMETRIC	7.44	18.0	1677	SANDSTONE	LOCAL	PAWNEE
197873	8/16/2002	0.70		VOLUMETRIC	7.41	18.3	2632	SANDSTONE	LOCAL	ODELL
197846	8/20/2002		DRY					ALLUVIUM	LOCAL	PAWNEE

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7766	8/15/2002	0.60		VOLUMETRIC	7.08	16.8	2670	ALLUVIUM	LOCAL	PAWNEE
7767	8/15/2002	0.90		VOLUMETRIC	6.87	17.4	2641	ALLUVIUM	LOCAL	PAWNEE
7769	8/20/2002		DRY					COLLUVIUM	LOCAL	PAWNEE
7788	8/19/2002	0.20		VOLUMETRIC	7.76		2802	SANDSTONE	LOCAL	OTTER
197859	8/19/2002	0.50		VOLUMETRIC	7.46	17.1	2124	ALLUVIUM	LOCAL	OTTER
197862	8/19/2002		NO FLOW					SANDSTONE	LOCAL	OTTER
197860	8/19/2002	0.20		VOLUMETRIC	7.96	19.4	2889	SANDSTONE	LOCAL	OTTER
199645	9/14/2002	0.10		VOLUMETRIC			3162	SANDSTONE	LOCAL	BREWSTER-ARNOLD
199646	9/14/2002		NOT MEASURABLE			18.8	454	ALLUVIUM	LOCAL	BREWSTER-ARNOLD
199647	9/14/2002		NO FLOW					ALLUVIUM	LOCAL	BREWSTER-ARNOLD
199644	9/5/2002							ALLUVIUM	LOCAL	BREWSTER-ARNOLD
199648	9/14/2002		NO FLOW					ALLUVIUM	LOCAL	BREWSTER-ARNOLD
7795	10/21/2002	0.10		VOLUMETRIC		9.8	1554	SANDSTONE	MIXED	ODELL
199684	10/21/2002								LOCAL	PAWNEE
199686	10/21/2002	1.30		VOLUMETRIC		10.6	2259		MIXED	PAWNEE
198768	10/6/2002	0.30		VOLUMETRIC	7.55	11.9	830	SANDSTONE	LOCAL	ELK
7796	9/28/2002	0.20		VOLUMETRIC	6.88	13.1	3821	SANDSTONE	MIXED	ODELL
205026	6/27/2003	0.40		VOLUMETRIC	7.16	14.3	2312	SANDSTONE	REGIONAL	PAWNEE
7800	9/28/2002	0.30		VOLUMETRIC	7.00	14.2	5123		MIXED	PAWNEE
199658	9/26/2002	1.40		VOLUMETRIC		15.0	2700	ALLUVIUM	LOCAL	ODELL
199659	9/27/2002	0.40		VOLUMETRIC		14.8	2328	COAL	REGIONAL	PAWNEE
199661	10/2/2002	1.40		VOLUMETRIC		11.8	1648	CLINKER	LOCAL	COOK
199662	10/2/2002	0.10		VOLUMETRIC		11.4	2545	SANDSTONE	LOCAL	COOK
199663	10/2/2002	0.50		VOLUMETRIC		10.0	2885	SANDSTONE	LOCAL	COOK
197704	7/21/2002		NOT MEASURABLE				3357	COLLUVIUM	LOCAL	CANYON
199685	10/21/2002	0.60		VOLUMETRIC		12.2	2433		LOCAL	COOK
204999	5/31/2003	0.40		VOLUMETRIC	7.32	12.1	3775	CLINKER	LOCAL	COOK
199583	9/25/2002	0.40		VOLUMETRIC	7.19	14.6	2732	SANDSTONE	LOCAL	COOK
199584	9/26/2002	1.60		VOLUMETRIC	7.07	11.8	2536	SANDSTONE	LOCAL	COOK
197706	7/21/2002		NO FLOW					COLLUVIUM	LOCAL	CANYON
205001	5/31/2003		DRY						LOCAL	CANYON
197607	7/21/2002	1.40		VOLUMETRIC		14.7	2591	COLLUVIUM	LOCAL	COOK
197610	7/21/2002	0.10		VOLUMETRIC		19.2	2771		LOCAL	COOK
199585	9/26/2002	1.80		VOLUMETRIC	7.12	11.6	3583	SANDSTONE	LOCAL	COOK
199586	9/26/2002	1.00		VOLUMETRIC	7.11	11.1	3565	SANDSTONE	LOCAL	COOK
199593	9/29/2002		DRY					ALLUVIUM	LOCAL	COOK
197608	7/21/2002	0.50		VOLUMETRIC		19.2	2527		LOCAL	COOK
199582	9/25/2002	1.00		VOLUMETRIC	7.16	11.5	1752	SANDSTONE	LOCAL	COOK
205000	5/31/2003	1.00		VOLUMETRIC	7.55	10.9	791	CLINKER	LOCAL	COOK

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205009	6/2/2003	0.60		VOLUMETRIC	7.70	9.6	1110	SANDSTONE	LOCAL	COOK
204935	7/21/2002		NO FLOW					CLINKER	LOCAL	COOK
205027	6/27/2003	0.20		VOLUMETRIC	7.81	12.8	2621	CLINKER	LOCAL	COOK
197512	7/19/2002		DRY					CLINKER	LOCAL	ANDERSON/DIETZ
197509	7/19/2002		DRY					CLINKER	LOCAL	ANDERSON/DIETZ
197508	7/19/2002	0.30		VOLUMETRIC		9.2	446	COLLUVIUM	LOCAL	ANDERSON/DIETZ
204943	4/10/2003	0.50		ESTIMATED		10.1	718	SANDSTONE	LOCAL	ANDERSON/DIETZ
204944	4/10/2003	1.10		VOLUMETRIC		5.9	1056	SANDSTONE	LOCAL	ANDERSON/DIETZ
197505	7/19/2002		NO FLOW					SANDSTONE	LOCAL	ANDERSON/DIETZ
204942	4/10/2003		NO FLOW					SANDSTONE	LOCAL	ANDERSON/DIETZ
197516	7/20/2002	0.60		VOLUMETRIC		19.7	616	COLLUVIUM	LOCAL	ANDERSON/DIETZ
197517	7/20/2002	1.40		VOLUMETRIC		15.3	513	CLINKER	LOCAL	ANDERSON/DIETZ
204941	4/10/2003	0.30		VOLUMETRIC		11.3	860	SANDSTONE	LOCAL	ANDERSON/DIETZ
204950	4/9/2003		NO FLOW					SANDSTONE	LOCAL	CANYON
197515	7/20/2002	0.40		VOLUMETRIC		12.2	544	SANDSTONE	LOCAL	ANDERSON/DIETZ
205075	7/23/2003	0.20		VOLUMETRIC	6.95	16.1	1085	CLINKER	LOCAL	ANDERSON/DIETZ
198985	8/15/2002	0.60		VOLUMETRIC	7.00	14.8	887	COAL	LOCAL	CANYON
198986	8/15/2002		NO FLOW							
198979	8/15/2002	0.80		VOLUMETRIC	7.00	14.1	1238	COAL	LOCAL	ANDERSON/DIETZ
198981	8/15/2002		NO FLOW					COAL	LOCAL	ANDERSON/DIETZ
199630	8/15/2002	0.30		VOLUMETRIC	7.00	11.8	2760	COAL	LOCAL	ANDERSON/DIETZ
205030	6/28/2003	0.90		VOLUMETRIC	7.28	12.4	1040	SANDSTONE	LOCAL	ANDERSON/DIETZ
204949	4/11/2003	0.50		ESTIMATED			422	CLINKER	LOCAL	ANDERSON/DIETZ
197510	7/19/2002	0.80		VOLUMETRIC		17.0	635	ALLUVIUM	LOCAL	ANDERSON/DIETZ
197511	7/19/2002	12.00		VOLUMETRIC			601	COLLUVIUM	LOCAL	ANDERSON/DIETZ
198974	7/12/2002	2.50		VOLUMETRIC		17.0	490	CLINKER	LOCAL	ANDERSON/DIETZ
204945	4/11/2003	1.40		VOLUMETRIC		4.3	445	CLINKER	LOCAL	ANDERSON/DIETZ
204946	4/11/2003	3.00		ESTIMATED		4.3	440	ALLUVIUM	LOCAL	ANDERSON/DIETZ
198973	7/12/2002	0.10		VOLUMETRIC		17.5	1342	COAL	LOCAL	ROLAND
205029	6/28/2003	0.60		VOLUMETRIC	6.80	14.5	1668	SANDSTONE	LOCAL	CANYON
205031	6/28/2003	0.20		VOLUMETRIC	7.14	12.5	1121	CLINKER	LOCAL	CANYON
205052	7/15/2003	0.20		VOLUMETRIC	7.08	12.5	1223	CLINKER	LOCAL	ANDERSON/DIETZ
205024	6/27/2003	0.10		VOLUMETRIC	6.95	14.0	1614	SANDSTONE	LOCAL	CANYON
205023	6/26/2003	0.50		VOLUMETRIC	7.30	14.7	1166	SANDSTONE	LOCAL	DIETZ
205022	6/26/2003	0.30		VOLUMETRIC	7.45	11.7	750	CLINKER	LOCAL	ANDERSON
205021	6/26/2003	2.70		VOLUMETRIC	6.95	13.3	1382	COLLUVIUM	LOCAL	ANDERSON
197500	7/18/2002	3.00		VOLUMETRIC		10.8	1321	ALLUVIUM	LOCAL	DIETZ
197504	7/18/2002		DRY					ALLUVIUM	LOCAL	DIETZ
199590	9/27/2002	0.80		VOLUMETRIC	7.18	12.2	3704	ALLUVIUM	LOCAL	OTTER

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199588	9/27/2002	0.90		VOLUMETRIC	7.41	13.4	3832	COAL	LOCAL	OTTER
199589	9/27/2002	0.30		VOLUMETRIC	6.83	14.5	1942	SANDSTONE	LOCAL	CANYON
199587	9/27/2002	1.20		VOLUMETRIC	7.34	10.8	454	SANDSTONE	LOCAL	DIETZ
197606	7/21/2002		DRY					CLINKER	LOCAL	ANDERSON
197603	7/21/2002		DRY					ALLUVIUM	LOCAL	ANDERSON
197604	7/21/2002	1.20		VOLUMETRIC		11.4	509	COLLUVIUM	LOCAL	ANDERSON
205004	6/1/2003	0.70		VOLUMETRIC	7.36	11.8	915	CLINKER	LOCAL	ANDERSON/DIETZ
205006	6/1/2003		NOT MEASURABLE		7.90	10.0	430	SANDSTONE	LOCAL	ANDERSON/DIETZ
205005	6/1/2003		NOT MEASURABLE					SANDSTONE	LOCAL	ANDERSON/DIETZ
197605	7/21/2002		NOT MEASURABLE			19.1	545	SANDSTONE	LOCAL	ANDERSON
197715	7/23/2002	0.10		VOLUMETRIC		14.3	532	CLINKER	LOCAL	ANDERSON
197712	7/23/2002	3.50		VOLUMETRIC		13.6	401	SANDSTONE	LOCAL	ANDERSON
197714	7/24/2002	1.50		VOLUMETRIC		16.4	469	SANDSTONE	LOCAL	ANDERSON
197601	7/20/2002	0.30		VOLUMETRIC		20.0	2420	SANDSTONE	LOCAL	OTTER
205094	7/20/2002	0.20		VOLUMETRIC			2816	COLLUVIUM	LOCAL	OTTER
197456	7/12/2002	14.30		VOLUMETRIC		12.2	635	SANDSTONE	LOCAL	DIETZ
198972	7/12/2002	0.50		VOLUMETRIC		10.3	397	ALLUVIUM	LOCAL	DIETZ
7909	7/11/2002	13.30		VOLUMETRIC		9.9	490	CLINKER	LOCAL	ANDERSON
204931	7/12/2002	0.30		VOLUMETRIC		14.2	1042	SANDSTONE	LOCAL	DIETZ
197396	7/18/2002		NO FLOW					SANDSTONE	LOCAL	COOK
197395	7/18/2002	7.50		VOLUMETRIC		10.8	1252	SANDSTONE	LOCAL	OTTER
197459	7/18/2002	0.10		VOLUMETRIC		17.0	3866	SANDSTONE	LOCAL	CANYON
197498	7/18/2002	0.70		VOLUMETRIC		15.5	2430	SANDSTONE	LOCAL	DIETZ
197471	7/18/2002	0.90		VOLUMETRIC		11.9	526	CLINKER	LOCAL	ANDERSON
197469	7/18/2002	2.70		VOLUMETRIC		12.1	2072	SANDSTONE	LOCAL	CANYON
205018	6/20/2003	2.60		VOLUMETRIC	7.47	11.5	1241	SANDSTONE	LOCAL	COOK
199682	10/20/2002	0.10		VOLUMETRIC		11.5	1189	SANDSTONE	LOCAL	COOK
204971	5/7/2003	0.20		VOLUMETRIC	7.28	9.5	2325	SANDSTONE	LOCAL	COOK
204972	5/7/2003		DRY						LOCAL	PAWNEE
197602	7/20/2002	0.30		VOLUMETRIC		19.8	4656	COLLUVIUM	REGIONAL	OTTER
199567	9/23/2002	0.20		VOLUMETRIC	6.73	12.9	2448	COAL	LOCAL	COOK
199578	9/23/2002	0.10		VOLUMETRIC	6.97	11.1	3929	SANDSTONE	LOCAL	ELK
199579	9/24/2002	0.10		VOLUMETRIC	7.55	11.3	3225	SANDSTONE	LOCAL	ELK
204969	5/7/2003	0.20		VOLUMETRIC	6.98	9.8	2115	SANDSTONE	LOCAL	CANYON
204970	5/7/2003	1.20		VOLUMETRIC	7.84	6.3	1092	CLINKER	LOCAL	COOK
197863	8/18/2002	0.40		VOLUMETRIC	7.20	14.5	2674	SANDSTONE	LOCAL	COOK
199568	9/23/2002	1.00		VOLUMETRIC	7.00	11.5	3830	SANDSTONE	LOCAL	COOK
204968	5/7/2003	0.50		VOLUMETRIC	6.79	8.9	3671	SANDSTONE	LOCAL	COOK
204953	4/10/2003	0.50		VOLUMETRIC	7.18	7.9	3556	SANDSTONE	LOCAL	COOK

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198891	9/10/2002	1.10		VOLUMETRIC	7.22	15.1	3365	SANDSTONE	LOCAL	CANYON
199660	10/2/2002	0.70		VOLUMETRIC		10.7	3409	CLINKER	LOCAL	COOK
205017	6/20/2003	0.60		VOLUMETRIC	7.06	14.1	1475	SANDSTONE	LOCAL	CANYON
198893	9/10/2002	0.40		VOLUMETRIC	7.22	18.3	3416	SANDSTONE	LOCAL	CANYON
199566	9/10/2002	0.80		VOLUMETRIC	7.22	15.1	2061	SANDSTONE	LOCAL	CANYON
198892	9/10/2002	0.20		VOLUMETRIC	7.00	15.7	2085	SANDSTONE/COAL	LOCAL	CANYON
197657	8/29/2002		NO FLOW					SANDSTONE	LOCAL	CANYON
197663	8/29/2002	0.20		VOLUMETRIC	7.33	17.8	2942	SANDSTONE	LOCAL	COOK
205019	6/20/2003	1.00		VOLUMETRIC	7.66	13.1	3846	CLINKER	LOCAL	COOK
199655	9/25/2002		DRY					SANDSTONE	LOCAL	COOK
204951	4/10/2003	1.00		VOLUMETRIC	7.04	5.2	3209	SANDSTONE	LOCAL	CANYON
205016	6/20/2003		DRY					ALLUVIUM	LOCAL	COOK
199565	9/10/2002	0.70		VOLUMETRIC	6.98	14.0	2023	SANDSTONE	LOCAL	CANYON
199569	9/10/2002	0.20		VOLUMETRIC	7.04	12.6	1846	SANDSTONE	LOCAL	CANYON
199574	9/12/2002		DRY					SANDSTONE	LOCAL	ANDERSON
197665	8/29/2002	0.20		VOLUMETRIC	7.19	15.6	1708	SANDSTONE	LOCAL	CANYON
199581	9/24/2002	0.20		VOLUMETRIC	6.86	12.6	1532	SANDSTONE	LOCAL	DIETZ
197864	8/18/2002	0.80		VOLUMETRIC	7.57	15.2	2382	ALLUVIUM	LOCAL	COOK
204952	4/10/2003	0.70		VOLUMETRIC	6.72	7.4	2960	COAL	LOCAL	COOK
205011	6/4/2003	15.00		VOLUMETRIC	6.99	12.0	680	SANDSTONE	LOCAL	ANDERSON
197666	8/20/2002	0.40		VOLUMETRIC	7.16	18.5	758	SANDSTONE	LOCAL	ANDERSON
197668	8/28/2002		NOT MEASURABLE					COLLUVIUM	LOCAL	ANDERSON/DIETZ
197669	8/28/2002		NOT MEASURABLE					ALLUVIUM	LOCAL	ANDERSON/DIETZ
205010	6/4/2003	0.90		VOLUMETRIC	6.91	8.3	3600	COLLUVIUM	LOCAL	CANYON
199570	9/12/2002	0.80		VOLUMETRIC	7.26	13.8	2520	CLINKER	MIXED	COOK
199571	9/12/2002		NO FLOW					ALLUVIUM	LOCAL	CANYON
199572	9/12/2002	0.60		VOLUMETRIC	6.86	14.6	3344	SANDSTONE	LOCAL	CANYON
199573	9/12/2002	0.70		VOLUMETRIC	6.83	13.1	2490	SANDSTONE	LOCAL	CANYON
197670	8/28/2002	0.60		VOLUMETRIC	7.62	16.3	1963	SANDSTONE	LOCAL	CANYON
197845	8/28/2002	0.10		VOLUMETRIC	7.92		2188	CLINKER	MIXED	COOK
205014	6/19/2003	0.20		VOLUMETRIC	7.78		2877	SANDSTONE	MIXED	COOK
205015	6/19/2003	0.80		VOLUMETRIC	7.81	11.0	2402	COLLUVIUM	MIXED	COOK
199631	8/15/2002		NOT MEASURABLE					COAL	LOCAL	ANDERSON/DIETZ
198983	8/15/2002		NO FLOW					ALLUVIUM	LOCAL	CANYON
204933	8/15/2002		NO FLOW					ALLUVIUM	LOCAL	CANYON
198984	8/15/2002		DRY					ALLUVIUM	LOCAL	COOK
197654	8/30/2002		DRY					CLINKER	REGIONAL	CANYON
204955	4/25/2003	0.50		VOLUMETRIC	6.84	9.2	2815	CLINKER	LOCAL	ANDERSON
204956	4/25/2003	1.70		VOLUMETRIC	6.98	8.7	1920	CLINKER	LOCAL	ANDERSON

Appendix A. Basic data for inventoried springs in the Ashland Ranger District

GWIC ID	Inventory Date	Measured Discharge (gpm)	Discharge Notes	Discharge Method	pH	Temperature (Degrees C)	Specific Conductance (umhos/cm @ 25 C)	Source Lithology [1]	Recharge Origin	Nearest overlying coalbed association
204957	4/25/2003	1.30		VOLUMETRIC	6.96	10.1	2171	SANDSTONE	LOCAL	DIETZ
199629	8/15/2002		NO FLOW					COAL/SANDSTONE	LOCAL	ANDERSON/DIETZ
205053	7/15/2003	0.20		VOLUMETRIC	7.78	16.4	658	CLINKER	LOCAL	ANDERSON/DIETZ
205054	7/15/2003	0.20		VOLUMETRIC	7.39	19.7	1137	SANDSTONE	LOCAL	ANDERSON/DIETZ
199558	8/13/2002	0.30		VOLUMETRIC	7.90	18.0	2181	SANDSTONE	LOCAL	DIETZ
199559	8/13/2002	0.30		VOLUMETRIC	7.19	14.8	1595	CLINKER	LOCAL	DIETZ
199560	8/13/2002	0.30		VOLUMETRIC	7.07	16.2	2763	SANDSTONE	LOCAL	DIETZ
199561	8/13/2002	0.80		VOLUMETRIC	7.68	16.0	2460	SANDSTONE	LOCAL	DIETZ
205045	7/13/2003		DRY					CLINKER	LOCAL	ANDERSON
204934	8/14/2002		NO FLOW					CLINKER	LOCAL	SMITH
205048	7/14/2003		NOT MEASURABLE					CLINKER	LOCAL	SMITH
204958	4/25/2003		DRY					CLINKER	LOCAL	DIETZ
204936	4/10/2003		NOT MEASURABLE			5.8	1598	ALLUVIUM	LOCAL	CANYON
204937	4/10/2003		NOT MEASURABLE			7.3	2680	ALLUVIUM	LOCAL	CANYON
204954	4/24/2003	6.70		VOLUMETRIC	7.08	8.5	1530	SANDSTONE	MIXED	DIETZ
205049	7/14/2003	0.60		VOLUMETRIC	7.65	18.4	3495	SANDSTONE	MIXED	DIETZ
197394	7/18/2002		NO FLOW					SANDSTONE	LOCAL	CANYON
197393	7/18/2002	0.60		VOLUMETRIC		19.8	3895	CLINKER	LOCAL	CANYON
205046	7/14/2003	0.60		VOLUMETRIC	7.72	12.8	2374	CLINKER	LOCAL	ANDERSON
205047	7/14/2003	0.90		VOLUMETRIC	7.43	13.1	2557	CLINKER	LOCAL	DIETZ
197454	7/11/2002	0.20		VOLUMETRIC		17.8	3526	SANDSTONE	REGIONAL	CANYON
205050	7/14/2003		DRY					SANDSTONE	LOCAL	ANDERSON
8013	7/11/2002		DRY					CLINKER	LOCAL	ANDERSON
205076	7/24/2003		DRY					CLINKER	LOCAL	ANDERSON
197453	7/11/2002		NO FLOW							
199575	9/13/2002	0.20		VOLUMETRIC	6.76	12.9	3206	SANDSTONE	LOCAL	ELK
199580	9/24/2002	0.40		VOLUMETRIC	6.53	8.6	1954	SANDSTONE	LOCAL	COOK
205039	7/12/2003	0.20		VOLUMETRIC	6.91	15.9	2887	SANDSTONE	LOCAL	COOK
205044	7/13/2003	0.20		VOLUMETRIC	7.05	16.4	3597	CLINKER	LOCAL	COOK
205077	7/24/2003	0.06		VOLUMETRIC				COLLUVIUM	REGIONAL	COOK
205080	7/24/2003	0.30		VOLUMETRIC	6.80	11.5	2465	SANDSTONE	LOCAL	CANYON
205079	7/24/2003	1.80		VOLUMETRIC	6.85	13.4	2535	SANDSTONE	REGIONAL	ELK
205078	7/24/2003	0.30		VOLUMETRIC	6.97	12.8	2865	COAL	REGIONAL	ELK
197452	7/11/2002	0.90		VOLUMETRIC		12.2	2770	COAL	REGIONAL	OTTER
205051	7/14/2003	0.10		VOLUMETRIC	7.11		3051	SANDSTONE	LOCAL	CANYON
205074	7/23/2003	0.30		VOLUMETRIC	6.76	11.2	4649	SANDSTONE	REGIONAL	CANYON
205043	7/13/2003	0.90		VOLUMETRIC	7.28	16.4	4130	SANDSTONE	REGIONAL	ELK
199576	9/13/2002	1.30		VOLUMETRIC	6.87	13.2	635	COAL	LOCAL	ANDERSON
197865	8/18/2002		NO FLOW						LOCAL	ANDERSON/DIETZ

Appendix A. Basic data for inventoried springs in the Ashland Ranger District

GWIC ID	Inventory Date	Measured Discharge (gpm)	Discharge Notes	Discharge Method	pH	Temperature (Degrees C)	Specific Conductance (umhos/cm @ 25 C)	Source Lithology [1]	Recharge Origin	Nearest overlying coalbed association
197866	8/18/2002	0.60		VOLUMETRIC	7.38	14.0	1438	SANDSTONE	LOCAL	CANYON
199577	9/14/2002	0.30		VOLUMETRIC	7.00	12.4	2833	SANDSTONE	LOCAL	CANYON
197867	8/18/2002	0.80		VOLUMETRIC	7.25	15.4	2995	SANDSTONE	LOCAL	COOK
197871	8/17/2002	0.80		VOLUMETRIC	7.37	12.4	3204	SANDSTONE	REGIONAL	CANYON
197869	8/17/2002		DRY					CLINKER	LOCAL	ANDERSON
205073	7/23/2003		DRY					CLINKER	LOCAL	ANDERSON
205042	7/13/2003	0.60		VOLUMETRIC	7.47	16.1	3245	SANDSTONE	LOCAL	CANYON
205040	7/13/2003	1.00		VOLUMETRIC	7.21	16.4	2634	SANDSTONE	LOCAL	CANYON
205041	7/13/2003	1.10		VOLUMETRIC	7.20	12.4	2585	SANDSTONE	MIXED	CANYON
205093	9/12/2002	0.40		VOLUMETRIC	6.25	11.7	1123	CLINKER	LOCAL	DIETZ
205036	7/12/2003	0.10		VOLUMETRIC	7.50		2780	COLLUVIUM	LOCAL	COOK
205037	7/12/2003	0.10		VOLUMETRIC	7.47		5336	CLINKER	LOCAL	COOK
205035	7/12/2003	0.20		VOLUMETRIC	7.61	19.8	3207	COAL	LOCAL	COOK
205033	7/12/2003		NOT MEASURABLE					SANDSTONE	REGIONAL	CANYON
205034	7/12/2003	0.70		VOLUMETRIC	6.91	12.5	3670	COLLUVIUM	REGIONAL	COOK
197870	8/17/2002	0.60		VOLUMETRIC	7.42	13.0	2585		REGIONAL	CANYON
197868	8/17/2002	0.60		VOLUMETRIC	7.31	14.5	3071	CLINKER	REGIONAL	COOK
205038	7/12/2003	0.60		VOLUMETRIC	7.28	12.8	4040	CLINKER	REGIONAL	COOK
205055	7/15/2003	0.01		ESTIMATED	8.15		2864	CLINKER	LOCAL	ANDERSON

Appendix A. Basic data for inventoried springs in the Ashland Ranger District

GWIC ID	Lithology [2] code 1	Lithology [2] code 2	Lithology [2] code 3	Impact [3] Potential
204995	125SWCB	125TGRV	125FRUN	
205025	110CDKB	125TGRV	125FRUN	
199638	125SWUB	125TGRV	125FRUN	
199636	125CDUB	125TGRV	125FRUN	
204992	110SWKB	125TGRV	125FRUN	
204994	125SWUB	125TGRV	125FRUN	
204987	110ALVM			
199633	125FRUB	125TGRV	125FRUN	
199635	125PWUB	125TGRV	125FRUN	
204993	110ALVM			
199614	125SWUB	125TGRV	125FRUN	
199610	125CDCB	125TGRV	125FRUN	
199639	125CDUB	125TGRV	125FRUN	
199640	110CDKB			
199641	125CDUB	125TGRV	125FRUN	
199643	125FRCB	125TGRV	125FRUN	
199632	125PWCB	125TGRV	125FRUN	
199611	125PWUB	125TGRV	125FRUN	
205072	125SWCB	125TGRV	125FRUN	
205060	125CDUB	125TGRV	125FRUN	
205061	125CDUB	125TGRV	125FRUN	
205062	110ALVM			
205063	125PWCB	125TGRV	125FRUN	
205065	110PWKB	125TGRV	125FRUN	
198849	125CDUB	125TGRV	125FRUN	
198851	125CDUB	125TGRV	125FRUN	
198853	125SWUB	125TGRV	125FRUN	
205059	110ALVM			
205058	125PWUB	125TGRV	125FRUN	
205064	125PWUB	125TGRV	125FRUN	
199623	125CKUB	125TGRV	125FRUN	
199594	125PWUB	125TGRV	125FRUN	
204989	125CKUB	125TGRV	125FRUN	
197843	125SWUB	125TGRV	125FRUN	
199620	125BACB	125TGRV	125FRUN	
199621	125BAUB	125TGRV	125FRUN	
199605	110ALVM			
199619	110CDKB	125TGRV	125FRUN	
199617	125CDUB	125TGRV	125FRUN	

Appendix A. Basic data for inventoried springs in the Ashland Ranger District

GWIC ID	Lithology [2] code 1	Lithology [2] code 2	Lithology [2] code 3	Impact [3] Potential
199618	125CDUB	125TGRV	125FRUN	
7247	125CDCB	125TGRV	125FRUN	
199603	125PWUB	125TGRV	125FRUN	
199600	125CDCB	125TGRV	125FRUN	
204990	125PWUB	125TGRV	125FRUN	
199597	110ALVM			
204932	110ALVM			
204986	110ALVM			
204988	125FRUB	125TGRV	125FRUN	
7246	110ALVM			
199609	125PWUB	125TGRV	125FRUN	
199616	110ALVM			
204983	125FRUB	125TGRV	125FRUN	
199622	125PWUB	125TGRV	125FRUN	
7249	125FRUB	125TGRV	125FRUN	
199598	125PWUB	125TGRV	125FRUN	
204985	110ALVM			
198777	125FRUB	125TGRV	125FRUN	
204980	125PWUB	125TGRV	125FRUN	
204984	125FRUB	125TGRV	125FRUN	
204981	110ALVM			
204982	110ALVM			
204973	110ALVM			
199602	125FRUB	125TGRV	125FRUN	
199601	110ALVM			
204991	110PWKB	125TGRV	125FRUN	
7253	110FRKB	125TGRV	125FRUN	
198817	110FRKB			
198819	110FRKB			
198810	125FRCB	125TGRV	125FRUN	
198821	110FRKB			
198822	110FRKB			
199624	125FRUB	125TGRV	125FRUN	
205070	125ODUB	125TGRV	125FRUN	
205071	125FRUB	125TGRV	125FRUN	
205067	125ODUB	125TGRV	125FRUN	
205068	125ODUB	125TGRV	125FRUN	
205069	125ODCB	125TGRV	125FRUN	
205066	125PWCB	125TGRV	125FRUN	

Appendix A. Basic data for inventoried springs in the Ashland Ranger District

GWIC ID	Lithology [2] code 1	Lithology [2] code 2	Lithology [2] code 3	Impact [3] Potential
204963	110ALVM			
7405	125PWCB	125TGRV	125FRUN	
204959	110ALVM			
204997	125SWUB	125TGRV	125FRUN	2
204960	125PWCB	125TGRV	125FRUN	
204961	125PWUB	125TGRV	125FRUN	
204962	125PWUB	125TGRV	125FRUN	
199612	125SWCB	125TGRV	125FRUN	2
7418	125SWUB	125TGRV	125FRUN	
204979	110ODKB			
204996	125PWUB	125TGRV	125FRUN	
204977	125FRUB	125TGRV	125FRUN	
7422	125ODUB	125TGRV	125FRUN	
199700	125ODUB	125TGRV	125FRUN	
204975	110ALVM			
199606	125FRUB	125TGRV	125FRUN	
199607	125FRUB	125TGRV	125FRUN	
199608	125FRUB	125TGRV	125FRUN	
204966	110FRKB	125TGRV	125FRUN	
204965	125PWUB	125TGRV	125FRUN	
198811	110ALVM			
204964	125FRUB	125TGRV	125FRUN	
198812	125FRUB	125TGRV	125FRUN	
197841	125FRUB	125TGRV	125FRUN	
198813	110FRKB			
205057	125PWUB	125TGRV	125FRUN	
197838	110ALVM			
197839	110ALVM			
197738	125FRUB	125TGRV	125FRUN	
197842	125FRUB	125TGRV	125FRUN	
204967	125FRUB	125TGRV	125FRUN	
197711	110ALVM			
197735	125FRUB	125TGRV	125FRUN	
197840	125FRUB	125TGRV	125FRUN	
204974	125FRUB	125TGRV	125FRUN	
197710	125PWUB	125TGRV	125FRUN	
198766	125FRUB	125TGRV	125FRUN	
199625	110ALVM			
199627	125FRUB	125TGRV	125FRUN	

Appendix A. Basic data for inventoried springs in the Ashland Ranger District

GWIC ID	Lithology [2] code 1	Lithology [2] code 2	Lithology [2] code 3	Impact [3] Potential
199626	125FRUB	125TGRV	125FRUN	
199628	125FRUB	125TGRV	125FRUN	
204976	125FRUB	125TGRV	125FRUN	
198798	125PWUB	125TGRV	125FRUN	
7565	125PWUB	125TGRV	125FRUN	
205012	125PWUB	125TGRV	125FRUN	
198793	110WAKB	125TGRV	125FRUN	
198967	125ODCB	125TGRV	125FRUN	
198969	125ODCB	125TGRV	125FRUN	
7598	125PWUB	125TGRV	125FRUN	
205056	125PWUB	125TGRV	125FRUN	
204978	125PWUB	125TGRV	125FRUN	
199694	125ODUB	125TGRV	125FRUN	
199695	125PWCB	125TGRV	125FRUN	
205020	125ODCB	125TGRV	125FRUN	
205007	125CKUB	125TGRV	125FRUN	
199697	125ELUB	125TGRV	125FRUN	
205008	125ELUB	125TGRV	125FRUN	
199696	125CKUB	125TGRV	125FRUN	
199667	125ELUB	125TGRV	125FRUN	
199665	125CKCB	125TGRV	125FRUN	
199666	125CKUB	125TGRV	125FRUN	
199677	110CKKB			
7606	125PWUB	125TGRV	125FRUN	
204998	125PWCB	125TGRV	125FRUN	
7607	125ODUB	125TGRV	125FRUN	
199673	125PWUB	125TGRV	125FRUN	
199649	110ALVM			
199654	125ODUB	125TGRV	125FRUN	
199676	125CKUB	125TGRV	125FRUN	
199653	110ALVM			
199668	110PWKB			
197707	125FRUB	125TGRV	125FRUN	
197709	125CKUB	125TGRV	125FRUN	
197708	125WAUB	125TGRV	125FRUN	
199595	110ALVM			
198862	125CKUB	125TGRV	125FRUN	
198888	125WAUB	125TGRV	125FRUN	
199596	110ALVM			

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GWIC ID	Lithology [2] code 1	Lithology [2] code 2	Lithology [2] code 3	Impact [3] Potential
199690	125WAUB	125TGRV	125FRUN	2
198890	110ALVM			
198889	125CKUB	125TGRV	125FRUN	
199679	125CNUB	125TGRV	125FRUN	
199680	125CNUB	125TGRV	125FRUN	
199691	110ALVM			
199693	125CKUB	125TGRV	125FRUN	
199699	110ALVM			
199687	125CKUB	125TGRV	125FRUN	
199698	110PWKB	125TGRV	125FRUN	
199669	125CKUB	125TGRV	125FRUN	
199670	125CKUB	125TGRV	125FRUN	
204947	125CKUB	125TGRV	125FRUN	
204940	125PWCB	125TGRV	125FRUN	
204939	125PWCB	125TGRV	125FRUN	2
204938	125PWUB	125TGRV	125FRUN	1
205013	110ANKB	125TGRV	125FRUN	
197726	110ALVM			
198789	110CKKB	125TGRV	125FRUN	
197878	110ALVM			
197879	125PWUB	125TGRV	125FRUN	
204948	110WAKB	125TGRV	125FRUN	2
197733	110ALVM			
197609	125CKUB	125TGRV	125FRUN	
197720	110CKKB	125TGRV	125FRUN	2
197861	125OTUB	125TGRV	125FRUN	
197880	110ALVM			2
205032	125ADUB	125TGRV	125FRUN	
205028	110ALVM			
197544	125ADUB	125TGRV	125FRUN	
197513	125OTUB	125TGRV	125FRUN	
197722	125ADUB	125TGRV	125FRUN	
205002	110CKKB	125TGRV	125FRUN	2
205003	110ALVM			
197717	125CNUB	125TGRV	125FRUN	
7757	110ALVM			
197872	125PWUB	125TGRV	125FRUN	
197873	125ODUB	125TGRV	125FRUN	
197846	110ALVM			

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GWIC ID	Lithology [2] code 1	Lithology [2] code 2	Lithology [2] code 3	Impact [3] Potential
7766	110ALVM			
7767	110ALVM			
7769	125PWUB	125TGRV	125FRUN	
7788	125OTUB	125TGRV	125FRUN	
197859	110ALVM			
197862	125OTUB	125TGRV	125FRUN	
197860	125OTUB	125TGRV	125FRUN	
199645	125BAUB	125TGRV	125FRUN	
199646	110ALVM			
199647	110ALVM			
199644	110ALVM			
199648	110ALVM			
7795	125ODUB	125TGRV	125FRUN	
199684	125PWUB	125TGRV	125FRUN	
199686	125PWUB	125TGRV	125FRUN	2
198768	125ELUB	125TGRV	125FRUN	
7796	125ODUB	125TGRV	125FRUN	
205026	125PWUB	125TGRV	125FRUN	1
7800	125PWUB	125TGRV	125FRUN	
199658	110ALVM			
199659	125PWCB	125TGRV	125FRUN	2
199661	110CKKB			
199662	125CKUB	125TGRV	125FRUN	
199663	125CKUB	125TGRV	125FRUN	
197704	125CNUB	125TGRV	125FRUN	
199685	125CKUB	125TGRV	125FRUN	
204999	110CKKB	125TGRV	125FRUN	
199583	125CKUB	125TGRV	125FRUN	
199584	125CKUB	125TGRV	125FRUN	
197706	125CNUB	125TGRV	125FRUN	
205001	125CNUB	125TGRV	125FRUN	
197607	125CKUB	125TGRV	125FRUN	
197610	125CKUB	125TGRV	125FRUN	
199585	125CKUB	125TGRV	125FRUN	
199586	125CKUB	125TGRV	125FRUN	
199593	110ALVM			
197608	125CKUB	125TGRV	125FRUN	
199582	125CKUB	125TGRV	125FRUN	1
205000	110CKKB	125TGRV	125FRUN	1

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GWIC ID	Lithology [2] code 1	Lithology [2] code 2	Lithology [2] code 3	Impact [3] Potential
205009	125CKUB	125TGRV	125FRUN	1
204935	110CKKB	125TGRV	125FRUN	
205027	110CKKB	125TGRV	125FRUN	
197512	110ADKB	125TGRV	125FRUN	
197509	110ADKB	125TGRV	125FRUN	
197508	125ADUB	125TGRV	125FRUN	
204943	125ADUB	125TGRV	125FRUN	
204944	125ADUB	125TGRV	125FRUN	
197505	125ADUB	125TGRV	125FRUN	
204942	125ADUB	125TGRV	125FRUN	
197516	125ADUB	125TGRV	125FRUN	
197517	110ADKB	125TGRV	125FRUN	
204941	125ADUB	125TGRV	125FRUN	
204950	125CNOB	125TGRV	125FRUN	
197515	125ADUB	125TGRV	125FRUN	
205075	110ADKB	125TGRV	125FRUN	
198985	125CNCB	125TGRV	125FRUN	
198986				
198979	125ADCB	125TGRV	125FRUN	
198981	125ADCB	125TGRV	125FRUN	
199630	125ADCB	125TGRV	125FRUN	
205030	125ADUB	125TGRV	125FRUN	
204949	110ADKB	125TGRV	125FRUN	
197510	110ALVM			
197511	125ADUB	125TGRV	125FRUN	
198974	110ADKB	125TGRV	125FRUN	
204945	110ADKB	125TGRV	125FRUN	
204946	110ALVM			
198973	125RLCB	125TGRV	125FRUN	
205029	125CNOB	125TGRV	125FRUN	
205031	110CNKB	125TGRV	125FRUN	
205052	110ADKB	125TGRV	125FRUN	
205024	125CNOB	125TGRV	125FRUN	
205023	125DIUB	125TGRV	125FRUN	
205022	110ANKB	125TGRV	125FRUN	
205021	125ANUB	125TGRV	125FRUN	
197500	110ALVM			
197504	110ALVM			
199590	110ALVM			

Appendix A. Basic data for inventoried springs in the Ashland Ranger District

GWIC ID	Lithology [2] code 1	Lithology [2] code 2	Lithology [2] code 3	Impact [3] Potential
199588	125OTCB	125TGRV	125FRUN	2
199589	125CNOB	125TGRV	125FRUN	
199587	125DIUB	125TGRV	125FRUN	
197606	110ANKB	125TGRV	125FRUN	
197603	110ALVM			
197604	125ANUB	125TGRV	125FRUN	
205004	110ADKB	125TGRV	125FRUN	
205006	125ADUB	125TGRV	125FRUN	
205005	125ADUB	125TGRV	125FRUN	
197605	125ANUB	125TGRV	125FRUN	
197715	110ANKB	125TGRV	125FRUN	
197712	125ANUB	125TGRV	125FRUN	
197714	125ANUB	125TGRV	125FRUN	
197601	125OTUB	125TGRV	125FRUN	1
205094	125OTUB	125TGRV	125FRUN	2
197456	125DIUB	125TGRV	125FRUN	
198972	110ALVM			
7909	110ANKB	125TGRV	125FRUN	
204931	125DIUB	125TGRV	125FRUN	
197396	125CKUB	125TGRV	125FRUN	
197395	125OTUB	125TGRV	125FRUN	1
197459	125CNOB	125TGRV	125FRUN	
197498	125DIUB	125TGRV	125FRUN	
197471	110ANKB	125TGRV	125FRUN	
197469	125CNOB	125TGRV	125FRUN	
205018	125CKUB	125TGRV	125FRUN	
199682	125CKUB	125TGRV	125FRUN	
204971	125CKUB	125TGRV	125FRUN	
204972	125PWUB	125TGRV	125FRUN	
197602	125OTUB	125TGRV	125FRUN	
199567	125CKCB	125TGRV	125FRUN	
199578	125ELUB	125TGRV	125FRUN	1
199579	125ELUB	125TGRV	125FRUN	1
204969	125CNOB	125TGRV	125FRUN	
204970	110CKKB	125TGRV	125FRUN	
197863	125CKUB	125TGRV	125FRUN	
199568	125CKUB	125TGRV	125FRUN	
204968	125CKUB	125TGRV	125FRUN	
204953	125CKUB	125TGRV	125FRUN	

Appendix A. Basic data for inventoried springs in the Ashland Ranger District

GWIC ID	Lithology [2] code 1	Lithology [2] code 2	Lithology [2] code 3	Impact [3] Potential
198891	125CNOB	125TGRV	125FRUN	
199660	110CKKB	125TGRV	125FRUN	
205017	125CNOB	125TGRV	125FRUN	
198893	125CNOB	125TGRV	125FRUN	
199566	125CNOB	125TGRV	125FRUN	
198892	125CNUB	125TGRV	125FRUN	
197657	125CNOB	125TGRV	125FRUN	
197663	125CKUB	125TGRV	125FRUN	1
205019	110CKKB	125TGRV	125FRUN	2
199655	125CKUB	125TGRV	125FRUN	
204951	125CNOB	125TGRV	125FRUN	
205016	110ALVM			
199565	125CNUB	125TGRV	125FRUN	
199569	125CNOB	125TGRV	125FRUN	
199574	125ANUB	125TGRV	125FRUN	
197665	125CNOB	125TGRV	125FRUN	
199581	125DIUB	125TGRV	125FRUN	
197864	110ALVM			2
204952	125CKCB	125TGRV	125FRUN	2
205011	125ANUB	125TGRV	125FRUN	
197666	125ANUB	125TGRV	125FRUN	
197668	125ADUB	125TGRV	125FRUN	
197669	110ALVM			
205010	125CNUB	125TGRV	125FRUN	
199570	110CKKB	125TGRV	125FRUN	
199571	110ALVM			
199572	125CNOB	125TGRV	125FRUN	
199573	125CNOB	125TGRV	125FRUN	
197670	125CNOB	125TGRV	125FRUN	
197845	110CKKB	125TGRV	125FRUN	
205014	125CKUB	125TGRV	125FRUN	1
205015	125CKUB	125TGRV	125FRUN	2
199631	125ADCB	125TGRV	125FRUN	
198983	110ALVM			
204933	110ALVM			
198984	110ALVM			
197654	110CNKB	125TGRV	125FRUN	2
204955	110ANKB	125TGRV	125FRUN	
204956	110ANKB	125TGRV	125FRUN	

Appendix A. Basic data for inventoried springs in the Ashland Ranger District

GWIC ID	Lithology [2] code 1	Lithology [2] code 2	Lithology [2] code 3	Impact [3] Potential
204957	125DIUB	125TGRV	125FRUN	
199629	125ADCB	125TGRV	125FRUN	
205053	110ADKB	125TGRV	125FRUN	
205054	125ADUB	125TGRV	125FRUN	
199558	125DIUB	125TGRV	125FRUN	
199559	110DIKB	125TGRV	125FRUN	
199560	125DIUB	125TGRV	125FRUN	
199561	125DIUB	125TGRV	125FRUN	
205045	110ANKB	125TGRV	125FRUN	
204934	110SMKB	125TGRV	125FRUN	
205048	110SMKB	125TGRV	125FRUN	
204958	110DIKB			
204936	110ALVM			
204937	110ALVM			
204954	125DIUB	125TGRV	125FRUN	
205049	125DIUB	125TGRV	125FRUN	2
197394	125CNOB	125TGRV	125FRUN	
197393	110CNKB	125TGRV	125FRUN	
205046	110ANKB	125TGRV	125FRUN	
205047	110DIKB	125TGRV	125FRUN	
197454	125CNOB	125TGRV	125FRUN	1
205050	125ANUB	125TGRV	125FRUN	
8013	110ANKB	125TGRV	125FRUN	
205076	110ANKB	125TGRV	125FRUN	
197453				
199575	125ELUB	125TGRV	125FRUN	
199580	125CKUB	125TGRV	125FRUN	
205039	125CKUB	125TGRV	125FRUN	
205044	110CKKB	125TGRV	125FRUN	
205077	125CKUB	125TGRV	125FRUN	
205080	125CNOB	125TGRV	125FRUN	
205079	125ELUB	125TGRV	125FRUN	1
205078	125ELCB	125TGRV	125FRUN	2
197452	125OTCB	125TGRV	125FRUN	2
205051	125CNOB	125TGRV	125FRUN	
205074	125CNOB	125TGRV	125FRUN	1
205043	125ELUB	125TGRV	125FRUN	1
199576	125ANCB	125TGRV	125FRUN	
197865	125ADUB	125TGRV	125FRUN	

Appendix A. Basic data for inventoried springs in the Ashland Ranger District

GWIC ID	Lithology [2] code 1	Lithology [2] code 2	Lithology [2] code 3	Impact [3] Potential
197866	125CNUB	125TGRV	125FRUN	
199577	125CNOB	125TGRV	125FRUN	
197867	125CKUB	125TGRV	125FRUN	1
197871	125CNOB	125TGRV	125FRUN	1
197869	110ANKB	125TGRV	125FRUN	
205073	110ANKB	125TGRV	125FRUN	
205042	125CNOB	125TGRV	125FRUN	
205040	125CNOB	125TGRV	125FRUN	
205041	125CNOB	125TGRV	125FRUN	
205093	110DIKB	125TGRV	125FRUN	
205036	125CKUB	125TGRV	125FRUN	
205037	110CKKB	125TGRV	125FRUN	
205035	125CKCB	125TGRV	125FRUN	
205033	125CNOB	125TGRV	125FRUN	
205034	125CKUB	125TGRV	125FRUN	2
197870	125CNUB	125TGRV	125FRUN	2
197868	110CKKB	125TGRV	125FRUN	2
205038	110CKKB	125TGRV	125FRUN	2
205055	110ANKB	125TGRV	125FRUN	

FOOTNOTES:

1 Source lithology: Where possible, geologic material was identified as the source for springs. Actual developments are not typically visible and sources are inferred from surrounding outcrops.

2 Lithology code: Code 1 gives the most specific detail such as the coal bed name or alluvium; code 2 gives geologic member name; code 3 gives the geologic formation name.

3 Impact potential: See text of report for detailed discussion. No value is given for sites presumed to be well outside the area of potential CBM impact.
A value of 1 indicates the site will most likely not be impactred, but is of interest for monitoring.
A value of 2 indicates the site is within the area of possible impacts if the associated coal bed is developed for CBM within the area.

Appendix B. Spring and stream monitor sites in the Ashland Ranger District

Site name	GWIC ID	Longitude	Latitude	Township	Range	Section	Tract	County	Spring source lithology	Nearest overlying coalbed association to spring
Monitored springs										
LEMONADE SPRING	198766	-105.92550	45.54550	03S	47E	28	ACAA	POWDER RIVER		FERRY
UPPER FIFTEEN MILE SPRING	197607	-105.93720	45.39200	05S	47E	16	DCDC	POWDER RIVER	COLLUVIUM	COOK
HAGEN 2 SPRING	205004	-106.26880	45.34500	06S	45E	6	ACDC	POWDER RIVER	CLINKER	ANDERSON/DIETZ
HEDUM SPRING	199568	-106.07100	45.28230	06S	46E	26	CDBA	POWDER RIVER	SANDSTONE	COOK
JOE ANDERSON SPRING	205011	-105.95470	45.27150	06S	47E	34	CABA	POWDER RIVER	SANDSTONE	ANDERSON
NORTH FORK SPRING	205010	-105.87360	45.29960	06S	48E	20	BDCA	POWDER RIVER	COLLUVIUM	CANYON
DEADMAN SPRING	199572	-105.87430	45.29030	06S	48E	29	BABB	POWDER RIVER	SANDSTONE	CANYON
CHIPMUNK SPRING	205049	-106.36110	45.21200	07S	44E	21	CCBB	ROSEBUD	SANDSTONE	DIETZ
ALKALI SPRING	197452	-106.15010	45.19140	07S	46E	31	BACD	POWDER RIVER	COAL	OTTER
SCHOOL HOUSE SPRING	205041	-106.00810	45.19440	07S	47E	32	BABA	POWDER RIVER	SANDSTONE	CANYON
Monitored stream										
EAST FORK HANGING WOMAN CREEK WEIR	223877	-106.40410	45.29090	06S	43E	25	ABDD	ROSEBUD		OTTER

Appendix B. Spring and stream monitor sites in the Ashland Ranger District

Site name	GWIC ID	Spring recharge origin	Altitude	Spring yield (gpm)	Spring yield date	Flow monitoring	Water quality sampling
Monitored springs							
LEMONADE SPRING	198766	LOCAL	3660	1.8	2/3/2006	QUARTERLY	
UPPER FIFTEEN MILE SPRING	197607	LOCAL	3805	0.6	1/26/2006	QUARTERLY	
HAGEN 2 SPRING	205004	LOCAL	3890	0.6	2/11/2006	QUARTERLY	
HEDUM SPRING	199568	LOCAL	3680	0.6	7/30/2005	QUARTERLY	
JOE ANDERSON SPRING	205011	LOCAL	4050	0.7	7/30/2005	QUARTERLY	
NORTH FORK SPRING	205010	LOCAL	3960	0.9	7/30/2005	QUARTERLY	
DEADMAN SPRING	199572	LOCAL	3940	0.6	9/12/2002	QUARTERLY	
CHIPMUNK SPRING	205049	LOCAL	3670	0.6	10/20/2003	MONTHLY	
ALKALI SPRING	197452	REGIONAL	3470	1.1	3/30/2005	MONTHLY	
SCHOOL HOUSE SPRING	205041	LOCAL	3735	0.9	8/21/2005	QUARTERLY	
Monitored stream							
EAST FORK HANGING WOMAN CREEK WEIR	223877	MIXED	3475	20	11/10/2005	MONTHLY	SEMI-ANNUAL

Appendix C. Water quality for wells, springs, and streams in the Ashland Ranger District

Sample	Gwic Id	Site Name	Latitude	Longitude	Township	Range	Section	Q Sec
Springs								
1974Q1069	7247	USDA FOREST SERVICE - MAXWELL SPRING	45.67240	-106.02930	02S	46E	10	DBAD
1974Q1067	7246	USDA FOREST SERVICE - CABIN CREEK SPRING	45.66710	-106.08160	02S	46E	17	BBAA
1974Q1065	7249	USDA FOREST SERVICE - DARLING DRAW SPRING	45.64310	-106.03130	02S	46E	22	DBDB
1974Q1063	7253	USDA FOREST SERVICE - HOLIDAY SPRING	45.63930	-105.97420	02S	47E	19	CDDB
1976Q0267	7253	USDA FOREST SERVICE - HOLIDAY SPRING	45.63930	-105.97420	02S	47E	19	CDDB
2004Q0224	7253	USDA FOREST SERVICE - HOLIDAY SPRING	45.63930	-105.97420	02S	47E	19	CDDB
1974Q0866	7405	USDA FOREST SERVICE - PASS SPRING	45.59720	-106.05810	03S	46E	4	CDBB
1974Q0151	7418	USDA FOREST SERVICE - COAL BANK SPRING	45.57400	-106.09590	03S	46E	18	BDAD
2004Q0227	7418	USDA FOREST SERVICE - COAL BANK SPRING	45.57400	-106.09590	03S	46E	18	BDAD
1974Q0877	7422	USDA FOREST SERVICE - STAFFORD SPRING	45.52160	-106.02500	03S	46E	34	DDDC
2004Q0229	198766	USDA FOREST SERVICE - LEMONADE SPRING	45.54550	-105.92550	03S	47E	28	ACAA
1974Q0130	7565	USDA FOREST SERVICE - PASS SPRING	45.48270	-106.24330	04S	44E	24	ABBB
1974Q0129	7598	USDA FOREST SERVICE - GENE CREEK SPRING	45.45780	-106.21720	04S	45E	30	DDBB
1974Q0138	7606	USDA FOREST SERVICE - MINERAL YAGER SPRING	45.45580	-106.05490	04S	46E	28	DAAB
2004Q0230	7606	USDA FOREST SERVICE - MINERAL YAGER SPRING	45.45580	-106.05490	04S	46E	28	DAAB
1974Q0128	7607	USDA FOREST SERVICE - COAL CREEK SPRING	45.45500	-106.09190	04S	46E	29	CBBD
1974Q0139	7757	USFS FOREST SERVICE - CHROMO SPRING	45.42940	-106.21810	05S	45E	6	DABC
1980Q2625	7766	USDA FOREST SERVICE - LITTLE BRIAN SPRING	45.40660	-106.21860	05S	45E	18	ACAA
1974Q0142	7767	USDA FOREST SERVICE - LOWER BRIAN 2 SPRING	45.40660	-106.21770	05S	45E	18	AACC
1980Q2627	7767	USDA FOREST SERVICE - LOWER BRIAN 2 SPRING	45.40660	-106.21770	05S	45E	18	AACC
2004Q0223	7767	USDA FOREST SERVICE - LOWER BRIAN 2 SPRING	45.40660	-106.21770	05S	45E	18	AACC
1980Q2626	7769	USDA FOREST SERVICE - UPPER BRIAN SPRING	45.40450	-106.22600	05S	45E	18	BDBD
1974Q0149	7788	USDA FOREST SERVICE - PAGET 2 SPRING	45.37290	-106.19650	05S	45E	29	DAAB
1974Q0127	7795	USDA FOREST SERVICE - COOMBE SPRING	45.41310	-106.05170	05S	46E	9	CBCC
1974Q0132	7796	USDA FOREST SERVICE - WILEY USE SPRING	45.39270	-106.08090	05S	46E	20	ABAC
1974Q0148	7800	USDA FOREST SERVICE - SMITH SPRING	45.37990	-106.04250	05S	46E	27	CADA
2006Q0684	197607	USDA FOREST SERVICE- UPPER FIFTEEN MILE SPRING	45.39200	-105.93720	05S	47E	16	DCDC
2007Q0328	197607	USDA FOREST SERVICE- UPPER FIFTEEN MILE SPRING	45.39200	-105.93720	05S	47E	16	DCDC
1976Q0270	7909	USDA FOREST SERVICE - COW CREEK 1 SPRING	45.30790	-106.25010	06S	45E	20	ABBC
2007Q0694	199573	USDA FOREST SERVICE - WILLOW SPRING	45.28310	-105.88790	06S	48E	30	DBBA
2007Q0693	204956	USDA FOREST SERVICE - CLARK DRAW 1 SPRING	45.21110	-106.40960	07S	43E	24	CADA
2004Q0222	205049	USDA FOREST SERVICE - CHIPMUNK SPRING	45.21200	-106.36110	07S	44E	21	CCBB
1980Q1269	8013	USDA FOREST SERVICE - HANDLEY SPRING	45.18520	-106.26580	07S	45E	31	DBCA
2007Q1051	197452	USDA FOREST SERVICE ALKALI SPRING	45.19140	-106.15010	07S	46E	31	BACD
2008Q0209	197452	USDA FOREST SERVICE ALKALI SPRING	45.19140	-106.15010	07S	46E	31	BACD
2004Q0228	205041	USDA FOREST SERVICE - SCHOOL HOUSE SPRING	45.19440	-106.00810	07S	47E	32	BABA
2004Q0225	205034	USDA FOREST SERVICE - WATER GAP SPRING	45.22990	-105.85940	07S	48E	17	AADB

Appendix C. Water quality for wells, springs, and streams in the Ashland Ranger District

Sample	Gwic Id	Site Name	Latitude	Longitude	Township	Range	Section	Q Sec
Streams								
1983Q0122	7585	OTTER CREEK ABOVE WILLOW CROSSING	45.49250	-106.17110	04S	45E	15	BCCD
1980Q2630	7779	OTTER CREEK * NEAR 15 MILE ROAD (2B)	45.39130	-106.14770	05S	45E	23	BACC
2007Q0336	223877	EAST FORK HANGING WOMAN CREEK WEIR	45.29090	-106.40410	06S	43E	25	ABDD
2007Q1055	223877	EAST FORK HANGING WOMAN CREEK WEIR	45.29090	-106.40410	06S	43E	25	ABDD
2008Q0180	223877	EAST FORK HANGING WOMAN CREEK WEIR	45.29090	-106.40410	06S	43E	25	ABDD
1976Q1397	7910	OTTER CREEK * .6 MI N FORT HOWES MT.	45.29220	-106.14720	06S	46E	30	BAAD
1984Q0147	8218	MORRIS JOHN * OTTER CREEK AT WEIR *	45.13300	-106.12220	08S	46E	18	DDAD
		OTTER CREEK (O-7S)	45.28761	-106.14624				
		OTTER CREEK (O-8S)	45.35185	-106.14879				
		OTTER CREEK (O-10S)	45.43167	-106.14993				
		OTTER CREEK (O-16S)	45.54577	-106.21212				
		OTTER CREEK (O-18S)	45.55645	-106.21686				
		OTTER CREEK (O-20S)	45.59893	-106.27088				
Wells								
1974Q1060	100472	USDA FOREST SERVICE - EAST FORK PIPELINE WELL	45.59350	-106.16420	03S	45E	10	BACB
1980Q0884	100472	USDA FOREST SERVICE - EAST FORK PIPELINE WELL	45.59350	-106.16420	03S	45E	10	BACB
2005Q0037	100472	USDA FOREST SERVICE - EAST FORK PIPELINE WELL	45.59350	-106.16420	03S	45E	10	BACB
1975Q0754	7589	USDA FOREST SERVICE - NEWELL PIPELINE WELL	45.47270	-106.21430	04S	45E	19	DADD
2005Q0457	183565	USDA FOREST SERVICE - SKINNER GULCH PIPELINE WELL	45.42750	-105.91710	05S	47E	3	BCCD
2005Q0038	105007	USFS * CUSTER NATIONAL FOREST TOOLEY CREEK WELL	45.21530	-106.26970	07S	45E	19	CAAA

Appendix C. Water quality for wells, springs, and streams in the Ashland Ranger District

Sample	Gwic Id	County	Site Type	Dominant Recharge origin	Aquifer	Depth (ft)	Comp Date	Agency	Sample Date	Water Temperature	Lab	Lab pH
Springs												
1974Q1069	7247	POWDER RIVER	SPRING	LOCAL	125CDCB			USGS	10/24/1974	9.5	MBMG	8.79
1974Q1067	7246	POWDER RIVER	SPRING	LOCAL	110ALVM			USGS	10/24/1974	9	MBMG	8.09
1974Q1065	7249	POWDER RIVER	SPRING	LOCAL	125FRUB			USGS	10/23/1974 11:00	10	MBMG	8.84
1974Q1063	7253	POWDER RIVER	SPRING	LOCAL	110FRKB			USGS	10/24/1974 10:00	9	MBMG	8.78
1976Q0267	7253	POWDER RIVER	SPRING	LOCAL	110FRKB			USFS	4/20/1976 9:30	6	MBMG	7.84
2004Q0224	7253	POWDER RIVER	SPRING	LOCAL	110FRKB			MBMG	10/21/2003 15:30	11.1	MBMG	7.81
1974Q0866	7405	POWDER RIVER	SPRING	REGIONAL	125PWUB			USGS	8/8/1974 10:05	14.5	MBMG	8.29
1974Q0151	7418	POWDER RIVER	SPRING	REGIONAL	125SWUB			USGS	1/18/1974 10:30	60	MBMG	8.1
2004Q0227	7418	POWDER RIVER	SPRING	REGIONAL	125SWUB			MBMG	10/21/2003 17:15	16	MBMG	7.91
1974Q0877	7422	POWDER RIVER	SPRING	REGIONAL	125ODUB			USGS	8/22/1974 14:00	16.5	MBMG	7.78
2004Q0229	198766	POWDER RIVER	SPRING	LOCAL	125FRUB			MBMG	10/21/2003 14:45		MBMG	7.43
1974Q0130	7565	ROSEBUD	SPRING	LOCAL	125PWCB			USGS	1/14/1974 14:40	3	MBMG	7.65
1974Q0129	7598	POWDER RIVER	SPRING	LOCAL	125PWUB			USGS	1/14/1974 11:30	3	MBMG	8.01
1974Q0138	7606	POWDER RIVER	SPRING	MIXED	125PWUB			USGS	1/16/1974 9:30	7.5	MBMG	7.71
2004Q0230	7606	POWDER RIVER	SPRING	MIXED	125PWUB			MBMG	10/21/2003 10:15	12.5	MBMG	7.98
1974Q0128	7607	POWDER RIVER	SPRING	MIXED	125ODUB			USGS	1/16/1974 10:30	8	MBMG	7.93
1974Q0139	7757	POWDER RIVER	SPRING	LOCAL	110ALVM			USGS	1/13/1974 18:00	4.5	MBMG	7.77
1980Q2625	7766	POWDER RIVER	SPRING	LOCAL	110ALVM			USGS	10/28/1980 9:10	12	MBMG	7.59
1974Q0142	7767	POWDER RIVER	SPRING	LOCAL	111ALVM			USGS	1/12/1973 12:30	1	MBMG	8.07
1980Q2627	7767	POWDER RIVER	SPRING	LOCAL	111ALVM			USGS	10/28/1980 9:10	7.5	MBMG	7.56
2004Q0223	7767	POWDER RIVER	SPRING	LOCAL	111ALVM			MBMG	10/20/2003	15.1	MBMG	7.35
1980Q2626	7769	POWDER RIVER	SPRING	LOCAL	125PWUB			USGS	10/28/1980 9:30	5	MBMG	7.55
1974Q0149	7788	POWDER RIVER	SPRING	LOCAL	125OTUB			USGS	1/16/1974 17:15	6	MBMG	8.04
1974Q0127	7795	POWDER RIVER	SPRING	LOCAL	125ODUB			USGS	1/16/1974 13:15	4.5	MBMG	7.75
1974Q0132	7796	POWDER RIVER	SPRING	LOCAL	125ODUB			USGS	1/18/1974 15:00	3.5	MBMG	7.81
1974Q0148	7800	POWDER RIVER	SPRING	LOCAL	125PWUB			USGS	1/16/1974 12:45	2	MBMG	7.51
2006Q0684	197607	POWDER RIVER	SPRING	LOCAL	125CKUB			MBMG	1/26/2006 11:30	3.9	MBMG	7.48
2007Q0328	197607	POWDER RIVER	SPRING	LOCAL	125CKUB			MBMG	8/18/2006 11:00	18.5	MBMG	7.28
1976Q0270	7909	ROSEBUD	SPRING	LOCAL	110ANKB			USFS	4/21/1976 11:30	7.5	MBMG	8.14
2007Q0694	199573	POWDER RIVER	SPRING	LOCAL	125CNOB			MBMG	10/28/2006 11:00	9	MBMG	6.92
2007Q0693	204956	ROSEBUD	SPRING	LOCAL	110ANKB			MBMG	10/28/2006 14:00	9.8	MBMG	6.92
2004Q0222	205049	ROSEBUD	SPRING	MIXED	125DIUB			MBMG	10/20/2003 16:00	11.7	MBMG	8.08
1980Q1269	8013	POWDER RIVER	SPRING	LOCAL	110ANKB			USGS	6/29/1980 13:30	14.5	MBMG	7.82
2007Q1051	197452	POWDER RIVER	SPRING	REGIONAL	125OTCB			MBMG	5/1/2007 17:30	9.6	MBMG	7.67
2008Q0209	197452	POWDER RIVER	SPRING	REGIONAL	125OTCB			MBMG	10/3/2007 12:15	11.9	MBMG	7.81
2004Q0228	205041	POWDER RIVER	SPRING	MIXED	125CNOB			MBMG	10/21/2003 11:45	11.1	MBMG	7.49
2004Q0225	205034	POWDER RIVER	SPRING	REGIONAL	125CKUB			MBMG	10/21/2003 13:15	11.3	MBMG	7.29

Appendix C. Water quality for wells, springs, and streams in the Ashland Ranger District

Sample	Gwic Id	County	Site Type	Dominant Recharge origin	Aquifer	Depth (ft)	Comp Date	Agency	Sample Date	Water Temperat ure	Lab	Lab pH
Streams												
1983Q0122	7585	POWDER RIVER	STREAM					USGS	3/29/1983 14:30	7.5	MBMG	8.22
1980Q2630	7779	POWDER RIVER	STREAM					USGS	10/21/1980 9:40	7	MBMG	8.26
2007Q0336	223877	ROSEBUD	STREAM					MBMG	8/18/2006 7:00	15	MBMG	7.93
2007Q1055	223877	ROSEBUD	STREAM					MBMG	5/1/2007 15:53	26.9	MBMG	7.06
2008Q0180	223877	ROSEBUD	STREAM					MBMG	9/21/2007 17:20	14.1	MBMG	7.91
1976Q1397	7910	POWDER RIVER	STREAM					USGS	10/20/1976 13:30	5.6	MBMG	8.18
1984Q0147	8218	POWDER RIVER	STREAM					USGS	5/21/1984 16:30	18	MBMG	7.76
		POWDER RIVER	STREAM					USGS	10/26/1977			
		POWDER RIVER	STREAM					USGS	10/26/1977			
		POWDER RIVER	STREAM					USGS	10/27/1977			
		POWDER RIVER	STREAM					USGS	10/27/1977			
		POWDER RIVER	STREAM					USGS	10/27/1977			
		POWDER RIVER	STREAM					USGS	10/28/1977			
Wells												
1974Q1060	100472	POWDER RIVER	WELL		125KNUB	193	4/1/1961	USGS	10/8/1974 14:00		MBMG	8.16
1980Q0884	100472	POWDER RIVER	WELL		125KNUB	193	4/1/1961	USGS	6/19/1980 16:00		MBMG	8.11
2005Q0037	100472	POWDER RIVER	WELL		125KNUB	193	4/1/1961	MBMG	7/20/2004 9:30	15.3	MBMG	8.82
1975Q0754	7589	POWDER RIVER	WELL		125KNCB	325	4/20/1958	USGS	6/26/1975 11:20	13	MBMG	8.02
2005Q0457	183565	POWDER RIVER	WELL		125PWUB	167		MBMG	4/26/2005 11:50	9.5	MBMG	8.07
2005Q0038	105007	POWDER RIVER	WELL		125CNOB	110	11/5/1978	MBMG	7/19/2004 16:00	13.2	MBMG	8.23

Appendix C. Water quality for wells, springs, and streams in the Ashland Ranger District

Sample	Gwic Id	Lab Specific Conductance	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Iron (mg/l)	Manganese (mg/l)	Silica (mg/l)	Bicarbonate (mg/l)	Carbonate (mg/l)	Sulfate (mg/l)	Chloride (mg/l)	Nitrate (mg/l)
Springs														
1974Q1069	7247	2093	18.4	16	477.5	6.2	0.32	<.01	13.1	845	33	375	5.3	<.1
1974Q1067	7246	1506	82	118	100	11.6	<.01	<.01	17.4	630	0	368	4	<.1
1974Q1065	7249	599.9	29	40	43.6	8.5	<.01	<.01	18.3	298	8	71	3	0.8
1974Q1063	7253	639.9	39	58	17.1	7.6	<.01	<.01	21.4	367	22	29	3	0.8
1976Q0267	7253	682.5	44	55	17.5	7.1	<.01	<.01	21.2	435	0	27	2.9	0.621
2004Q0224	7253	713	45.6	55.2	17.3	8.14	0.022	<0.001	20.9	401	0	24.2	1.9	1.47 P
1974Q0866	7405	5402	50	53	1335	12.1	<.01	<.01	10	1522	0	1969	11.3	2.3
1974Q0151	7418	4507	103	59	1000	10.4	<.01	<.01	12.4	1117	0	1714	10.7	1
2004Q0227	7418	5320	102	56.8	1253	11.3	0.631	0.187	10.2	1128.5	0	2385	12	<0.5 P
1974Q0877	7422	3956	113	113	755	10.8	<.01	0.04	14.1	1074	0	1412	12.5	<.1
2004Q0229	198766	2060	154	134	149	8	0.088	0.03	13.2	723.9	0	653	<10.0	<0.5 P
1974Q0130	7565	5040	238	424	670	18.3	<.01	<.01	14.8	1166	0	2712	9.9	1.7
1974Q0129	7598	1791	113	161	94.7	6.3	<.01	<.01	12.3	620	0	648	5.1	<.1
1974Q0138	7606	5719	356	514	541.3	20.8	0.03	0.24	18.6	922	0	3334	8.4	<.1
2004Q0230	7606	5060	318	507	466	20.1	0.142	0.145	16.4	893	0	3071	7.28	4.03 P
1974Q0128	7607	5596	266	416	737.5	20	<.01	<.01	17.7	883	0	3094	10.6	0.8
1974Q0139	7757	1573	133	141	37.8	4.9	0.04	<.01	18.6	693	0	427	5.9	<.1
1980Q2625	7766	2091	129	197	82.9	7.8	0.022	0.028	18.5	664	0	750	10	0.1
1974Q0142	7767	2884	160	351	122.5	10.3	0.02	<.01	17.1	734	0	1474	10.1	0.2
1980Q2627	7767	3180	156	371	119	10.3	0.032	0.038	17.2	662	0	1580	13.6	<.01
2004Q0223	7767	2420	168	270	90.8	8.2	0.8	0.185	16.4	709.2	0	1201	8.54	<0.5 P
1980Q2626	7769	3370	200	375	142	12.9	0.015	0.004	18.6	811	0	1640	16.5	0.07
1974Q0149	7788	2900	149	253	253.8	8.1	<.01	<.01	14.4	598	0	1462	11.1	0.1
1974Q0127	7795	2182	96	179	223.8	11.5	<.01	<.01	16.9	859	0	730	6.6	<.1
1974Q0132	7796	2854	184	205	317.5	8.8	0.11	<.01	14.8	864	0	1270	6.5	0.6
1974Q0148	7800	4295	230	493	317.5	16.9	<.01	0.16	16.6	993	0	2382	11.8	1.107
2006Q0684	197607	2350	112	130	335	8.85	0.013	0.01	11.1	1127.3	0	544	5.15	<0.5 P
2007Q0328	197607	2310	106	113	299	10.5	0.009	0.008	13.5	1045.1	0	515	5.16	<0.5 P
1976Q0270	7909	422.2	45.4	19	18	3.8	<.01	<.01	23	200	0	55.3	2.6	0.563
2007Q0694	199573	2480	140	111	332	8.74	0.201	0.139	11.5	766.2	0	879	<10.0	<1.0 P
2007Q0693	204956	1933	91.7	84	263	9.03	0.96	0.158	15.4	677.8	0	557	12.2	<0.5 P
2004Q0222	205049	3390	95.2	132	583	10.7	0.046	<0.005	12	965	0	1282	24.4	<0.5 P
1980Q1269	8013	621.4	50.7	26.3	43.9	7	0.041	0.028	26.8	278.9	0	92.3	5	0.23
2007Q1051	197452	2650	55.8	94.3	485	9.19	0.066	0.02	10.3	1022.4	0	644	21.6	<1.0
2008Q0209	197452	2620	56	96.2	523	7.92	0.06	0.02	9.73	1190.7	0	782	18.3	<1.0 P
2004Q0228	205041	2660	157	147	308	8.95	0.699	0.126	14.2	809.3	0	1019	6.97	<0.5 P
2004Q0225	205034	3550	164	174	526	15.2	0.91	0.197	13.6	781.6	0	1685	9.22	<0.5 P

Appendix C. Water quality for wells, springs, and streams in the Ashland Ranger District

Sample	Gwic Id	Lab Specific Conductance	Calcium (mg/l)	Magnesium (mg/l)	Sodium (mg/l)	Potassium (mg/l)	Iron (mg/l)	Manganese (mg/l)	Silica (mg/l)	Bicarbonate (mg/l)	Carbonate (mg/l)	Sulfate (mg/l)	Chloride (mg/l)	Nitrate (mg/l)
Streams														
1983Q0122	7585	3490	126	225	439	17.8	0.03	0.11	6.1	617	0	1700	22.4	0.05
1980Q2630	7779	2961	95.4	190	337	17.5	0.015	0.05	7.7	544	0	1300	16.8	0.04
2007Q0336	223877	1430	81.8	69.6	102	13.4	0.078	0.015	22.6	577.3	0	272	6.66	<0.5 P
2007Q1055	223877	1256	84.3	70.4	115	14.5	<0.005	0.061	18.5	433.5	0	335	6	<0.5 P
2008Q0180	223877	1549	105	92.7	147	11.9	0.046	0.002	24.1	614.3	0	460	8.18	<0.5 P
1976Q1397	7910	2755	119	171	324	16.8	0.05	0.05	15.2	625.1	0	1139.1	12	0
1984Q0147	8218	4679	186	333	640	14.8	0.038	0.021	5.5	690	0	2550	15.7	0.23
			110	180	300					630		1100		
			19	160	250					610		840		
			83	290	630					700		2100		
			96	230	570					830		1600		
			73	140	370					730		980		
			82	150	390					620		1100		
Wells														
1974Q1060	100472	2134	57	67	367	6.5	<.01	0.23	6.9	688	0	600	6.4	0.2
1980Q0884	100472	1800	20.7	20.9	428	4.5	0.017	0.054	7.5	803	0	385	7.6	0.52
2005Q0037	100472	1643	4.27	2.16	416	2.11	0.027	0.002	7.64	788.93	36.6	185	8.64	<0.25 P
1975Q0754	7589	3681.2	9.1	6.3	1027.5	5.7	<.01	0.01	7.4	2498	0	200	10.8	1.4
2005Q0457	183565	3660	75.3	63.2	781	9.53	3.24	0.065	7.84	533.1	0	1670	<10.0	<2.5 P
2005Q0038	105007	2230	35.4	37.3	522	8.93	0.03	0.04	10.1	832.1	0	588	<5.0	<0.50 P

Appendix C. Water quality for wells, springs, and streams in the Ashland Ranger District

Sample	Gwic Id	Flouride (mg/l)	Orthophosphate (mg/l)	Silver (ug/l)	Aluminum (ug/l)	Arsenic (ug/l)	Boron (ug/l)	Barium (ug/l)	Beryllium (ug/l)	Bromide (ug/l)	Cadmium (ug/l)	Cobalt (ug/l)	Chromium (ug/l)	Copper (ug/l)
Springs														
1974Q1069	7247	1.3												
1974Q1067	7246	0.3												
1974Q1065	7249	2.3												
1974Q1063	7253	1.5												
1976Q0267	7253	1.5			50	2					<10.			<10.
2004Q0224	7253	1.76	<0.05	<1	<30	3.91	169	187	<2	<50	<1	<2	<2	<2
1974Q0866	7405	0.4												
1974Q0151	7418	0.5												
2004Q0227	7418	<0.5	<2.5	<10	<300	<10	430	<20	<20	<500	<10	<20	<20	<20
1974Q0877	7422	1.3												
2004Q0229	198766	<1.0	<1.0	<5	41.7	<5	231	15.5	<10	<1000	<5	<10	11.4	<10
1974Q0130	7565	0.2												
1974Q0129	7598	0.4												
1974Q0138	7606	0.3												
2004Q0230	7606	<0.5	<0.5	<10	<300	<10	1436	<20	<20	<500	<10	<20	<20	<20
1974Q0128	7607	0.5												
1974Q0139	7757	0.4												
1980Q2625	7766	0.82		<2.	40		410				<2.		4	26
1974Q0142	7767	0.6												
1980Q2627	7767	0.26		<2.	40		600				4		12	35
2004Q0223	7767	<0.5	<0.5	<1	43.2	<1	377	15.6	<2	<500	<1	<2	<2	<2
1980Q2626	7769	0.31		4	80		730				3		12	46
1974Q0149	7788	0.4												
1974Q0127	7795	0.4												
1974Q0132	7796	0.4												
1974Q0148	7800	0.5												
2006Q0684	197607	0.726	<0.5	<5	<30	<5	379	11.9	<2	<500	<1	<2	<10	<5
2007Q0328	197607	0.782	<0.5	<5	<30	<5	547	16.5	<2	<500	<1	<2	<10	<5
1976Q0270	7909	1.1			50	8.2					<10.			<10.
2007Q0694	199573	<1.0	<1.0	<5	<50	<5	<150	15	<10	<1000	<5	<10	<10	<10
2007Q0693	204956	1.16	<0.5	<5	<30	<5	521	20.7	<2	<500	<1	<2	<10	<5
2004Q0222	205049	4.89	<0.5	<10	<150	<10	<300	<20	<20	<500	<10	<20	<20	<20
1980Q1269	8013	0.63		<2.	<30.		190	90			4		<2.	<2.
2007Q1051	197452	1.61	<0.5	<2.5	<5	<1.0	223	10.8	<0.5	<500	<0.5	<0.5	<0.5	<1.0
2008Q0209	197452	1.49	<1.0	<0.5	<2.0	0.476	180	12.2	<0.1	<1000	<0.1	0.133	<0.1	<0.2
2004Q0228	205041	<0.5	<0.5	<5	<150	<5	238	10.5	<10	<500	<5	<5	<10	<10
2004Q0225	205034	<0.5	<2.5	<10	<300	<10	481	<20	<20	<500	<10	<20	<20	<20

Appendix C. Water quality for wells, springs, and streams in the Ashland Ranger District

Sample	Gwic Id	Flouride (mg/l)	Orthophosphate (mg/l)	Silver (ug/l)	Aluminum (ug/l)	Arsenic (ug/l)	Boron (ug/l)	Barium (ug/l)	Beryllium (ug/l)	Bromide (ug/l)	Cadmium (ug/l)	Cobalt (ug/l)	Chromium (ug/l)	Copper (ug/l)
Streams														
1983Q0122	7585	1.7												
1980Q2630	7779	0.26		<2.	30		310				<2.		<2.	19
2007Q0336	223877	1.19	<0.5	<1	<10	1.2	210	72.5	<2	<500	<1	<2	<2	<2
2007Q1055	223877	1.19	<0.5	<0.5	4.01	1.71	180	93.9	<0.1	<500	<0.1	0.299	<0.1	0.368
2008Q0180	223877	1.53	<0.5	<1.0	<2.0	0.748	245	80.6	<0.1	<500	<0.1	0.147	<0.5	0.331
1976Q1397	7910	0.6												
1984Q0147	8218	0.2												
Wells														
1974Q1060	100472	0.9												
1980Q0884	100472	2.8		<2.	<20.		210	20			<2.		<2.	4
2005Q0037	100472	1.31	<0.10	<1	<10	3.24	163	23.7	<2	<100	<1	<2	3.64	2.64
1975Q0754	7589	1.2												
2005Q0457	183565	<1.0	<1.0	<5	<30	<5	113	<10	<2	<1000	<1	<2	<10	<5
2005Q0038	105007	0.734	<0.50	<5	<30	<5	246	8.88	<2	<500	<1	<2	<10	<5

Appendix C. Water quality for wells, springs, and streams in the Ashland Ranger District

Sample	Gwic Id	Mercury (ug/l)	Lithium (ug/l)	Molyb-denum (ug/l)	Nickel (ug/l)	Lead (ug/l)	Antimony (ug/l)	Selenium (ug/l)	Tin (ug/l)	Strontium (ug/l)	Titanium (ug/l)	Thallium (ug/l)	Uranium (ug/l)	Vanadium (ug/l)
Springs														
1974Q1069	7247													
1974Q1067	7246													
1974Q1065	7249													
1974Q1063	7253													
1976Q0267	7253					<50.								
2004Q0224	7253		64.7	<10	2.9	<2	<2	1.78		1426	<1	<5	2.63	20.2
1974Q0866	7405													
1974Q0151	7418													
2004Q0227	7418		300	<100	<20	<20	<20	<10		5550	<10	<50	<5	<50
1974Q0877	7422													
2004Q0229	198766		127	<50	<10	<10	<10	<5		2931	<1	<25	8.68	<25
1974Q0130	7565													
1974Q0129	7598													
1974Q0138	7606													
2004Q0230	7606		465	<100	<20	<20	<20	<10		5138	<10	<50	62.4	<50
1974Q0128	7607													
1974Q0139	7757													
1980Q2625	7766		89	<20.	<10.	<40.				1730	18			11
1974Q0142	7767													
1980Q2627	7767		110	<20.	20	<40.				2570	20			15
2004Q0223	7767		125	<10	11.3	<2	<2	<1		2696	<1	<5	11.78	<5
1980Q2626	7769		140	<20.	30	<40.				3440	27			22
1974Q0149	7788													
1974Q0127	7795													
1974Q0132	7796													
1974Q0148	7800													
2006Q0684	197607		175	<10	<2	<10	<10	<5		2038	<1	<25	5.26	<10
2007Q0328	197607		195	<10	<2	<10	<10	<5		2136	<10	<25	5.73	<10
1976Q0270	7909					<50.								
2007Q0694	199573		155	<50	<10	<10	<10	<5		3648	<5	<25	1.2	<25
2007Q0693	204956		129	<10	<2	<10	<10	<5		2078	1.49	<20	<3	<10
2004Q0222	205049		189	<100	<20	<20	<20	<10		2765	<5	<50	8.5	<50
1980Q1269	8013		52	13	<10.	<40.		1.5		920	<1.			28
2007Q1051	197452		162	<5	<0.5	<1.0	<0.5	<2.5		1488	<1	<0.5	0.637	<0.5
2008Q0209	197452		150	<1.0	0.762	<0.2	<0.1	0.827		1489	<1.0	327	0.788	<0.1
2004Q0228	205041		174	<50	<10	<10	<10	<5		2929	<5	<25	6.16	<25
2004Q0225	205034		254	<100	<20	<20	<20	<10		2266	<10	<50	<5	<50

Appendix C. Water quality for wells, springs, and streams in the Ashland Ranger District

Sample	Gwic Id	Mercury (ug/l)	Lithium (ug/l)	Molyb-denum (ug/l)	Nickel (ug/l)	Lead (ug/l)	Antimony (ug/l)	Selenium (ug/l)	Tin (ug/l)	Strontium (ug/l)	Titanium (ug/l)	Thallium (ug/l)	Uranium (ug/l)	Vanadium (ug/l)
Streams														
1983Q0122	7585													
1980Q2630	7779		110	<20.	<10.	<40.				1300	12			4
2007Q0336	223877		79.8	<10	<2	<2	<2	<1		1309	<1	<5	5.43	<5
2007Q1055	223877		79	4.41	0.39	<0.2	0.173	2.91		1397	1.66	<0.1	5.92	2.78
2008Q0180	223877		93.4	4.12	<0.1	<0.2	<0.1	1.69		1670	1.19	<0.1	7.82	0.965
1976Q1397	7910		150											
1984Q0147	8218													
Wells														
1974Q1060	100472													
1980Q0884	100472		44	18	15	<40.		0.1		480	<1.			<1.
2005Q0037	100472		32	<10	<2	<2	<2	<1		249	<1	<5	<1	<5
1975Q0754	7589													
2005Q0457	183565		148	<10	<2	<10	<10	<5		2172	<1	<25	<2.5	<10
2005Q0038	105007		190	<10	<2	<10	<10	<5		1142	<1	20.3	<3	<10

Appendix C. Water quality for wells, springs, and streams in the Ashland Ranger District

Sample	Gwic Id	Zinc (ug/l)	Zirconium (ug/l)	Procedure	Total Dissolved Solids (mg/L)	Sodium Adsorption Ratio
Springs						
1974Q1069	7247				1362	19.6
1974Q1067	7246				1011	1.7
1974Q1065	7249				371	1.2
1974Q1063	7253				380	0.4
1976Q0267	7253	20		DISSOLVED	391	0.4
2004Q0224	7253	9.78	<2	DISSOLVED	374	0.4
1974Q0866	7405			DISSOLVED	4191	31.4
1974Q0151	7418				3460	19.5
2004Q0227	7418	<20	<20	DISSOLVED	4392	24.7
1974Q0877	7422				2960	12.0
2004Q0229	198766	3.68		DISSOLVED	1471	2.1
1974Q0130	7565				4662	6.0
1974Q0129	7598			DISSOLVED	1346	1.3
1974Q0138	7606				5247	4.3
2004Q0230	7606	<20	<20	DISSOLVED	4852	3.8
1974Q0128	7607				4997	6.6
1974Q0139	7757			DISSOLVED	1109	0.5
1980Q2625	7766	<4.	<4.	DISSOLVED	1525	1.1
1974Q0142	7767				2507	1.2
1980Q2627	7767	<4.	<4.	DISSOLVED	2596	1.2
2004Q0223	7767	4.32	<2	DISSOLVED	2116	1.0
1980Q2626	7769	<4.	7	DISSOLVED	2809	1.4
1974Q0149	7788			DISSOLVED	2446	2.9
1974Q0127	7795				1687	3.1
1974Q0132	7796			DISSOLVED	2433	3.8
1974Q0148	7800				3958	2.7
2006Q0684	197607	<2	<2	DISSOLVED	1704	5.1
2007Q0328	197607	2.16	<2	DISSOLVED	1580	4.8
1976Q0270	7909	10		DISSOLVED	267	0.6
2007Q0694	199573	<10	<10	DISSOLVED	1863	5.1
2007Q0693	204956	<2	<2	DISSOLVED	1371	4.8
2004Q0222	205049	<20	<10	DISSOLVED	2622	9.1
1980Q1269	8013	9	<4.	DISSOLVED	391	1.2
2007Q1051	197452	<1.0	<0.5	DISSOLVED	1826	9.2
2008Q0209	197452	0.45	0.287	DISSOLVED	2082	9.8
2004Q0228	205041	<10	<10	DISSOLVED	2063	4.2
2004Q0225	205034	<20	<20	DISSOLVED	2975	6.8

Appendix C. Water quality for wells, springs, and streams in the Ashland Ranger District

Sample	Gwic Id	Zinc (ug/l)	Zirconium (ug/l)	Procedure	Total Dissolved Solids (mg/L)	Sodium Adsorption Ratio
Streams						
1983Q0122	7585			DISSOLVED	2842	5.4
1980Q2630	7779	<4.	<4.	DISSOLVED	2234	4.6
2007Q0336	223877	<2	<2	DISSOLVED	855	2.0
2007Q1055	223877	<0.2	0.174	DISSOLVED	860	2.2
2008Q0180	223877	0.5	<0.1	DISSOLVED	1155	2.5
1976Q1397	7910			DISSOLVED	2105	4.5
1984Q0147	8218				4085	6.5
					2000	4.1
					1569	4.1
					3447	7.3
					2904	7.2
					1922	5.8
					2027	5.9
Wells						
1974Q1060	100472			DISSOLVED	1450	7.8
1980Q0884	100472	120	<4.	DISSOLVED	1273	15.9
2005Q0037	100472	3.01	<2	DISSOLVED	1052	40.9
1975Q0754	7589				2498	64.1
2005Q0457	183565	7.6	<2	DISSOLVED	2875	16.1
2005Q0038	105007	9.28	<2	DISSOLVED	1613	14.6

Appendix D. Basic data for inventoried stream reaches in the Ashland Ranger District

GWIC ID	Original Site Name	Plate 3 Name	Drainage	Plate 3 Sub-Area Number	Downstream Sequence	Nearest Overlying Coalbed
215839	HOOVER DRAW 1TOP	HD-U	BEAR CK	14	1	CANYON
215841	HOOVER DRAW 1A	HD-LQ	BEAR CK	14	2	CANYON
215840	HOOVER DRAW 1BOTTOM	HD-L	BEAR CK	14	3	CANYON
215856	TOOLEY CREEK 1TOP	TOOLEY	BEAR CK	13	1	CANYON
215824	NORTH HILLS OF COW CREEK 1A	NHCCKM	COW CK	11	1	DIETZ
215823	NORTH HILLS OF COW CREEK 1BOTTOM	NHCCKL	COW CK	11	2	DIETZ
215821	COW CREEK 1A NORTH	CCKUR	COW CK	11	3	DIETZ
215822	COW CREEK 1A SOUTH	CCKARV	COW CK	11	4	DIETZ
215820	COW CREEK 1B	CCKUC	COW CK	11	5	DIETZ
215819	COW CREEK 1C	CCKLC	COW CK	11	6	DIETZ
215818	COW CREEK 1D	CCKUR1	COW CK	11	7	CANYON
215817	COW CREEK 1BOTTOM	CCKUR2	COW CK	11	8	CANYON
215816	COW CREEK 2TOP	CCKM4	COW CK	11	9	OTTER
215815	COW CREEK 2A	CCKM3	COW CK	11	10	OTTER
215814	COW CREEK 2B	CCKM2	COW CK	11	11	OTTER
215813	COW CREEK 2BOTTOM	CCKM1	COW CK	11	12	OTTER
215812	COW CREEK 3TOP	CCKLT	COW CK	11	13	OTTER
215810	COW CREEK 3B	COWB95	COW CK	11	14	OTTER
215811	COW CREEK 3A	CCKLR	COW CK	11	15	OTTER
215809	COW CREEK 3BOTTOM	CCKB	COW CK	11	16	OTTER
215826	TIMBER CREEK 1TOP	TC-T	EAST FK	5	1	ANDERSON/DIETZ
215827	TIMBER CREEK 1BOTTOM	TC-L	EAST FK	5	2	ANDERSON/DIETZ
223877	EAST FORK MAIN CHANNEL 1TOP	S25	EAST FK	6	1	OTTER
215843	EAST FORK MAIN CHANNEL 1BOTTOM	S25L	EAST FK	6	2	OTTER
215896	POKER JIM RES. 1TOP	POKRCU	EAST FK	7	1	ANDERSON/DIETZ
215897	POKER JIM RES. 1A	POKRC1	EAST FK	7	2	ANDERSON/DIETZ
215898	POKER JIM RES. 1B	POKRC2	EAST FK	7	3	ANDERSON/DIETZ
215899	POKER JIM RES. 1BOTTOM	POKRCL	EAST FK	7	4	ANDERSON/DIETZ
215884	PARRISH 1TOP	PAR1T	EAST FK	7	5	ANDERSON/DIETZ
215885	PARRISH 1A	PAR1A	EAST FK	7	6	ANDERSON/DIETZ
215886	PARRISH 1BOTTOM	PAR1B	EAST FK	7	7	ANDERSON/DIETZ
215834	DAVIS CREEK AT RESERVOIR 1TOP	DC-RT	EAST FK	7	8	ANDERSON/DIETZ
215835	DAVIS CREEK UNDER RES. 1TOP	DC-UT	EAST FK	7	9	ANDERSON/DIETZ
215836	DAVIS CREEK.1BOTTOM	DC-UL	EAST FK	7	10	ANDERSON/DIETZ
215833	EAST FORK S. DAVIS CREEK 3BOTTOM	DC-UB	EAST FK	7	11	ANDERSON/DIETZ
215837	DAVIS CREEK 2TOP	DC-MT	EAST FK	7	12	ANDERSON/DIETZ
215838	DAVIS CREEK 2BOTTOM	DC-ML	EAST FK	7	13	ANDERSON/DIETZ
215881	RED ROCK 1TOP	RR1T	EAST FK	7	14	CANYON

Appendix D. Basic data for inventoried stream reaches in the Ashland Ranger District

GWIC ID	Original Site Name	Plate 3 Name	Drainage	Plate 3 Sub-Area Number	Downstream Sequence	Nearest Overlying Coalbed
215882	RED ROCK 1A	RR1A	EAST FK	7	15	CANYON
215883	RED ROCK 1BOTTOM	RR1B	EAST FK	7	16	CANYON
215832	EAST FORK S. DAVIS CREEK 3TOP	DCS-2U	EAST FK	8	1	DIETZ
215831	EAST FORK S. DAVIS CREEK 2TOP	DCS-2T	EAST FK	8	2	DIETZ
215830	EAST FORK S. DAVIS CREEK 2BOTTOM	DCS-2B	EAST FK	8	3	DIETZ
215829	EAST FORK SOUTH OF DAVIS CREEK 1TOP	DCS-LT	EAST FK	8	4	DIETZ
215828	EAST FORK TRIBUTARY SOUTH OF DAVIS CREEK 1BOTTOM	DCS-1B	EAST FK	8	5	DIETZ
215893	HOMECREEK 1TOP	HOMCKT	HOME CK	1	1	SAWYER
215894	HOMECREEK 1A	HOMCK1	HOME CK	1	2	SAWYER
215895	HOMECREEK 1BOTTOM	HOMCKB	HOME CK	1	3	SAWYER
215877	HORSE CREEK 1TOP	HOCKLT	HORSE CK	12	1	CANYON
215878	HORSE CREEK 1A	HOCKL1	HORSE CK	12	2	CANYON
215879	HORSE CREEK 1B	HOCKL2	HORSE CK	12	3	CANYON
215880	HORSE CREEK 1BOTTOM	HOCKLB	HORSE CK	12	4	CANYON
215887	NORTH FORK LEE CREEK 1TOP	NFLEET	LEE CK	9	1	COOK
215888	NORTH FORK LEE CREEK 1A	NFLEE1	LEE CK	9	2	COOK
215889	NORTH FORK LEE CREEK 1BOTTOM	NFLEEB	LEE CK	9	3	COOK
215890	HOLBROOK DRAW 1TOP	HOLBDT	LEE CK	10	1	DIETZ
215891	HOLBROOK DRAW 1A	HOLBD1	LEE CK	10	2	DIETZ
215892	HOLBROOK DRAW 1BOTTOM	HOLBDB	LEE CK	10	3	DIETZ
215853	HAY CREEK 1TOP	HAYCKU	ODELL CK	3	1	COOK
215854	HAYCREEK 1A	HAYCK1	ODELL CK	3	2	COOK
215855	HAY CREEK 1BOTTOM	HAYCKL	ODELL CK	3	3	COOK
215846	COAL BANK 1TOP	COALBT	ODELL CK	4	1	ANDERSON/DIETZ
215844	COAL BANK 1A	COALB1	ODELL CK	4	2	ANDERSON/DIETZ
215845	COAL BANK 1BOTTOM	COALBB	ODELL CK	4	3	ANDERSON/DIETZ
215864	SEC11 1TOP	SEC11UP	ODELL CK	4	4	ANDERSON/DIETZ
215865	SEC11 1A	SEC11UP1	ODELL CK	4	5	ANDERSON/DIETZ
215866	SEC11 1B	SEC11UP2	ODELL CK	4	6	ANDERSON/DIETZ
215867	SEC11 1C	SEC11UP3	ODELL CK	4	7	ANDERSON/DIETZ
215868	SEC11 1BOTTOM	SEC11UPE	ODELL CK	4	8	ANDERSON/DIETZ
215869	SEC11 2TOP	SEC11MDT	ODELL CK	4	9	ANDERSON/DIETZ
215870	SEC11 2A	SEC11MD1	ODELL CK	4	10	ANDERSON/DIETZ
215871	SEC11 2B	SEC11MD2	ODELL CK	4	11	ANDERSON/DIETZ
215872	SEC11 2BOTTOM	SEC11MDB	ODELL CK	4	12	ANDERSON/DIETZ
215873	SEC11 3TOP	SEC11LOT	ODELL CK	4	13	ANDERSON/DIETZ
215874	SEC11 3A	SEC11LO1	ODELL CK	4	14	ANDERSON/DIETZ
215875	SEC11 3BOTTOM	SEC11LOB	ODELL CK	4	15	ANDERSON/DIETZ

Appendix D. Basic data for inventoried stream reaches in the Ashland Ranger District

GWIC ID	Original Site Name	Plate 3 Name	Drainage	Plate 3 Sub-Area Number	Downstream Sequence	Nearest Overlying Coalbed
215876	SEC11 4TOP/BOTTOM	SEC11BOT	ODELL CK	4	16	ANDERSON/DIETZ
215851	STOCKER BRANCH S1TOP	SBCKU	ODELL CK	4	17	ANDERSON/DIETZ
215850	STOCKER BRANCH S1A	SBCK1	ODELL CK	4	18	ANDERSON/DIETZ
215852	STOCKER BRANCH S1BOTTOM	SBCKB	ODELL CK	4	19	ANDERSON/DIETZ
215861	STOCKER BRANCH N1TOP	SB	ODELL CK	4	20	ANDERSON/DIETZ
215862	STOCKER BRANCH 1BOTTOM	SB2	ODELL CK	4	21	CANYON
215863	STOCKER BRANCH 2TOP	SBP	ODELL CK	4	22	CANYON
199227	OTTER CREEK 1A	OC 1A	OTTER CK	2	1	OTTER
7910	OTTER CREEK 1B	OC 1B	OTTER CK	2	2	OTTER
215858	OTTER CREEK 2A	OC 2A	OTTER CK	2	3	OTTER THROUGH KNOBLOCH
215857	OTTER CREEK 2B	OC 2B	OTTER CK	2	4	OTTER THROUGH KNOBLOCH
215847	KELTY SPRING 1TOP	KELTYS	TAYLOR CK	15	1	FERRY
215848	KELTY SPRING 1A	KELTY1	TAYLOR CK	15	2	FERRY
215849	KELTY SPRING 1BOTTOM	KELTYB	TAYLOR CK	15	3	FERRY

Appendix D. Basic data for inventoried stream reaches in the Ashland Ranger District

GWIC ID	USGS Quadrangle	County	Town-ship	Range	Section	Tract	Site Type	Inventory Date	Latitude	Longitude	Discharge Rate (gpm)
215839	OTTER	POWDER RIVER	7 S	45 E	32	ABCD	STREAM	11/17/2004	45.18575	-106.23721	0.0
215841	OTTER	POWDER RIVER	7 S	45 E	33	ABCD	STREAM	11/17/2004	45.18529	-106.23482	2.1
215840	OTTER	POWDER RIVER	7 S	45 E	33	ABCD	STREAM	11/17/2004	45.18533	-106.23326	0.0
215856	OTTER	POWDER RIVER	7 S	45 E	20	ABCD	SPRING	10/12/2004	45.21320	-106.23897	0.0
215824	FORT HOWES	POWDER RIVER	6 S	45 E	17	ABCD	STREAM	10/14/2004	45.31410	-106.24193	1.0
215823	FORT HOWES	POWDER RIVER	6 S	45 E	17	ABCD	STREAM	10/14/2004	45.31368	-106.24151	0.0
215821	FORT HOWES	POWDER RIVER	6 S	45 E	17	ABCD	STREAM	10/18/2004	45.31175	-106.24738	1.0
215822	FORT HOWES	POWDER RIVER	6 S	45 E	20	ABCD	STREAM	10/18/2004	45.30948	-106.24835	11.2
215820	FORT HOWES	POWDER RIVER	6 S	45 E	20	ABCD	STREAM	10/18/2004	45.31009	-106.24171	2.7
215819	FORT HOWES	POWDER RIVER	6 S	45 E	20	ABCD	STREAM	10/18/2004	45.30843	-106.23934	12.0
215818	FORT HOWES	POWDER RIVER	6 S	45 E	21	ABCD	STREAM	10/20/2004	45.30555	-106.22141	13.5
215817	FORT HOWES	POWDER RIVER	6 S	45 E	21	ABCD	STREAM	10/20/2004	45.30466	-106.21834	0.0
215816	FORT HOWES	POWDER RIVER	6 S	45 E	23	ABCD	STREAM	10/14/2004	45.29689	-106.19246	0.0
215815	FORT HOWES	POWDER RIVER	6 S	45 E	23	ABCD	STREAM	10/14/2004	45.29669	-106.19103	3.5
215814	FORT HOWES	POWDER RIVER	6 S	45 E	26	ABCD	STREAM	10/14/2004	45.29559	-106.18958	1.3
215813	FORT HOWES	POWDER RIVER	6 S	45 E	26	ABCD	STREAM	10/14/2004	45.29482	-106.18848	0.0
215812	FORT HOWES	POWDER RIVER	6 S	45 E	26	ABCD	STREAM	10/13/2004	45.29482	-106.18487	0.0
215810	FORT HOWES	POWDER RIVER	6 S	45 E	26	ABCD	STREAM	10/14/2004	45.29489	-106.18475	13.5
215811	FORT HOWES	POWDER RIVER	6 S	45 E	26	ABCD	STREAM	10/14/2004	45.29380	-106.17978	6.0
215809	FORT HOWES	POWDER RIVER	6 S	45 E	26	ABCD	STREAM	10/13/2004	45.29349	-106.17797	0.0
215826	BROWNS MT.	ROSEBUD	6 S	43 E	12	ABCD	STREAM	11/19/2004	45.32633	-106.40308	0.5
215827	BROWNS MT.	ROSEBUD	6 S	43 E	12	ABCD	STREAM	11/19/2004	45.32566	-106.40332	0.0
223877	BROWNS MT.	ROSEBUD	6 S	43 E	25	ABCD	STREAM	11/11/2004	45.29087	-106.40412	8.6
215843	BROWNS MT.	ROSEBUD	6 S	43 E	25	ABCD	STREAM	11/11/2004	45.29091	-106.40563	6.3
215896	POKER JIM	ROSEBUD	6 S	44 E	21	ABCD	STREAM	11/19/2004	45.30299	-106.34512	0.0
215897	POKER JIM	ROSEBUD	6 S	44 E	21	ABCD	STREAM	11/19/2004	45.30230	-106.34405	4.0
215898	POKER JIM	ROSEBUD	6 S	44 E	21	ABCD	STREAM	11/19/2004	45.30198	-106.34293	6.0
215899	POKER JIM	ROSEBUD	6 S	44 E	21	ABCD	STREAM	11/19/2004	45.30161	-106.34234	0.0
215884	POKER JIM	ROSEBUD	6 S	44 E	21	ABCD	STREAM	11/15/2004	45.29942	-106.34328	0.0
215885	POKER JIM	ROSEBUD	6 S	44 E	21	ABCD	STREAM	11/15/2004	45.29915	-106.34341	2.5
215886	POKER JIM	ROSEBUD	6 S	44 E	21	ABCD	STREAM	11/15/2004	45.29912	-106.34347	0.0
215834	POKER JIM	ROSEBUD	6 S	44 E	22	ABCD	STREAM	11/17/2004	45.29690	-106.32618	0.0
215835	POKER JIM	ROSEBUD	6 S	44 E	22	ABCD	STREAM	11/17/2004	45.29690	-106.32618	2.0
215836	POKER JIM	ROSEBUD	6 S	44 E	22	ABCD	STREAM	11/17/2004	45.29829	-106.32858	2.6
215833	POKER JIM	ROSEBUD	6 S	44 E	22	ABCD	STREAM	11/17/2004	45.29824	-106.32973	0.0
215837	POKER JIM	ROSEBUD	6 S	44 E	22	ABCD	STREAM	11/17/2004	45.29720	-106.33217	5.8
215838	POKER JIM	ROSEBUD	6 S	44 E	22	ABCD	STREAM	11/17/2004	45.29756	-106.33392	0.0
215881	POKER JIM	ROSEBUD	6 S	44 E	28	ABCD	STREAM	11/11/2004	45.29533	-106.34445	0.0

Appendix D. Basic data for inventoried stream reaches in the Ashland Ranger District

GWIC ID	USGS Quadrangle	County	Town-ship	Range	Section	Tract	Site Type	Inventory Date	Latitude	Longitude	Discharge Rate (gpm)
215882	POKER JIM	ROSEBUD	6 S	44 E	21	ABCD	STREAM	11/11/2004	45.29568	-106.34487	13.5
215883	POKER JIM	ROSEBUD	6 S	44 E	21	ABCD	STREAM	11/11/2004	45.29585	-106.34546	0.0
215832	POKER JIM	ROSEBUD	6 S	44 E	28	ABCD	STREAM	11/19/2004	45.27951	-106.34376	0.0
215831	POKER JIM	ROSEBUD	6 S	44 E	28	ABCD	STREAM	11/19/2004	45.28164	-106.34606	1.0
215830	POKER JIM	ROSEBUD	6 S	44 E	28	ABCD	STREAM	11/19/2004	45.28252	-106.34749	0.0
215829	POKER JIM	ROSEBUD	6 S	44 E	28	ABCD	STREAM	11/19/2004	45.28387	-106.35313	1
215828	POKER JIM	ROSEBUD	6 S	44 E	28	ABCD	STREAM	11/19/2004	45.28420	-106.35507	0.0
215893	COLEMAN DRAW	POWDER RIVER	3 S	46 E	21	ABCD	STREAM	11/17/2004	45.56951	-106.05309	0.0
215894	COLEMAN DRAW	POWDER RIVER	3 S	46 E	21	ABCD	STREAM	11/17/2004	45.56977	-106.05708	21
215895	COLEMAN DRAW	POWDER RIVER	3 S	46 E	21	ABCD	STREAM	11/17/2004	45.56997	-106.05743	0.0
215877	FORT HOWES	POWDER RIVER	6 S	45 E	32	ABCD	STREAM	11/10/2004	45.27565	-106.23994	0.0
215878	FORT HOWES	POWDER RIVER	6 S	45 E	32	ABCD	STREAM	11/10/2004	45.27578	-106.23882	5.0
215879	FORT HOWES	POWDER RIVER	6 S	45 E	32	ABCD	STREAM	11/10/2004	45.27658	-106.23772	5.5
215880	FORT HOWES	POWDER RIVER	6 S	45 E	32	ABCD	STREAM	11/10/2004	45.27611	-106.23581	0.0
215887	STROUD CREEK	ROSEBUD	7 S	44 E	18	ABCD	STREAM	11/16/2004	45.23038	-106.38697	0.0
215888	STROUD CREEK	ROSEBUD	7 S	44 E	18	ABCD	STREAM	11/16/2004	45.23057	-106.38844	1.0
215889	STROUD CREEK	ROSEBUD	7 S	44 E	18	ABCD	STREAM	11/16/2004	45.23064	-106.38862	0.0
215890	HAMILTON DRAW	ROSEBUD	7 S	44 E	9	ABCD	STREAM	11/16/2004	45.24317	-106.34638	0.0
215891	HAMILTON DRAW	ROSEBUD	7 S	44 E	9	ABCD	STREAM	11/16/2004	45.24195	-106.34673	8.0
215892	HAMILTON DRAW	ROSEBUD	7 S	44 E	9	ABCD	STREAM	11/16/2004	45.24188	-106.34795	0.0
215853	POKER JIM	ROSEBUD	5 S	44 E	27	ABCD	STREAM	11/18/2004	45.37152	-106.29559	0.0
215854	POKER JIM	ROSEBUD	5 S	44 E	27	ABCD	STREAM	11/18/2004	45.37154	-106.29527	0.8
215855	POKER JIM	ROSEBUD	5 S	44 E	27	ABCD	STREAM	11/18/2004	45.37154	-106.29504	0.0
215846	POKER JIM	ROSEBUD	6 S	44 E	12	ABCD	STREAM	11/17/2004	45.33087	-106.29210	0.0
215844	POKER JIM	ROSEBUD	6 S	44 E	12	ABCD	STREAM	11/17/2004	45.33139	-106.29243	0.8
215845	POKER JIM	ROSEBUD	6 S	44 E	12	ABCD	STREAM	11/17/2004	45.33178	-106.29271	0.0
215864	POKER JIM	ROSEBUD	6 S	44 E	14	ABCD	STREAM	11/8/2004	45.32428	-106.31136	0.0
215865	POKER JIM	ROSEBUD	6 S	44 E	11	ABCD	STREAM	11/8/2004	45.32493	-106.31210	2.0
215866	POKER JIM	ROSEBUD	6 S	44 E	11	ABCD	STREAM	11/9/2004	45.32563	-106.31355	4.0
215867	POKER JIM	ROSEBUD	6 S	44 E	11	ABCD	STREAM	11/9/2004	45.32615	-106.31396	5.0
215868	POKER JIM	ROSEBUD	6 S	44 E	11	ABCD	STREAM	11/8/2004	45.32773	-106.31482	0.0
215869	POKER JIM	ROSEBUD	6 S	44 E	11	ABCD	STREAM	11/9/2004	45.32835	-106.31472	0.0
215870	POKER JIM	ROSEBUD	6 S	44 E	11	ABCD	STREAM	11/9/2004	45.32838	-106.31427	4.5
215871	POKER JIM	ROSEBUD	6 S	44 E	11	ABCD	STREAM	11/9/2004	45.32919	-106.31352	1.5
215872	POKER JIM	ROSEBUD	6 S	44 E	11	ABCD	STREAM	11/9/2004	45.33071	-106.31254	0.0
215873	POKER JIM	ROSEBUD	6 S	44 E	11	ABCD	STREAM	11/9/2004	45.33102	-106.31279	0.0
215874	POKER JIM	ROSEBUD	6 S	44 E	11	ABCD	STREAM	11/9/2004	45.33173	-106.31270	3.0
215875	POKER JIM	ROSEBUD	6 S	44 E	11	ABCD	STREAM	11/9/2004	45.33185	-106.31248	0.0

Appendix D. Basic data for inventoried stream reaches in the Ashland Ranger District

GWIC ID	USGS Quadrangle	County	Town-ship	Range	Section	Tract	Site Type	Inventory Date	Latitude	Longitude	Discharge Rate (gpm)
215876	POKER JIM	ROSEBUD	6 S	44 E	11	ABCD	STREAM	11/9/2004	45.33255	-106.31257	0.0
215851	POKER JIM	ROSEBUD	6 S	44 E	10	ABCD	STREAM	11/18/2004	45.33472	-106.32661	0.0
215850	POKER JIM	ROSEBUD	6 S	44 E	10	ABCD	STREAM	11/18/2004	45.33482	-106.32622	23.0
215852	POKER JIM	ROSEBUD	6 S	44 E	10	ABCD	STREAM	11/18/2004	45.33561	-106.32638	0.0
215861	POKER JIM	ROSEBUD	6 S	44 E	3	ABCD	STREAM	11/4/2004	45.34478	-106.32045	0.8
215862	POKER JIM	ROSEBUD	6 S	44 E	2	ABCD	STREAM	11/4/2004	45.34155	-106.31355	3.0
215863	POKER JIM	ROSEBUD	6 S	44 E	2	ABCD	STREAM	11/4/2004	45.34343	-106.30644	0.2
199227	OTTER	POWDER RIVER	7S	45 E	13	CDAD	STREAM	10/13/2004	45.22528	106.16750	7
7910	FORT HOWES	POWDER RIVER	6S	46 E	30	ABCB	STREAM	10/13/2004	45.29222	-106.14720	135
215858	KING MOUNTAIN	POWDER RIVER	5 S	45 E	23	ABCD	STREAM	10/13/2004	45.39144	-106.14336	34
215857	KING MOUNTAIN	POWDER RIVER	5 S	45 E	14	ABCD	STREAM	10/13/2004	45.40341	-106.14121	11
215847	GOODSPEED	POWDER RIVER	6 S	46 E	26	ABCD	SPRING	11/18/2004	45.28182	-106.05412	0.5
215848	GOODSPEED	POWDER RIVER	6 S	46 E	35	ABCD	STREAM	11/18/2004	45.28019	-106.05443	0.5
215849	GOODSPEED	POWDER RIVER	6 S	46 E	35	ABCD	STREAM	11/18/2004	45.27953	-106.05455	0.0

Appendix D. Basic data for inventoried stream reaches in the Ashland Ranger District

GWIC ID	Discharge Method	Altitude (feet)	Temperature (C)	Specific Conductance (uS)	ADJACENT[1] LITHOLOGY	IMPACT[2] POTENTIAL	
215839	NO FLOW	3580	6.9	3770	SANDSTONE	1	
215841	VOLUMETRIC	3570	6.2	3175	SANDSTONE	1	
215840	NO FLOW	3570			SANDSTONE	1	
215856	VOLUMETRIC	3610	12.8	2852	SANDSTONE		
215824	WEIR	3890	10.4	474	COAL/CLINKER		
215823	NO FLOW	3880			COAL/CLINKER		
215821	WEIR	3780	7.6	433	COAL/CLINKER		
215822	FLUME	3875	7.8	539	COAL/CLINKER		
215820	VOLUMETRIC	3890	7.6	586	COAL/CLINKER		
215819	VOLUMETRIC	3880	8.7	606	COAL/CLINKER		
215818	FLUME	3760	6.1	768	COAL/CLINKER		
215817	NO FLOW	3750			COAL/CLINKER		
215816	NO FLOW	3435			COAL/CLINKER	2	
215815	WEIR	3430	12.0	1096	COAL/CLINKER	2	
215814	WEIR	3420	12.0	1105	COAL/CLINKER	2	
215813	NO FLOW	3410			COAL/CLINKER	2	
215812	NO FLOW	3420			COAL/CLINKER	2	
215810	FLUME	3430	11.6	1244	COAL/CLINKER	2	
215811	WEIR	3410	12.0	1238	COAL/CLINKER	2	
215809	NO FLOW	3410			COAL/CLINKER	2	
215826	ESTIMATED	3890	3.7	815	COAL/CLINKER		
215827	NO FLOW	3880			COAL/CLINKER		
223877	VOLUMETRIC	3475	8.0	1670		2	
215843	VOLUMETRIC	3475	3.0	1570		2	
215896	NO FLOW	3900			COAL/CLINKER		
215897	WEIR	3860	4.5	494	COAL/CLINKER		
215898	WEIR	3850	2.5	509	COAL/CLINKER		
215899	NO FLOW	3835			COAL/CLINKER		
215884	NO FLOW	3810			SANDSTONE		
215885	WEIR	3810	4.6	704	SANDSTONE		
215886	NO FLOW	3810			SANDSTONE		
215834	NO FLOW	3870	3.2	650	COAL/CLINKER		
215835	VOLUMETRIC	3870	7.7	675	COAL/CLINKER		
215836	VOLUMETRIC	3850	6.6	616	COAL/CLINKER		
215833	NO FLOW	3850			COAL/CLINKER		
215837	VOLUMETRIC	3830	8.2	676	SANDSTONE		
215838	NO FLOW	3820			SANDSTONE		
215881	NO FLOW	3755			COAL/CLINKER		

Appendix D. Basic data for inventoried stream reaches in the Ashland Ranger District

GWIC ID	Discharge Method	Altitude (feet)	Temperature (C)	Specific Conductance (uS)	ADJACENT [1] LITHOLOGY	IMPACT [2] POTENTIAL	
215882	FLUME	3755	8.3	816	COAL/CLINKER		
215883	NO FLOW	3750			COAL/CLINKER		
215832	FLOW BLOCKED BY ICE	3760			COAL/CLINKER		
215831	VOLUMETRIC	3750	7.3	3987	COAL/CLINKER		
215830	FLOWING UNDER ICE	3740			COAL/CLINKER		
215829	ESTIMATED	3730			COAL/CLINKER		
215828	NO FLOW	3730			COAL/CLINKER		
215893	NO FLOW	3240			SANDSTONE	2	
215894	FLOAT AND STOPWATCH	3238	3.7	3610	SANDSTONE	2	
215895	NO FLOW	3236			SANDSTONE	2	
215877	NO FLOW	3695			SANDSTONE/COAL		
215878	WEIR	3710	6.3	2523	SANDSTONE/COAL		
215879	WEIR	3710	6.2	2373	SANDSTONE/COAL		
215880	NO FLOW	3720			SANDSTONE/COAL		
215887	NO FLOW	3495			CLINKER / SS	2	
215888	WEIR	3490	5.2	2809	CLINKER / SS	2	
215889	NO FLOW	3490			CLINKER / SS		
215890	NO FLOW	3720			SANDSTONE		
215891	WEIR	3715	2.0	2216	SANDSTONE		
215892	NO FLOW	3710			SANDSTONE		
215853	NO FLOW	3540			COAL/CLINKER		
215854	WEIR	3540	2.6	1360	COAL/CLINKER		
215855	NO FLOW	3540			COAL/CLINKER		
215846	NO FLOW	3835			COAL/CLINKER		
215844	WEIR	3830	3.9	446	COAL/CLINKER		
215845	NO FLOW	3825			COAL/CLINKER		
215864	NO FLOW	3935			SANDSTONE		
215865	WEIR	3930	7.6	422	SANDSTONE		
215866	WEIR	3920	7.6	274	SANDSTONE		
215867	WEIR	3910	6.8	402	SANDSTONE		
215868	NO FLOW	3890			SANDSTONE		
215869	NO FLOW	3890			SANDSTONE		
215870	WEIR	3890	9.2	516	SANDSTONE		
215871	WEIR	3890	9.6	521	SANDSTONE		
215872	NO FLOW	3875			SANDSTONE		
215873	NO FLOW	3875			SANDSTONE		
215874	WEIR	3870	8.9	645	SANDSTONE		
215875	NO FLOW	3865			SANDSTONE		

Appendix D. Basic data for inventoried stream reaches in the Ashland Ranger District

GWIC ID	Discharge Method	Altitude (feet)	Temperature (C)	Specific Conductance (uS)	ADJACENT [1] LITHOLOGY	IMPACT [2] POTENTIAL
215876	NO FLOW	3855			SANDSTONE	
215851	NO FLOW	3910			COAL/CLINKER	
215850	FLUME	3910	7.6	655	COAL/CLINKER	
215852	NO FLOW	3890			COAL/CLINKER	
215861	WEIR	3915	6.7	419	COAL/CLINKER	
215862	WEIR	3800	4.7	938	COAL/CLINKER	
215863	VOLUMETRIC	3755	3.7	1001	COAL/CLINKER	
199227	FLOAT AND STOPWATCH	3380	8.1	3767		1
7910	FLOAT AND STOPWATCH	3270	10.8	3482		1
215858	VOLUMETRIC	3160	11.3	4655		1
215857	VELOCITY METER	3140	8.7	4788		1
215847	VOLUMETRIC	3710	7.7	2720	SANDSTONE	
215848	WEIR	3690	5.3	3940	SANDSTONE	
215849	NO FLOW	3680			SANDSTONE	

FOOTNOTES:

1 Where possible, the lithology adjacent to the point where was began to flow was identified.

2 Impact potential: See text of report for detailed discussion. No value is given for sites presumed to be well outside the area of potential CBM impact.
A value of 1 indicates the site will most likely not be impactred, but is of interest for monitoring.
A value of 2 indicates the site is within the area of possible impacts if the associated coal bed is developed for CBM within the area.

Appendix E. Basic data for inventoried wells in the Ashland Ranger District

GWIC ID	Site Name	Use	Longitude	Latitude	Town-ship	Range	Section	Tract	County
	Inventoried stock wells within the project boundary								
94661	LISCOM WELL	Stock	-106.03230	45.77820	01S	46E	3	DBAA	POWDER RIVER
94666	COYOTE WELL	Stock	-106.05050	45.75240	01S	46E	16	AACC	POWDER RIVER
98567	COTTONWOOD WELL	Stock	-106.16990	45.69830	02S	45E	3	BBBC	POWDER RIVER
183564	WHITETAIL RANGER STATION	Stock	-105.97580	45.64040	02S	47E	19	CDCA	POWDER RIVER
205090	WHITETAIL WELL	Stock	-105.96250	45.64440	02S	47E	20	CBBD	POWDER RIVER
98663	MANNING WELL	Stock	-105.85740	45.64840	02S	48E	19	BCCA	POWDER RIVER
100472	EAST FORK PIPELINE WELL	Stock	-106.16420	45.59350	03S	45E	10	B	POWDER RIVER
205091	WEST HOME WELL	Stock	-106.08470	45.60570	03S	46E	6	AADA	POWDER RIVER
205089	LOWER HOME WELL	Stock	-106.01220	45.57130	03S	46E	14	DBBB	POWDER RIVER
205088	SCHOOL HOUSE PIPELINE WELL	Stock	-106.00360	45.56370	03S	46E	23	AAAC	POWDER RIVER
205081	USDA FOREST SERVICE - LEMONADE PIPELINE WELL	Stock	-105.92670	45.54530	03S	47E	28	ACAC	POWDER RIVER
7589	NEWELL PIPELINE WELL	Stock	-106.21430	45.47270	04S	45E	19	DADD	POWDER RIVER
223927	DRY CREEK PIPELINE WELL	Stock	-106.33550	45.48410	04S	44E	17	CCBC	POWDER RIVER
101944	USDA FOREST SERVICE - KING CREEK WELL	Stock	-106.25930	45.47240	04S	44E	23	DCAA	ROSEBUD
199563	USDA FOREST SERVICE - HOLE IN THE WALL WELL	Stock	-106.32180	45.44020	04S	44E	32	ABAA	POWDER RIVER
161284	USDA FOREST SERVICE - TENMILE WELL	Stock	-106.11210	45.43990	04S	46E	31	CBCA	POWDER RIVER
223879	10 MILE CREEK PIPELINE WELL	Stock	-106.11220	45.44000	04S	46E	31	CBBD	POWDER RIVER
183560	NANCE PROPERTIES INC	Stock	-106.42050	45.43870	05S	43E	4	AAAB	ROSEBUD
183559	IP-11 MARK NANCE	Stock	-106.45490	45.41140	05S	43E	8	CDCB	ROSEBUD
103155	PADGET CREEK PIPELINE WELL	Stock	-106.29400	45.39390	05S	44E	22	BBBD	ROSEBUD
183565	SKINNER GULCH PIPELINE WELL	Stock	-105.91710	45.42750	05S	47E	3	BCCD	POWDER RIVER
205092	USDA FOREST SERVICE - CHROMO PIPELINE	Stock	-106.19570	45.43800	05S	45E	5	AAAA	POWDER RIVER
205087	USDA FOREST SERVICE - WATT PIPELINE WELL	Stock	-106.06660	45.38030	05S	46E	21	CDCD	POWDER RIVER
205082	USDA FOREST SERVICE - SPRING CREEK PIPELINE W	Stock	-105.95380	45.38830	05S	47E	20	ACAC	POWDER RIVER
205083	USDA FOREST SERVICE - MASON WELL	Stock	-105.86150	45.26370	06S	48E	32	DDBC	POWDER RIVER
144969	PIPELINE WELL 7(PL-1W) LOHOF	Stock	-106.30740	45.23540	07S	44E	14	ABD	ROSEBUD
105007	TOOLEY CREEK WELL	Stock	-106.26970	45.21530	07S	45E	19	CAAA	POWDER RIVER
223890	TAYLOR CREEK PIPELINE WELL	Stock	-105.99280	45.22130	07S	47E	21	BBCC	POWDER RIVER
223883	DICK FLETCHER PIPELINE WELL	Stock	-106.16550	45.22260	07S	45E	24	ABAB	POWDER RIVER

Appendix E. Basic data for inventoried wells in the Ashland Ranger District

GWIC ID	Site Name	Use	Longitude	Latitude	Town-ship	Range	Section	Tract	County
205084	USDA FOREST SERVICE - INDIAN WELL	Stock	-106.07600	45.24940	07S	46E	10	AADD	POWDER RIVER
205085	USDA FOREST SERVICE - STEWART WELL	Stock	-106.07580	45.24780	07S	46E	10	ADAD	POWDER RIVER
224006	INDIAN CREEK PIPELINE WELL	Stock	-106.07540	45.24760	07S	46E	10	AADA	POWDER RIVER
224007	STEWART PIPELINE WELL	Stock	-106.06850	45.24380	07S	46E	11	BDCA	POWDER RIVER
205086	USDA FOREST SERVICE - WINDMILL AT SAYLE	Stock	-105.99400	45.22620	07S	47E	16	CCCB	POWDER RIVER
	Monitoring wells near and within the project area boundary								
7569	WO-13	Monitor	-106.18500	45.51860	04S	45E	4	BDDB	POWDER RIVER
7573	WO-15	Monitor	-106.18550	45.51860	04S	45E	4	BDDB	POWDER RIVER
7574	WO-16	Monitor	-106.18610	45.51580	04S	45E	4	CAAC	POWDER RIVER
210094	WO-14	Monitor	-106.18490	45.51830	04S	45E	4	BDDB	POWDER RIVER
207101	OC-28	Monitor	-106.19280	45.47170	04S	45E	21	CCBD	POWDER RIVER
223240	USGS 452411106301601	Monitor	-106.50440	45.40300	05S	42E	14	ADDC	ROSEBUD
223236	USGS 452355106333701	Monitor	-106.56030	45.39860	05S	42E	16	CCAB	ROSEBUD
203701	CBM02-8FG	Monitor	-106.54710	45.36880	05S	42E	28	DDAC	ROSEBUD
203700	CBM02-8DS	Monitor	-106.54700	45.36870	05S	42E	28	DDAC	ROSEBUD
203697	CBM02-8KC	Monitor	-106.54730	45.36890	05S	42E	28	DDAC	ROSEBUD
203699	CBM02-8SS	Monitor	-106.54720	45.36880	05S	42E	28	DDAC	ROSEBUD
226919	NC05-1 NEAR BIRNEY VILLAGE	Monitor	-106.47690	45.41060	05S	43E	7	C	ROSEBUD
228124	NC05-2	Monitor	-106.47720	45.41050	05S	43E	7	CCDC	ROSEBUD
223952	WA-2	Monitor	-106.46210	45.40200	05S	43E	17	BCDD	ROSEBUD
214354	WA-7	Monitor	-106.43470	45.39330	05S	43E	21	BABC	ROSEBUD
207097	MK-4	Monitor	-106.43630	45.39190	05S	43E	21	BBDC	ROSEBUD
207099	WL-2	Monitor	-106.43580	45.39190	05S	43E	21	BBDC	ROSEBUD
207096	IB-2	Monitor	-106.43720	45.39300	05S	43E	21	BBDB	ROSEBUD
207098	NM-4	Monitor	-106.43610	45.39160	05S	43E	21	BCAB	ROSEBUD
7755	77-26	Monitor	-106.18390	45.43520	05S	45E	4	ABCC	POWDER RIVER
7770	WO-8	Monitor	-106.14110	45.39220	05S	45E	23	ABCA	POWDER RIVER
7772	WO-9	Monitor	-106.14190	45.39250	05S	45E	23	ABCA	POWDER RIVER
7775	WO-10	Monitor	-106.14300	45.39250	05S	45E	23	ABCB	POWDER RIVER
7778	WO-7	Monitor	-106.13860	45.39220	05S	45E	23	ABDA	POWDER RIVER
7783	WO-4	Monitor	-106.14860	45.39410	05S	45E	23	BBAA	POWDER RIVER
215085	WO-11	Monitor	-106.14330	45.39270	05S	45E	23	ABCC	POWDER RIVER

Appendix E. Basic data for inventoried wells in the Ashland Ranger District

GWIC ID	Site Name	Use	Longitude	Latitude	Town-ship	Range	Section	Tract	County
7782	WO-3	Monitor	-106.14940	45.39470	05S	45E	23	BBAA	POWDER RIVER
7776	WO-5	Monitor	-106.13860	45.39220	05S	45E	23	ABDA	POWDER RIVER
7780	WO-1	Monitor	-106.14940	45.39470	05S	45E	23	BBAA	POWDER RIVER
7777	WO-6	Monitor	-106.13860	45.39220	05S	45E	23	ABDA	POWDER RIVER
7781	WO-2	Monitor	-106.14940	45.39470	05S	45E	23	BBAA	POWDER RIVER
7903	HWC86-9	Monitor	-106.50270	45.29660	06S	43E	19	DACD	ROSEBUD
7905	HWC86-7	Monitor	-106.50330	45.29580	06S	43E	19	DDBA	ROSEBUD
7906	HWC86-8	Monitor	-106.50300	45.29610	06S	43E	19	DDBA	ROSEBUD
214096	HWCQ-2	Monitor	-106.50090	45.19130	07S	43E	32	AAAA	ROSEBUD
214097	HWCQ-1	Monitor	-106.50050	45.19120	07S	43E	32	AAAA	ROSEBUD
203703	CBM03-10AC	Monitor	-106.60450	45.11410	08S	42E	29	ADAD	BIG HORN
203704	CBM03-10SS	Monitor	-106.60450	45.11410	08S	42E	29	ADAD	BIG HORN
8101	HWC-86-2	Monitor	-106.48270	45.13500	08S	43E	17	DDCA	BIG HORN
8103	HWC-86-5	Monitor	-106.48220	45.13410	08S	43E	17	DDDC	BIG HORN
8107	HWC-01	Monitor	-106.48660	45.13380	08S	43E	20	DDDD	BIG HORN
207143	HC-01	Monitor	-106.47500	45.13140	08S	43E	21	BBDA	BIG HORN
8118	HC-24	Monitor	-106.47470	45.12970	08S	43E	21	BDBB	BIG HORN
8140	FC-01	Monitor	-106.51660	45.10250	08S	43E	31	BBDA	BIG HORN
8141	FC-02	Monitor	-106.51660	45.10250	08S	43E	31	BBDA	BIG HORN
203705	CBM03-11AC	Monitor	-106.36320	45.17930	08S	44E	5	BBBB	BIG HORN
203708	CBM03-11CC	Monitor	-106.36470	45.17930	08S	44E	5	BBBB	BIG HORN
203707	CBM03-11DC	Monitor	-106.36410	45.17930	08S	44E	5	BBBB	BIG HORN
8191	BC-06	Monitor	-106.21000	45.13870	08S	45E	16	DBCB	POWDER RIVER
8192	BC-07	Monitor	-106.21000	45.13870	08S	45E	16	DBCB	POWDER RIVER
203709	CBM03-12COC	Monitor	-106.21210	45.13520	08S	45E	16	DBCB	POWDER RIVER
191634	75-23	Monitor	-106.20110	45.09660	08S	45E	34	BDBC	POWDER RIVER

Appendix E. Basic data for inventoried wells in the Ashland Ranger District

GWIC ID	Land-surface altitude (feet)	Aquifer [1]	Nearest overlying Coal Bed [1]	Well total depth (feet)	Well yield (gpm)	Static water level date	Static water level (feet)	Static water level altitude (ft)	IMPACT [2] POTENTIAL
		Inventoried stock wells within the project boundary							
94661	3275	TONGUE RIVER MEMBER (SANDSTONE)	KNOBLOCH	135	10.0	9/27/2005	98.37	3177	
94666	3294	TONGUE RIVER MEMBER (SANDSTONE)		190	5.0	9/27/2005	134.86	3159	
98567	3350	TONGUE RIVER MEMBER (SANDSTONE)	KNOBLOCH	250	5.0	7/16/2003	163.00	3187	
183564	4045	CLINKER	FERRY	60		1/11/2006	41.29	4004	
205090	3850	TONGUE RIVER MEMBER							
98663	3550	TONGUE RIVER MEMBER (SANDSTONE)	SAWYER	223	5.0	7/15/2003	130.00	3420	
100472	3210	KNOBLOCH UNDERBURDEN (COAL AND SANDSTONE)	KNOBLOCH	193	5.0	4/1/1961	82.00	3017	
205091	3265	TONGUE RIVER MEMBER				6/22/2003			
205089	3355	TONGUE RIVER MEMBER				6/21/2003			1
205088	3345	ALLUVIUM (HOME CREEK)	PAWNEE	50		5/21/2006	25.30	3320	
205081	3605	ALLUVIUM (HOME CREEK)	FERRY	27		5/21/2006	8.06	3597	
7589	3290	KNOBLOCH COAL (COAL)	KNOBLOCH	325	5.0				2
223927	3050	ALLUVIUM (DRY CREEK)	KNOBLOCH	78		2/3/2006	65.67	2984	
101944	3635	ALLUVIUM (KING CREEK)	PAWNEE	16	5.0	5/1/1930	13.00	3622	
199563	3265	TONGUE RIVER MEMBER							1
161284	3215	TONGUE RIVER MEMBER (SANDSTONE)	NANCE	280	15.0	5/26/1993	155.00	3060	
223879	3210	TONGUE RIVER MEMBER				1/26/2005	72.76	3137	1
183560	3035	ALLUVIUM (TONGUE RIVER)	KNOBLOCH	20		1/11/2006	10.24	3025	
183559	3085	TONGUE RIVER MEMBER (SANDSTONE)		540					
103155	3385	TONGUE RIVER MEMBER (SANDSTONE AND COAL)		135	10.0	2/3/2006	74.68	3310	1
183565	3730	PAWNEE UNDERBURDEN	PAWNEE	167		1/26/2006	49.50	3681	2
205092	3295	TONGUE RIVER MEMBER (SANDTONE AND COAL)	KNOBLOCH	225		1/29/2006	225.00	3070	2
205087	3295	ALLUVIUM (FIFTEEN MILE CREEK)	ODELL	46		1/26/2003	22.42	3273	1
205082	3630	TONGUE RIVER MEMBER	ELK	50		9/13/2007	20.78	3609	1
205083	3680	TONGUE RIVER MEMBER							1
144969	3850	TONGUE RIVER MEMBER (SANDSTONE)	DIETZ	225	15.0	2/3/2006	133.53	3716	1
105007	3755	CANYON OVERBURDEN (SANDSTONE)	DIETZ	110	12.0	1/11/2006	37.11	3718	1
223890	3910	TONGUE RIVER MEMBER	CANYON	150		1/26/2006	122.84	3787	
223883	3395	ALLUVIUM (OTTER CREEK)	OTTER	42		1/26/2006	13.79	3381	1

Appendix E. Basic data for inventoried wells in the Ashland Ranger District

GWIC ID	Land-surface altitude (feet)	Aquifer [1]	Nearest overlying Coal Bed [1]	Well total depth (feet)	Well yield (gpm)	Static water level date	Static water level (feet)	Static water level altitude (ft)	IMPACT [2] POTENTIAL
205084	3615	ALLUVIUM (TAYLOR CREEK)	ELK	24		2/3/2006	18.26	3597	1
205085	3505	ALLUVIUM (TAYLOR CREEK)	ELK	25		2/3/2006	22.04	3483	1
224006	3515	ALLUVIUM (TAYLOR CREEK)	ELK	24		2/3/2006	18.26	3497	1
224007	3540	ALLUVIUM (TAYLOR CREEK)	ELK	25		2/3/2006	22.04	3518	1
205086	3770	TONGUE RIVER MEMBER							1
		Monitoring wells near and within the project area boundary							
7569	3020	ALLUVIUM		68.0	10.0	1/29/2006	8.51	3011.5	
7573	3022	ALLUVIUM		63.0	12.0	1/26/2006	8.53	3013.5	
7574	3040	ALLUVIUM		61.0	3.7	1/26/2006	22.74	3017.3	
210094	3010	ALLUVIUM		66.1		10/18/2004	9.93	3000.1	
207101	3171.0	KNOBLOCH COAL				1/29/2006	68.81	3102.2	
223240	3220	FLOWERS-GOODALE COAL		420.0		6/16/2005	106.90	3113.1	
223236	3400	KNOBLOCH COAL		376.0		8/25/2005	262.69	3137.3	
203701	3260.6	FLOWERS-GOODALE COAL		480.4	0.5	1/27/2006	101.96	3158.7	
203700	3260.5	FLOWERS-GOODALE OVERBURDEN		446.0	0.3	1/27/2006	102.24	3158.3	
203697	3262.3	KNOBLOCH COAL		208.0	1.0	1/27/2006	157.98	3104.3	
203699	3262.2	KNOBLOCH UNDERBURDEN		224.0	10.0	1/27/2006	160.06	3102.1	
226919	3170			780.0					
228124	3170			348.0					
223952	3068.5	ALLUVIUM				10/25/1980	45.20	3145.0	
214354	3179	ALLUVIUM				12/22/2005	55.15	3123.8	
207097	3195.3	KNOBLOCH COAL		188.0		12/22/2005	119.65	3075.7	
207099	3187.6	KNOBLOCH COAL		199.0		12/22/2005	117.30	3070.3	
207096	3191.6	KNOBLOCH UNDERBURDEN		245.0		12/22/2005	119.53	3072.1	
207098	3195.3	NANCE COAL		294.0		12/22/2005	120.14	3075.2	
7755	3284	KNOBLOCH COAL		216.8	3.6	1/26/2006	145.32	3138.7	
7770	3155	ALLUVIUM		33.0	12.0	1/26/2006	15.23	3139.8	
7772	3150	ALLUVIUM		45.0	21.8	1/26/2006	11.53	3138.5	
7775	3145	ALLUVIUM		41.4		1/26/2006	8.63	3136.4	
7778	3160	ALLUVIUM		40.0	29.0	1/26/2006	26.58	3133.4	
7783	3140	ALLUVIUM		31.5		12/31/2006	9.57	3130.4	
215085	3145	ALLUVIUM		38.5		1/26/2006	8.81	3136.2	

Appendix E. Basic data for inventoried wells in the Ashland Ranger District

GWIC ID	Land-surface altitude (feet)	Aquifer [1]	Nearest overlying Coal Bed [1]	Well total depth (feet)	Well yield (gpm)	Static water level date	Static water level (feet)	Static water level altitude (ft)	IMPACT [2] POTENTIAL
7782	3186	KNOBLOCH OVERBURDEN		66.0	17.8	1/26/2006	46.05	3140.0	
7776	3160	KNOBLOCH UNDERBURDEN		192.0	20.4	1/26/2006	16.97	3143.0	
7780	3190	KNOBLOCH UNDERBURDEN		172.0	8.0	1/26/2006	37.26	3152.7	
7777	3160	LOWER KNOBLOCH COAL		82.0	7.0	1/26/2006	24.27	3135.7	
7781	3188	LOWER KNOBLOCH COAL		112.0	19.0	1/26/2006	44.46	3143.5	
7903	3170	ALLUVIUM		44.0		2/2/2006	10.44	3159.6	
7905	3170	ALLUVIUM		71.0		2/2/2006	8.98	3161.0	
7906	3170	ALLUVIUM		67.0		2/2/2006	9.47	3160.5	
214096	3340	ALLUVIUM		19.0		2/2/2006	11.83	3328.2	
214097	3340	ALLUVIUM		19.5		2/2/2006	11.87	3328.1	
203703	4130	ANDERSON COAL		560.0	0.3	12/22/2005	531.11	3598.9	
203704	4130	ANDERSON-DIETZ 1 AND 2 OVERBURDEN		462.0	1.0	12/22/2005	372.30	3757.7	
8101	3460	ALLUVIUM		50.0		12/22/2005	19.62	3440.4	
8103	3455	ALLUVIUM		33.0		12/22/2005	14.45	3440.6	
8107	3530	CANYON COAL		232.0	7.5	12/28/2005	87.89	3442.1	
207143	3457.0	ALLUVIUM		19.7	17.0	10/20/2005	11.39	3445.6	
8118	3500	CANYON OVERBURDEN		150.0	7.1	10/20/2005	52.72	3447.3	
8140	3735	ANDERSON COAL		133.0	0.0	8/31/2005	129.04	3606.0	
8141	3735	DIETZ COAL		260.0		8/31/2005	240.63	3494.4	
203705	3950	ANDERSON COAL		211.0	1.0	12/18/2005	155.71	3794.3	
203708	3950	CANYON COAL		438.0	1.5	12/18/2005	382.22	3567.8	
203707	3950	DIETZ COAL		271.0	0.2	12/18/2005	227.76	3722.2	
8191	3715	CANYON COAL		188.0	4.6	12/18/2005	89.05	3626.0	
8192	3715	CANYON OVERBURDEN		66.0	0.8	12/18/2005	41.96	3673.0	
203709	3715	COOK COAL		351.0	3.0	12/18/2005	166.43	3548.6	
191634	3780	CANYON COAL		247.0		12/18/2005	130.20	3649.8	

FOOTNOTES:
1 Aquifer and nearest overlying coal bed were determined from well depth and geologic maps and cross sections.
2 Impact potential: See text of report for detailed discussion. No value is given for sites presumed to be well outside the area of potential CBM impact.
A value of 1 indicates the site will most likely not be impactred, but is of interest for monitoring.
A value of 2 indicates the site is within the area of possible impacts if the associated coal bed is developed for CBM within the area.

Appendix F. Well monitor sites in and near the Ashland Ranger District

GWIC ID	Site Name	Longitude	Latitude	Town ship	Range	Section	Tract	County	Land-surface altitude (feet)	Aquifer
94661	LISCOM WELL	-106.03230	45.77820	01S	46E	3	DBAA	POWDER RIVER	3275.0	FORT UNION FORMATION
94666	COYOTE WELL	-106.05050	45.75240	01S	46E	16	AACC	POWDER RIVER	3294.0	FORT UNION FORMATION
183564	WHITETAIL RANGER STATION	-105.97580	45.64040	02S	47E	19	CDCA	POWDER RIVER	4045.0	FORT UNION FORMATION
100472	EAST FORK WELL	-106.16420	45.59350	03S	45E	10	B	POWDER RIVER	3210.0	
7573	WO-15	-106.18550	45.51860	04S	45E	4	BDDB	POWDER RIVER	3022.0	ALLUVIUM
210094	WO-14	-106.18490	45.51830	04S	45E	4	BDDB	POWDER RIVER	3010.0	
7574	WO-16	-106.18610	45.51580	04S	45E	4	CAAC	POWDER RIVER	3040.0	ALLUVIUM
7589	NEWELL PIPELINE WELL	-106.21430	45.47270	04S	45E	19	DADD	POWDER RIVER	3290.0	TONGUE RIVER FORMATION
207101	OC-28	-106.19280	45.47170	04S	45E	21	CCBD	POWDER RIVER	3171.0	KNOBLOCH COAL
223240	USGS 452411106301601	-106.50440	45.40300	05S	42E	14	ADDC	ROSEBUD	3220.0	
223236	USGS 452355106333701	-106.56030	45.39860	05S	42E	16	CCAB	ROSEBUD	3400.0	
203697	CBM02-8KC	-106.54730	45.36890	05S	42E	28	DDAC	ROSEBUD	3262.3	KNOBLOCH COAL
203699	CBM02-8SS	-106.54720	45.36880	05S	42E	28	DDAC	ROSEBUD	3262.2	KNOBLOCH UNDERBURDEN
203700	CBM02-8DS	-106.54700	45.36870	05S	42E	28	DDAC	ROSEBUD	3260.5	FLOWERS-GOODALE OVERBURDEN
203701	CBM02-8FG	-106.54710	45.36880	05S	42E	28	DDAC	ROSEBUD	3260.6	FLOWERS-GOODALE COAL
183560	NANCE PROPERTIES INC	-106.42050	45.43870	05S	43E	4	AAAB	ROSEBUD	3035.0	ALLUVIUM
226919	NC05-1 NEAR BIRNEY VILLAGE	-106.47690	45.41060	05S	43E	7	C	ROSEBUD	3170.0	
228124	NC05-2	-106.47720	45.41050	05S	43E	7	CCDC	ROSEBUD	3170.0	
183559	IP-11 MARK NANCE	-106.45490	45.41140	05S	43E	8	CDCB	ROSEBUD	3085.0	
223952	WA-2	-106.46210	45.40200	05S	43E	17	BCDD	ROSEBUD	3068.5	ALLUVIUM
214354	WA-7	-106.43470	45.39330	05S	43E	21	BABC	ROSEBUD	3179.0	ALLUVIUM
207096	IB-2	-106.43720	45.39300	05S	43E	21	BBDB	ROSEBUD	3191.6	KNOBLOCH UNDERBURDEN
207097	MK-4	-106.43630	45.39190	05S	43E	21	BBDC	ROSEBUD	3195.3	KNOBLOCH COAL
207099	WL-2	-106.43580	45.39190	05S	43E	21	BBDC	ROSEBUD	3187.6	KNOBLOCH COAL
207098	NM-4	-106.43610	45.39160	05S	43E	21	BCAB	ROSEBUD	3195.3	NANCE COAL
103155	PADGET CREEK PIPELINE WELL	-106.29400	45.39390	05S	44E	22	BBBD	ROSEBUD	3385.0	TONGUE RIVER FORMATION
7755	77-26	-106.18390	45.43520	05S	45E	4	ABCC	POWDER RIVER	3284.0	KNOBLOCH COAL
7770	WO-8	-106.14110	45.39220	05S	45E	23	ABCA	POWDER RIVER	3155.0	ALLUVIUM
7772	WO-9	-106.14190	45.39250	05S	45E	23	ABCA	POWDER RIVER	3150.0	ALLUVIUM
7775	WO-10	-106.14300	45.39250	05S	45E	23	ABCB	POWDER RIVER	3145.0	ALLUVIUM
215085	WO-11	-106.14330	45.39270	05S	45E	23	ABCC	POWDER RIVER	3145.0	ALLUVIUM
7776	WO-5	-106.13860	45.39220	05S	45E	23	ABDA	POWDER RIVER	3160.0	KNOBLOCH UNDERBURDEN
7777	WO-6	-106.13860	45.39220	05S	45E	23	ABDA	POWDER RIVER	3160.0	LOWER KNOBLOCH COAL
7778	WO-7	-106.13860	45.39220	05S	45E	23	ABDA	POWDER RIVER	3160.0	ALLUVIUM
7780	WO-1	-106.14940	45.39470	05S	45E	23	BBAA	POWDER RIVER	3190.0	KNOBLOCH UNDERBURDEN
7781	WO-2	-106.14940	45.39470	05S	45E	23	BBAA	POWDER RIVER	3188.0	LOWER KNOBLOCH COAL
7782	WO-3	-106.14940	45.39470	05S	45E	23	BBAA	POWDER RIVER	3186.0	KNOBLOCH OVERBURDEN
7783	WO-4	-106.14860	45.39410	05S	45E	23	BBAA	POWDER RIVER	3140.0	ALLUVIUM
183565	SKINNER GULCH PIPELINE WELL	-105.91710	45.42750	05S	47E	3	BCCD	POWDER RIVER	3730.0	TONGUE RIVER FORMATION
7903	HWC86-9	-106.50270	45.29660	06S	43E	19	DACD	ROSEBUD	3170.0	ALLUVIUM
7905	HWC86-7	-106.50330	45.29580	06S	43E	19	DDBA	ROSEBUD	3170.0	ALLUVIUM

Appendix F. Well monitor sites in and near the Ashland Ranger District

GWIC ID	Site Name	Longitude	Latitude	Town ship	Range	Section	Tract	County	Land-surface altitude (feet)	Aquifer
7906	HWC86-8	-106.50300	45.29610	06S	43E	19	DDBA	ROSEBUD	3170.0	ALLUVIUM
214096	HWCQ-2	-106.50090	45.19130	07S	43E	32	AAAA	ROSEBUD	3340.0	ALLUVIUM
214097	HWCQ-1	-106.50050	45.19120	07S	43E	32	AAAA	ROSEBUD	3340.0	ALLUVIUM
144969	PIPELINE WELL 7(PL-1W) LOHOF	-106.30740	45.23540	07S	44E	14	ABD	ROSEBUD	3850.0	TONGUE RIVER FORMATION
105007	TOOLEY CREEK WELL	-106.26970	45.21530	07S	45E	19	CAAA	POWDER RIVER	3755.0	FORT UNION FORMATION
223890	TAYLOR CREEK PIPELINE WELL	-105.99280	45.22130	07S	47E	21	BBCC	POWDER RIVER	3910.0	TONGUE RIVER FORMATION
203703	CBM03-10AC	-106.60450	45.11410	08S	42E	29	ADAD	BIG HORN	4130.0	ANDERSON COAL
203704	CBM03-10SS	-106.60450	45.11410	08S	42E	29	ADAD	BIG HORN	4130.0	ANDERSON-DIETZ 1 AND 2 OVERBURDEN
8101	HWC-86-2	-106.48270	45.13500	08S	43E	17	DDCA	BIG HORN	3460.0	ALLUVIUM
8103	HWC-86-5	-106.48220	45.13410	08S	43E	17	DDDC	BIG HORN	3455.0	ALLUVIUM
8107	HWC-01	-106.48660	45.13380	08S	43E	20	DDDD	BIG HORN	3530.0	CANYON COAL
8118	HC-24	-106.47470	45.12970	08S	43E	21	BDBB	BIG HORN	3500.0	CANYON OVERBURDEN
207143	HC-01	-106.47500	45.13140	08S	43E	21	BBDA	BIG HORN	3457.0	ALLUVIUM
8140	FC-01	-106.51660	45.10250	08S	43E	31	BBDA	BIG HORN	3735.0	ANDERSON COAL
8141	FC-02	-106.51660	45.10250	08S	43E	31	BBDA	BIG HORN	3735.0	DIETZ COAL
203705	CBM03-11AC	-106.36320	45.17930	08S	44E	5	BBBB	BIG HORN	3950.0	ANDERSON COAL
203707	CBM03-11DC	-106.36410	45.17930	08S	44E	5	BBBB	BIG HORN	3950.0	DIETZ COAL
203708	CBM03-11CC	-106.36470	45.17930	08S	44E	5	BBBB	BIG HORN	3950.0	CANYON COAL
8191	BC-06	-106.21000	45.13870	08S	45E	16	DBCB	POWDER RIVER	3715.0	CANYON COAL
8192	BC-07	-106.21000	45.13870	08S	45E	16	DBCB	POWDER RIVER	3715.0	CANYON OVERBURDEN
203709	CBM03-12COC	-106.21210	45.13520	08S	45E	16	DBCB	POWDER RIVER	3715.0	COOK COAL
191634	75-23	-106.20110	45.09660	08S	45E	34	BDBC	POWDER RIVER	3780.0	CANYON COAL

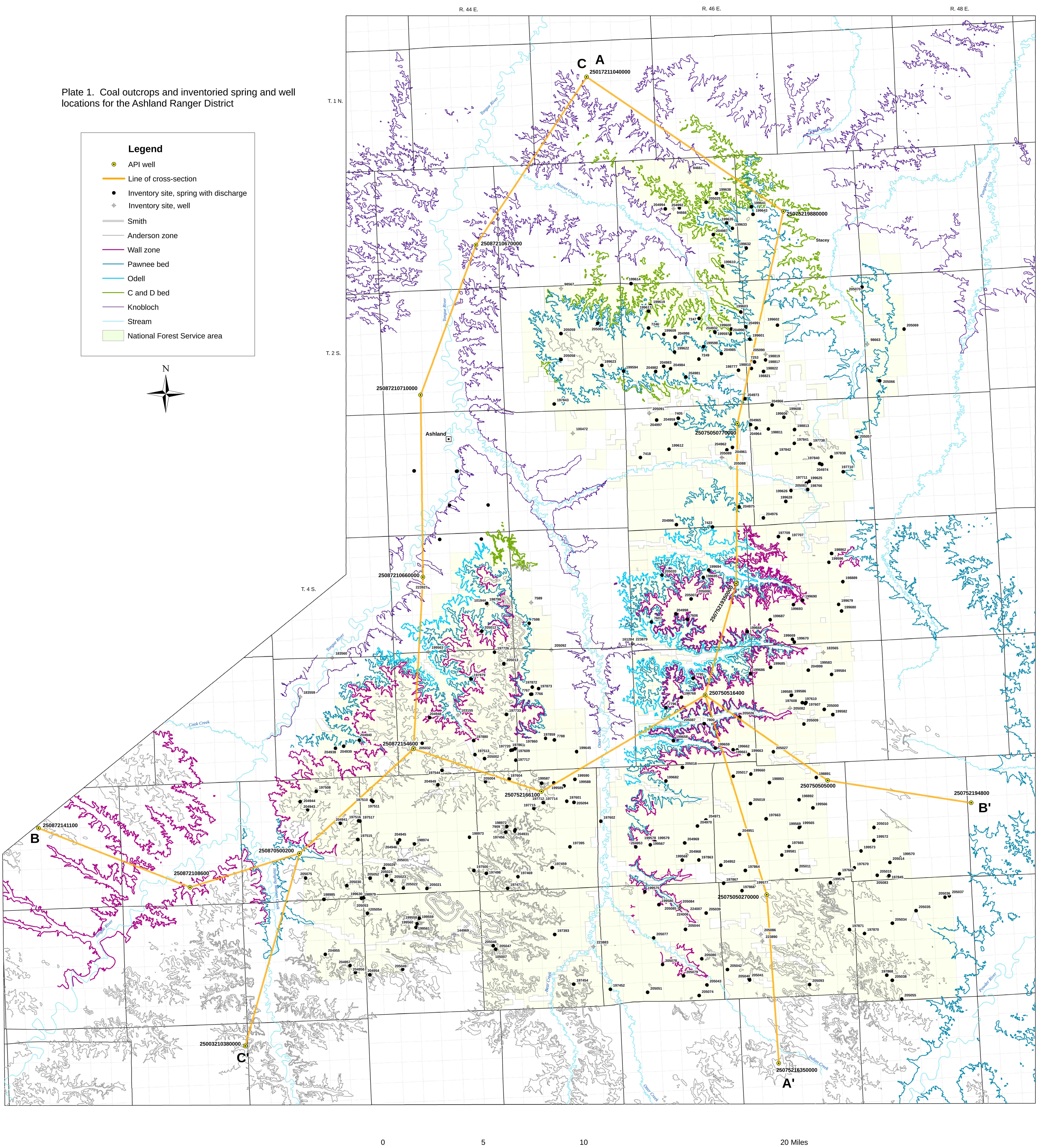
Appendix F. Well monitor sites in and near the Ashland Ranger District

GWIC ID	Well total depth (feet)	Well yield (gpm)	Static water level date	Static water level (feet)	Static water level altitude (ft)	Comments	2007 planned SWL monitoring	2007 planned QW sample collection
94661	135.0	10.0	9/27/2005	98.37	3176.6		QUARTERLY	
94666	190.0	5.0	9/27/2005	134.86	3159.1		QUARTERLY	
183564	60.0		1/11/2006	41.29	4003.7		QUARTERLY	
100472	193.0	5.0	4/1/1961	82.00	3017.0		QUARTERLY	
7573	63.0	12.0	1/26/2006	8.53	3013.5		SEMI-ANNUAL	
210094	66.1		10/18/2004	9.93	3000.1		SEMI-ANNUAL	
7574	61.0	3.7	1/26/2006	22.74	3017.3		SEMI-ANNUAL	
7589	325.0	5.0					SEMI-ANNUAL	
207101			1/29/2006	68.81	3102.2		SEMI-ANNUAL	
223240	420.0		6/16/2005	106.90	3113.1		QUARTERLY	
223236	376.0		8/25/2005	262.69	3137.3		QUARTERLY	
203697	208.0	1.0	1/27/2006	157.98	3104.3		QUARTERLY	
203699	224.0	10.0	1/27/2006	160.06	3102.1		QUARTERLY	
203700	446.0	0.3	1/27/2006	102.24	3158.3		QUARTERLY	
203701	480.4	0.5	1/27/2006	101.96	3158.7		QUARTERLY	
183560	20.0		1/11/2006	10.24	3024.8		QUARTERLY	
226919	780.0						QUARTERLY	
228124	348.0						QUARTERLY	
183559	540.0		4/13/2004	-12.71	3097.71		QUARTERLY	
223952			10/25/1980	45.20	3145.0		MONTHLY	SEMI-ANNUAL
214354			12/22/2005	55.15	3123.8		QUARTERLY	
207096	245.0		12/22/2005	119.53	3072.1		QUARTERLY	
207097	188.0		12/22/2005	119.65	3075.7		QUARTERLY	
207099	199.0		12/22/2005	117.30	3070.3		QUARTERLY	
207098	294.0		12/22/2005	120.14	3075.2		QUARTERLY	
103155	135.0	10.0	2/3/2006	74.68	3310.3		QUARTERLY	
7755	216.8	3.6	1/26/2006	145.32	3138.7		SEMI-ANNUAL	
7770	33.0	12.0	1/26/2006	15.23	3139.8		QUARTERLY	
7772	45.0	21.8	1/26/2006	11.53	3138.5		QUARTERLY	
7775	41.4		1/26/2006	8.63	3136.4		QUARTERLY	
215085	38.5		1/26/2006	8.81	3136.2		QUARTERLY	
7776	192.0	20.4	1/26/2006	16.97	3143.0		QUARTERLY	
7777	82.0	7.0	1/26/2006	24.27	3135.7		QUARTERLY	
7778	40.0	29.0	1/26/2006	26.58	3133.4		QUARTERLY	
7780	172.0	8.0	1/26/2006	37.26	3152.7		QUARTERLY	
7781	112.0	19.0	1/26/2006	44.46	3143.5		QUARTERLY	
7782	66.0	17.8	1/26/2006	46.05	3140.0		QUARTERLY	
7783	31.5		12/31/2006	9.57	3130.4		QUARTERLY	
183565	167.0		1/26/2006	49.50	3680.5		QUARTERLY	
7903	44.0		2/2/2006	10.44	3159.6		MONTHLY	
7905	71.0		2/2/2006	8.98	3161.0		MONTHLY	SEMI-ANNUAL

Appendix F. Well monitor sites in and near the Ashland Ranger District

GWIC ID	Well total depth (feet)	Well yield (gpm)	Static water level date	Static water level (feet)	Static water level altitude (ft)	Comments	2007 planned SWL monitoring	2007 planned QW sample collection
7906	67.0		2/2/2006	9.47	3160.5		MONTHLY	
214096	19.0		2/2/2006	11.83	3328.2		QUARTERLY	
214097	19.5		2/2/2006	11.87	3328.1		QUARTERLY	
144969	225.0	15.0	2/3/2006	133.53	3716.5		QUARTERLY	
105007	110.0	12.0	1/11/2006	37.11	3717.9		QUARTERLY	
223890	150.0		1/26/2006	122.84	3787.2		QUARTERLY	
203703	560.0	0.3	12/22/2005	531.11	3598.9		MONTHLY	
203704	462.0	1.0	12/22/2005	372.30	3757.7		MONTHLY	
8101	50.0		12/22/2005	19.62	3440.4		MONTHLY	
8103	33.0		12/22/2005	14.45	3440.6		MONTHLY	
8107	232.0	7.5	12/28/2005	87.89	3442.1		MONTHLY	
8118	150.0	7.1	10/20/2005	52.72	3447.3		SEMI-ANNUAL	
207143	19.7	17.0	10/20/2005	11.39	3445.6		SEMI-ANNUAL	
8140	133.0	0.0	8/31/2005	129.04	3606.0		MONTHLY	
8141	260.0		8/31/2005	240.63	3494.4		MONTHLY	
203705	211.0	1.0	12/18/2005	155.71	3794.3		QUARTERLY	
203707	271.0	0.2	12/18/2005	227.76	3722.2		QUARTERLY	
203708	438.0	1.5	12/18/2005	382.22	3567.8		QUARTERLY	
8191	188.0	4.6	12/18/2005	89.05	3626.0		QUARTERLY	
8192	66.0	0.8	12/18/2005	41.96	3673.0		QUARTERLY	
203709	351.0	3.0	12/18/2005	166.43	3548.6		QUARTERLY	
191634	247.0		12/18/2005	130.20	3649.8		MONTHLY	

Plate 1. Coal outcrops and inventoried spring and well locations for the Ashland Ranger District



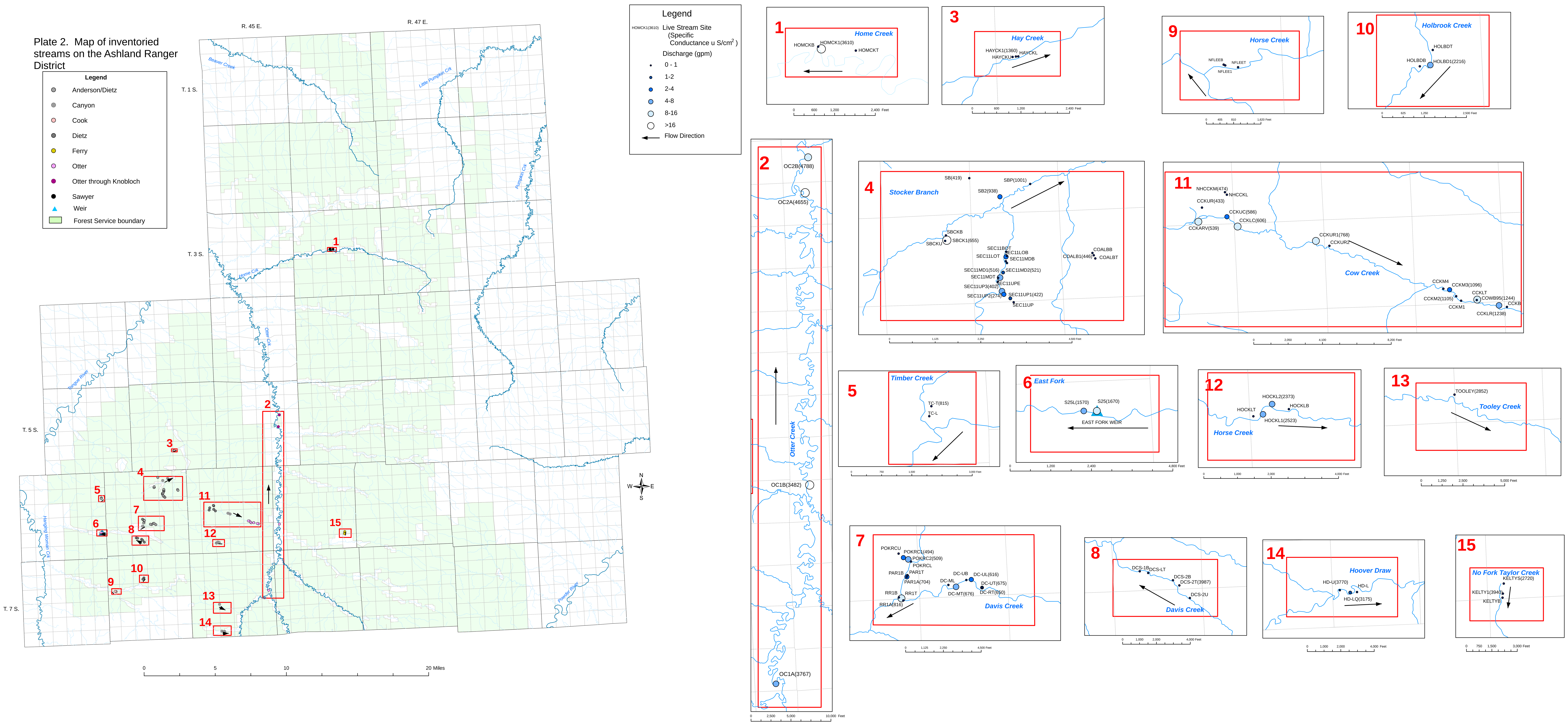
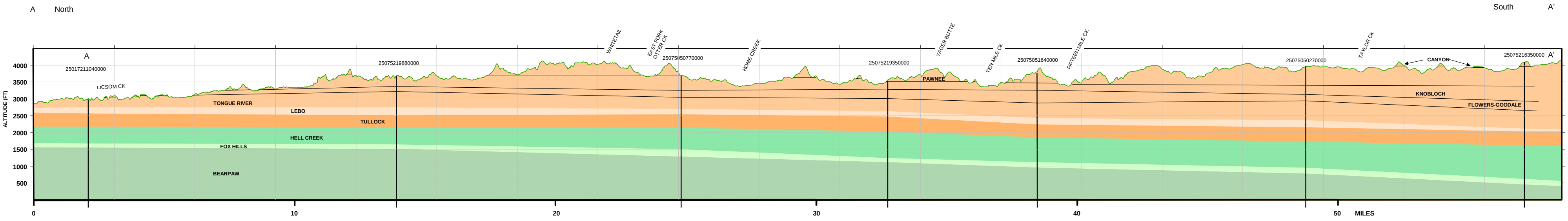
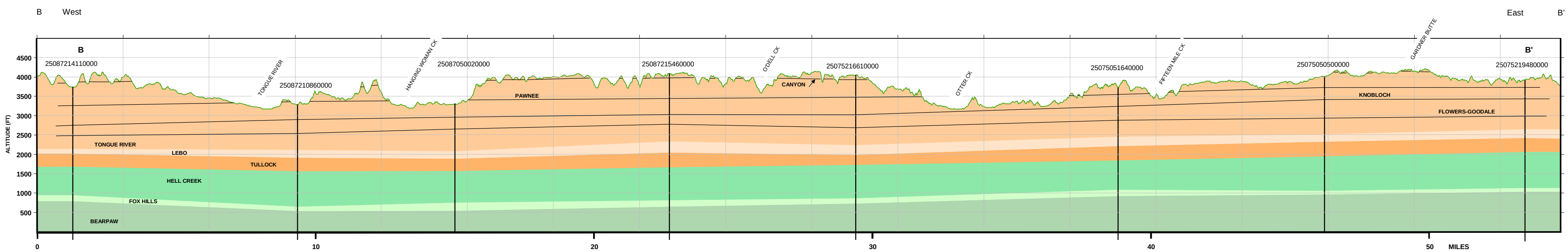


Plate 2. Map of inventoried streams on the Ashland Ranger District

Plate 3. Geologic cross sections across the Ashland Ranger District. Locations of lines are shown on Plate 1.





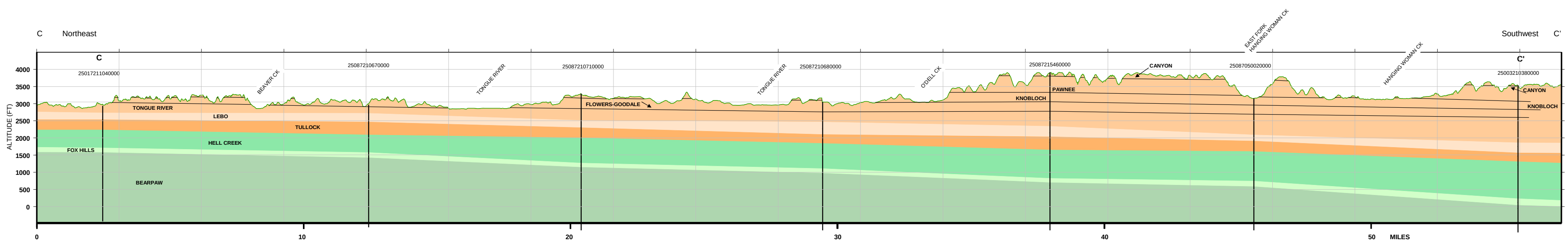


Plate 4. Water quality for springs and streams on the Ashland Ranger District.

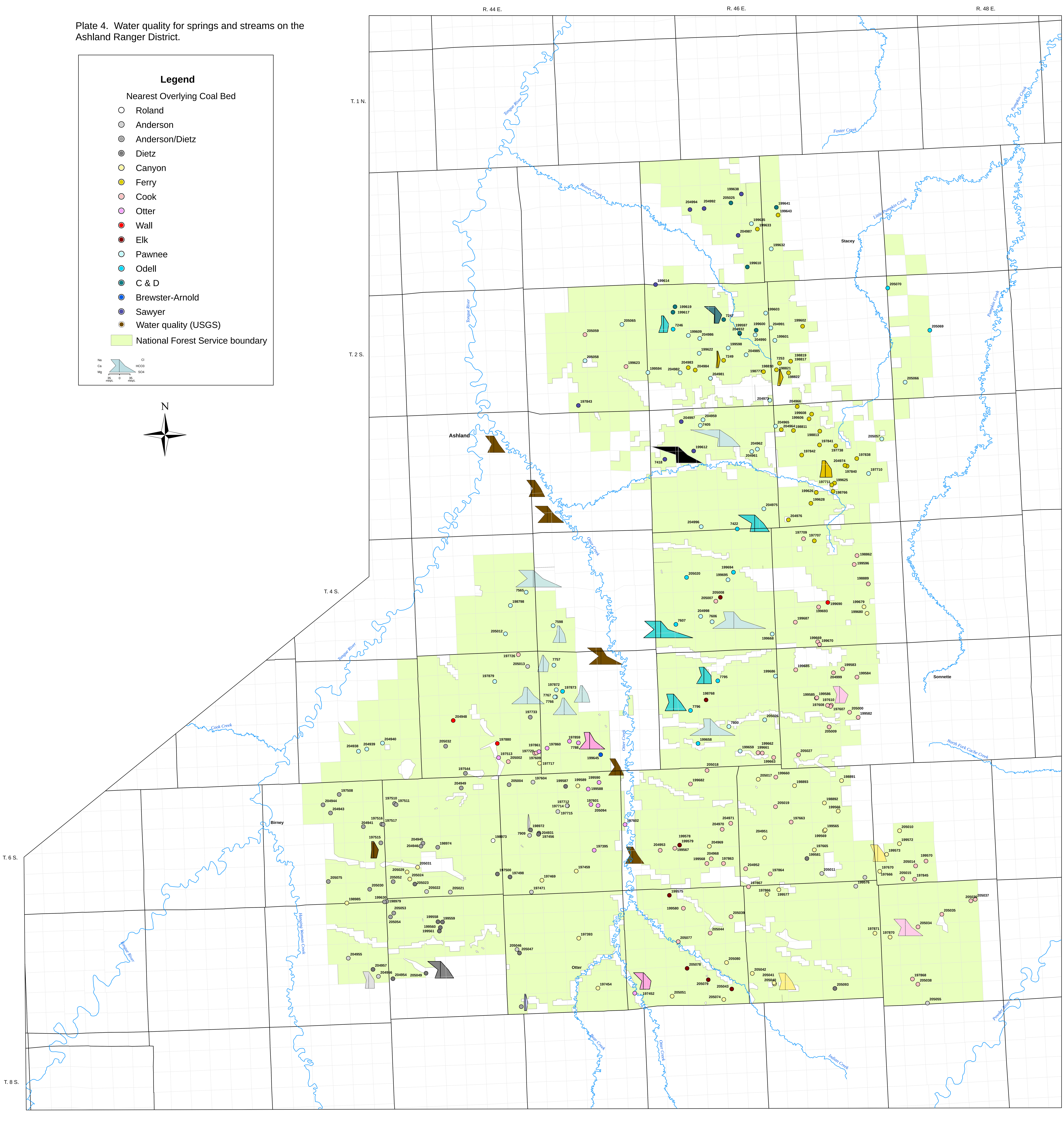


Plate 5. Map of spring flow with coal bed associations on the Ashland Ranger District

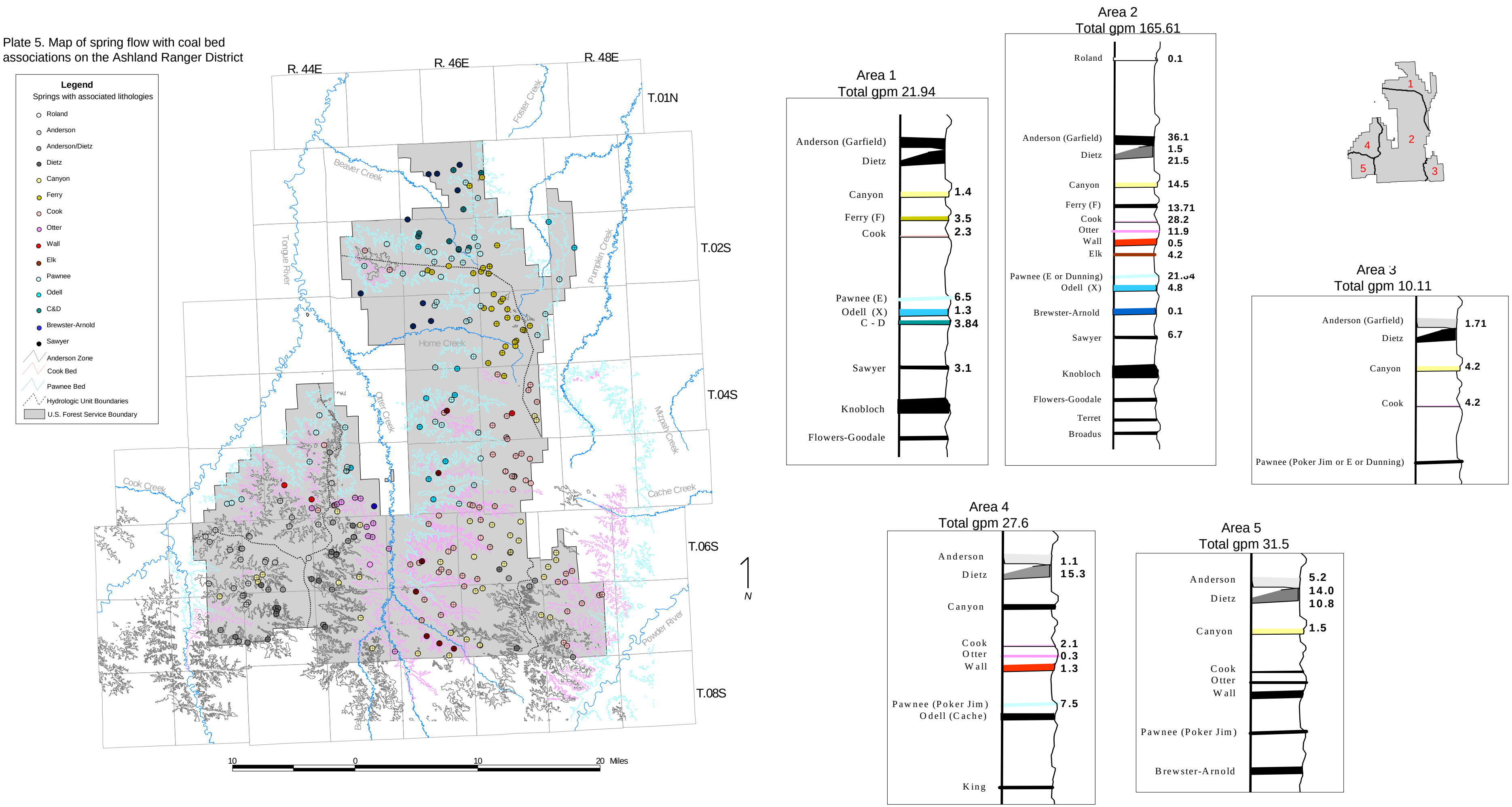


Plate 6. Springs, streams, and wells that might be expected to be impacted by coalbed methane production

Legend

Stream Impact

- Additional sites that should be monitored (value of 1 in Appendix D)
- Potential for impact (Value of 2 in Appendix D)

Well Impact

- Additional sites that should be monitored (value of 1 in Appendix D)
- Potential for impact (Value of 2 in Appendix D)

Spring Impact

- Additional sites that should be monitored (value of 1 in Appendix D)
- Potential for impact (Value of 2 in Appendix D)

- Anderson zone
- Knobloch
- Stream
- National Forest Service area