3.3 WATER RESOURCES

3.3.1 Introduction

This section discusses water resources in the proposed Project area. The description of water resources is based on information provided in the 2011 Final Environmental Impact Statement (Final EIS) as well as new circumstances or information relevant to environmental concerns that have become available since the publication of the Final EIS, including the proposed major reroute in Nebraska and numerous minor (less than 1 mile) route modifications in Montana and South Dakota. The information provided here builds on the information provided in the Final EIS as well as the 2013 Draft Supplemental EIS and, in many instances, replicates that information with relatively minor changes and updates: other information is entirely new or substantially altered from that presented in the Final EIS.

Specifically, the following information, data, methods, and/or analyses have been substantially updated from the 2011 document:

- Well data (depth, hydrogeology, and water quality) near the proposed Project area in Montana and South Dakota were added.
- Tribal lands are considered in the Surface Water sections.
- Major proposed route modifications in much of Nebraska necessitated new data collection and analysis including wells locations, water depths, water quality, and hydrogeologic (aquifer) analysis.
- The number and type of stream crossings and stream crossing methods have changed due to route modifications as well as updated field survey information provided by TransCanada Keystone Pipeline, LP (Keystone). The stream crossing assessment was comprised of a desktop analysis based on National Hydrography Dataset (NHD) information and supplemented by Keystone field survey descriptions where available.
- Based on the limitations of the data used in the desktop analysis, the intermittent and ephemeral stream categories were combined and assessed as intermittent streams, and no distinction between these categories was maintained. This document separates makes the distinction between ephemeral and intermittent streams.
- State and federally designated or mapped floodplain areas were assessed in Montana, South Dakota, and Nebraska from publicly available map data. Not all counties along the proposed Project route are mapped. Project locations that intersected mapped floodplains were listed.
- Floodplains for the Cheyenne, Little Missouri, and Bad River in South Dakota were identified in a desktop analysis that included effective floodplain areas regardless of designation.
- The number and depth of reported wells within one mile of the proposed pipeline route have been identified.
- A detailed discussion of the aquifers and aquifer properties was added.
- A major new alignment in the sand hills portion of Nebraska and an assessment of existing conditions associated with the new alignment were added.

- A cross-section showing the general relationship of geologic and hydrologic units was added;
- Maps showing well locations and depths by state were added.
- Tables on the well information by route mile were updated and new tables were added.

The following information, data, methods, and/or analyses have been substantially updated from the 2013 Draft Supplemental EIS:

- Well data details were added or updated along the alignment route including Geographic Information System map coordinates for each registered well;
- A discussion of stream crossing methodology was expanded, including boring techniques.
- Specific discussions of spill potential and potential effects have been moved to Sections 4.3, Water Resources, and 4.13, Potential Releases.
- Additional discussion of Wild and Scenic Rivers Act designated segments has been added.
- Route modifications included a relocation of the Niobrara River crossing. This crossing is located between designated Wild and Scenic River segments managed by the National Park Service. Portions of the Missouri River watershed that could be affected by proposed Project's construction activities, operations, or potential releases have been included in this analysis.
- Water distribution system crossing criteria supplied by the U.S. Bureau of Reclamation (BOR), specifically as it relates to the Mni Wiconi water line crossed by the proposed project was added.
- BOR facility locations listed by approximate milepost (MP) as crossed by the proposed Project were added.
- In response to public and agency comments, text has been revised throughout the section where necessary.

Summary

The proposed Project would cross several primary groundwater aquifers[1] and regional aquitards[2] in the Project area. The aquifers encountered within the Project area range from large regional aquifers present in multiple states to shallow alluvial aquifers related to stream sediment, aeolian, and loess deposits[3]. The primary groundwater aquifers within the Project area include the Great Plains Aquifer (GPA), the Western Interior Plains Aquifer (WIPA), the Northern Great Plains Aquifer System (NGPAS), the Northern High Plains Aquifer (NHPAQ), and multiple unnamed alluvial aquifers. Within the Project area, the pipeline crosses approximately 25 miles of alluvial aquifers underlain by aquitards, 226 miles of the NGPAS, and 294 miles of the NHPAQ (190 miles of which are combined NHPAQ and alluvial aquifers).

[1] An aquifer is a geological formation, groups of formations, or part of a formation that is capable of yielding a significant amount of water to a well or spring.
[2] An aquitard is a confining bed that retards but does not prevent the flow of water to or from an adjacent aquifer.
[3] Loess is a blanket deposit of buff-colored calcareous silt, homogeneous, nonstratified, weakly coherent, porous, and friable (easily crumbled); it is thought to be from windblown dust of Pleistocene in age.

Depth to first groundwater within the Project corridor is reported to range from zero feet deep to over 300 feet deep. Water bearing zones with reported water depths of less than 50 feet below ground surface (bgs) and within 1 mile of the proposed Project corridor were identified for potential groundwater quality impacts from pipeline construction and operations. Based on available well records, approximately 250 to 300 miles of the proposed Project corridor have reported groundwater depths of less than 50 feet bgs. Deeper aquifers below 300 feet or that are saline were excluded from evaluation except where groundwater extraction activities occur.

Federal, state, and local databases were searched to compile groundwater information from domestic, irrigation, and public water supply well data. Agency-sponsored water quality information as well as available databases indicated that water within the proposed Project area contains moderate to high levels of total dissolved solids (TDS), dissolved carbonates, and nitrates. The primary source of TDS is attributed to saline intrusions[4] from deeper aquifers while the elevated nitrate concentration is attributed to soil characteristics and agricultural activities.

The proposed Project route would cross approximately 1,073 surface waterbodies; of those, 14 are planned for crossing with the horizontal directional drill (HDD) construction method. In addition to HDD pipeline installations, for some waterbody crossings the Project would use variations of open trench pipeline installations to protect habitats and aquatic species that depend on flowing surface water. Some waterbodies that the proposed Project encounters would require site-specific design and permitting based on protected conditions or areas that were determined to be of high consequence. The Pipeline and Hazardous Materials Safety Administration identifies High Consequence Areas for hazardous liquid pipelines. These designations focus on populated areas, drinking water sources, and unusually sensitive ecological resources. These are specific locations where a spill could have the most significant adverse consequences. Once identified, pipeline operators are required to devote additional focus, efforts, and analysis in High Consequence Areas to ensure the integrity of pipelines.

Figure 3.3.1-1 provides a summary of waterbodies crossed by the proposed Project for each state[5]. These are separated by waterbody categories (Perennial, Intermittent, Canals and Other). Waterbodies categorized as other include manmade seasonal impoundments and ponds.

[4] Saline intrusion is a marine geologic deposit that can contain high concentrations of salt, which can leach into groundwater that comes in contact with the rocks. This water cannot be used by animals or crops without treatment and therefore is not used. This high salt (saline) water is typically below geologic deposits that contain usable groundwater.

[5] In addition to the planned pipeline, the additional supporting infrastructure for the proposed Project (a pipe yard and a rail siding in North Dakota and two pumps stations in Kansas) are not anticipated to impact surface waterbodies; therefore North Dakota and Kanas have no entries in the waterbody summaries or tables in this section.

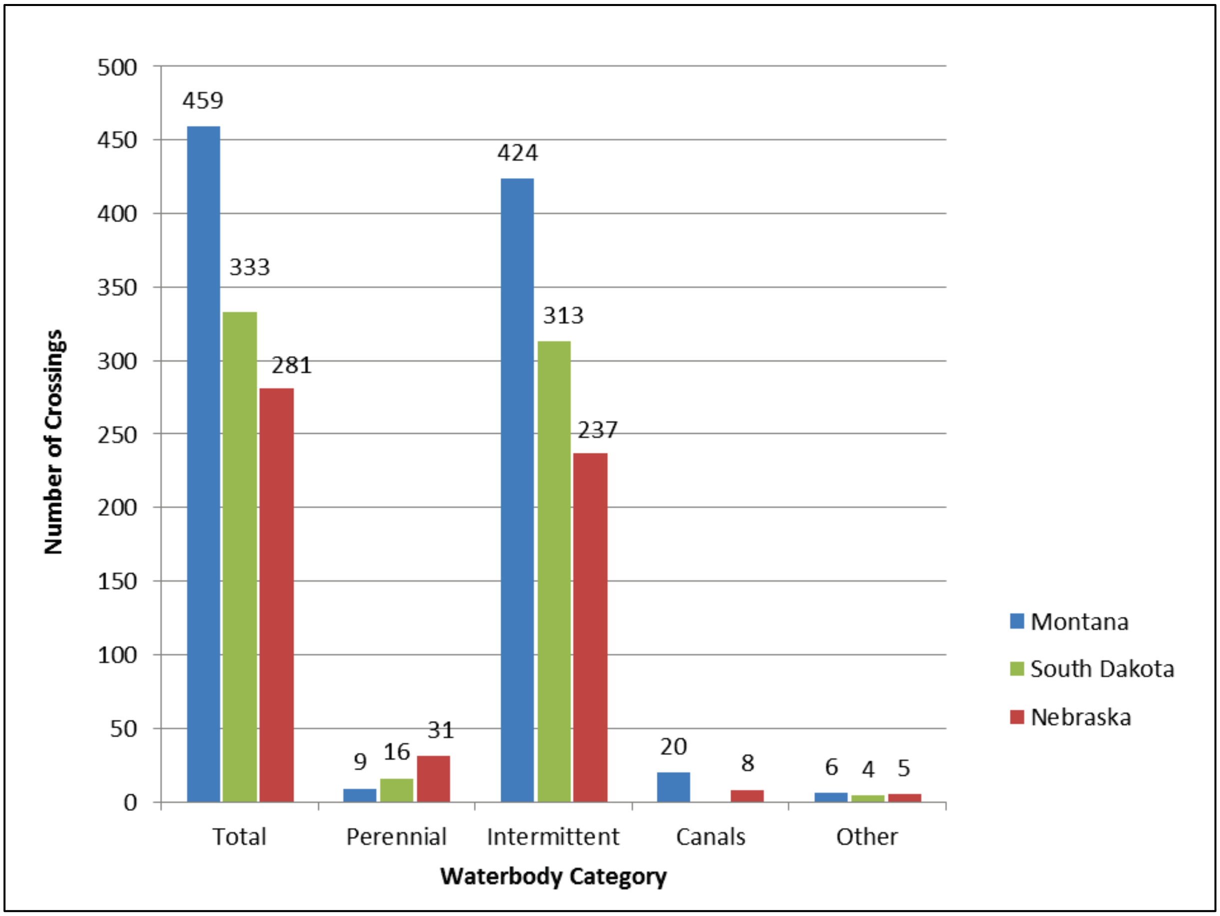


Figure 3.3.1-1 Waterbodies Crossed by Category

The affected environment assessment for waterbodies is based on several different surface water condition criteria including perennial versus intermittent, impaired versus not impaired, and multiple use classifications. For the purposes of the Final Supplemental EIS and based on limitations of the desktop level of investigation, intermittent and ephemeral waterbodies are assessed as a single category of stream. The U.S. Army Corps of Engineers nationwide permit program has the following definitions of these waterbodies:

- An intermittent stream has flowing water during certain times of the year, when groundwater provides water for stream flow. During dry periods, intermittent streams may not have flowing water. Runoff from rainfall is a supplemental source of water for stream flow.
- An ephemeral stream has flowing water only during, and for a short duration after, precipitation events in a typical year. Ephemeral stream beds are located above the water table year-round. Groundwater is not a source of water for the stream. Runoff from rainfall is the primary source of water for stream flow.
- An impaired waterbody is one that is polluted to the point where it does not meet its designated use. For example, a waterbody designated for swimming could become impaired if pollution increased to the point where it was not desirable or safe for people to swim. A

lake designated for aquatic life could become impaired if it became polluted to the point where certain types of fish that used to thrive there could no longer live. As a waterbody becomes impaired, the existing aquatic ecosystem changes for the worse, fish or wildlife habitat is degraded, and in extreme cases, public health may be threatened. These impaired waterbodies along proposed Project route have been assessed to determine any effects that could be incurred by the proposed Project construction or operation.

State-designated uses and water quality assessments have been reviewed to fully assess the waterbodies potentially affected by the proposed Project. Figure 3.3.1-2 provides a summary of the designated uses for waterbodies crossed by the proposed Project by state.

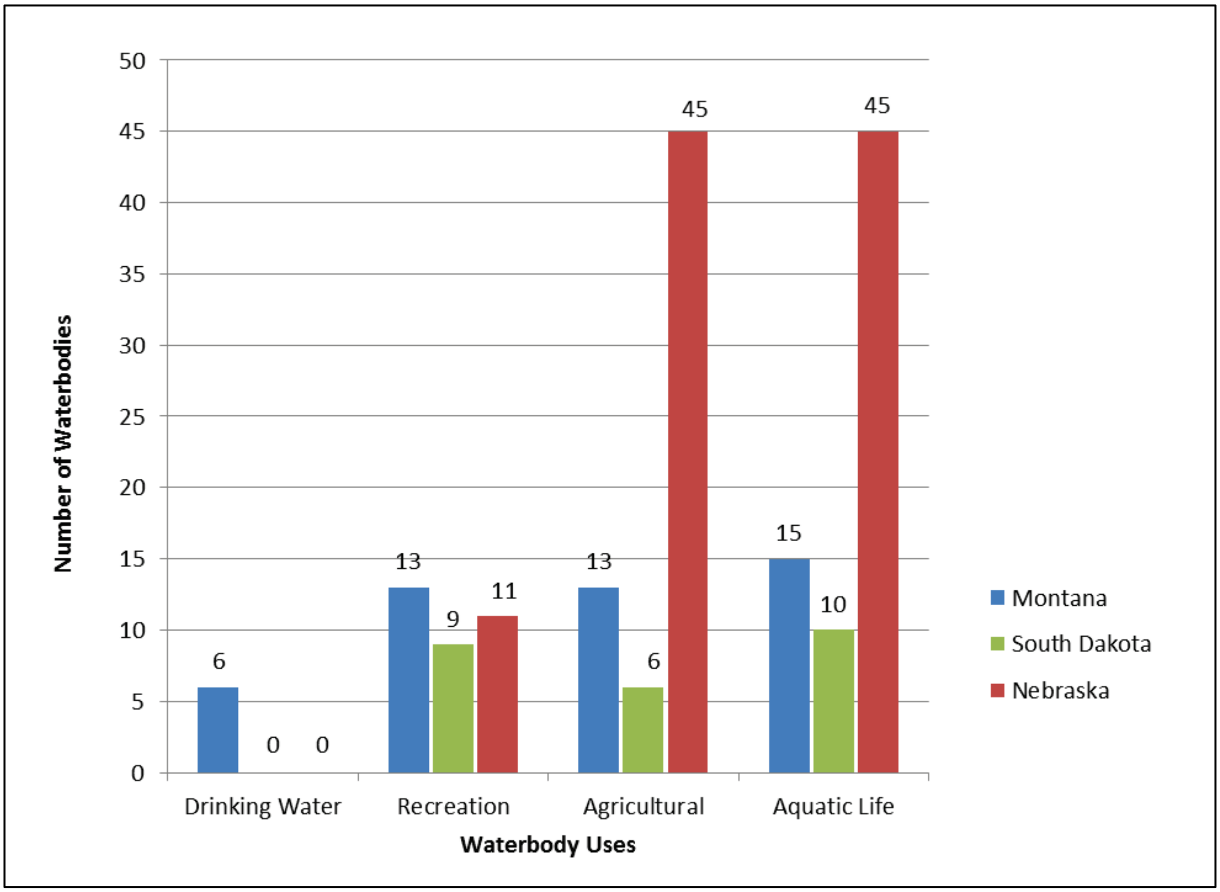


Figure 3.3.1-2 Waterbodies Crossed with Designated Uses

Primarily due to the changes in geography and latitude over the extent of the project, significant variations in the types and sizes of affected waterbodies would be encountered by the proposed Project.

Connected actions that would be constructed in areas similar to the proposed Project route include the Bakken Marketlink Project, the Big Bend to Witten 230-kilovolt (kV) Transmission Line, and electrical distribution lines and substations. The preliminary Bakken Marketlink route would cross seven intermittent waterbodies as well as the Sandstone Creek, a perennial waterbody (see Figure 2.1.12-3 for a map of the preliminary route). This connected action is not expected to impact the beneficial uses for Sandstone Creek, which are listed in the Montana Department of Environmental Quality (MDEQ) Final Water Quality Integrated Report (MDEQ 2012). The surface water resource and groundwater conditions for the connected actions are expected to be similar to the surface water resource and groundwater conditions discussed for the proposed Project route.

3.3.2 Groundwater

3.3.2.1 Hydrogeologic Setting

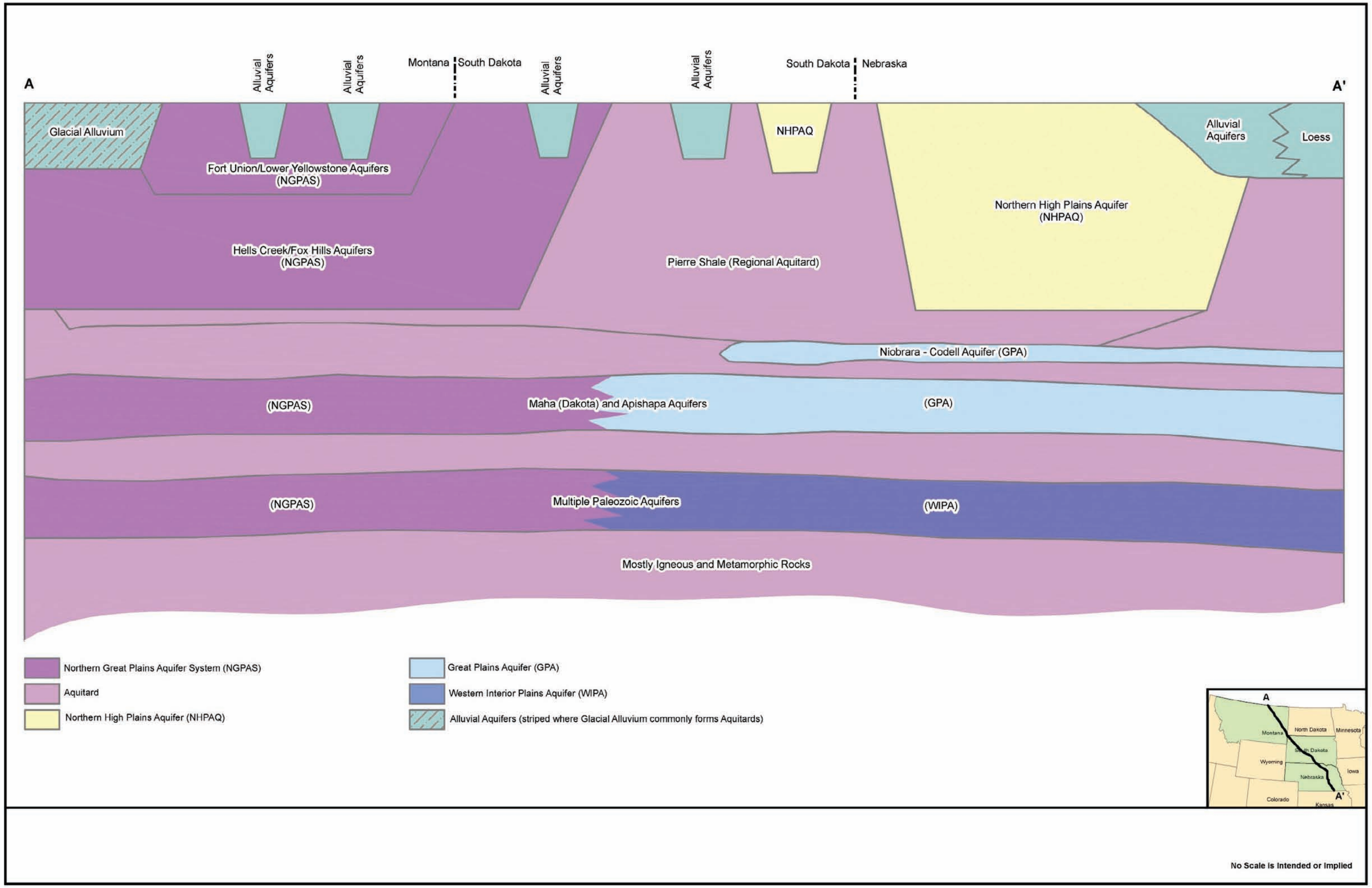
Groundwater resources are a primary source of irrigation and potable water along much of the proposed pipeline route. Several primary groundwater aquifers and aquifer groups underlie the proposed Project area, including the following:

- Alluvial aquifers
- NHPAQ
- GPA
- NGPAS
- WIPA

Each of these aquifers is described in the following subsections. To establish a context and better understanding of the specific conditions along the proposed pipeline route, the regional large-scale groundwater conditions and interactions of these aquifers and aquifer groups are described (see Figure 3.3.2-1).

Alluvial Aquifers

Alluvial aquifers along the proposed pipeline route typically consist of sediments deposited in stream valleys. In some areas of Nebraska crossed by the proposed route, the alluvial aquifer deposits also include aeolian (dune and sheet deposits) sands and loess (windblown silt deposits). These unconsolidated deposits range from a few feet to hundreds of feet thick. They are typically related to continental glaciation deposits in the proposed Project area, and are typically reworked sediments derived from local formations throughout the central portion of the proposed route (Miller and Appel 1997, University of Nebraska 1998).



Sources: Whitehead 1996, Miller and Appel 1997, Esri 2013

Figure 3.3.2-1 Schematic Hydrogeologic Cross-Section along Proposed Pipeline Route

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Groundwater in the alluvial aquifers is characteristically shallow (less than 50 feet bgs) and often unconfined. Wells completed in the alluvial deposits in the proposed Project area are typically less than 100 feet deep and have yields that range from one to several thousand gallons per minute (gpm) (Whitehead 1996). As would be expected given the range of observed well yields, the aquifer characteristics that measure the amount of groundwater and how easily it flows (transmissivity, storativity, and hydraulic conductivity[6]) of these deposits vary widely across the study area as well as locally. Table 3.3-1 contains information on general aquifer well yields for units along the proposed Project route. Unconsolidated alluvial aquifers are a primary source of groundwater for irrigation, domestic, commercial, and/or industrial use throughout much of the proposed Project area.

Table 3.3-1 Groundwater Yield Estimates by Aquifer

Aquifer	Regional Aquifer Group(s)[a]	State	Range of Yield[b]
Judith River Formation	NGPAS	MT	5-20
Missouri River Alluvium	AA	MT	5-300
Hells Creek/Fox Hills	NGPAS	MT	5-20
Fox Hills	NGPAS	MT	5-20
Fort Union	NGPAS	MT	15-25
Yellowstone R. Alluvium	AA	MT	50-500
Hells Creek/Fox Hills	NGPAS	SD	5-20
Ogallala Formation	NHPAQ	SD	0-50
Pleistocene River Terrace	AA	SD	250-750
White River Alluvium	AA	SD	1-30
Ogallala Formation	NHPAQ	NE	250-750
Sand Hills Unit	NHPAQ/AA	NE	100-1,000
Ogallala Formation	NHPAQ	NE	250-750
Platte River Unit	NHPAQ/AA	NE	5-500
Eastern Nebraska Unit	NHPAQ/AA	NE	5-250

Sources: Based on available well data from Nebraska Department of Natural Resources (NDNR) 2012, South Dakota Department of Environment and Natural Resources (SDDENR) 2012a, and Montana Bureau of Mines and Geology 2012

[a] NGPAS = Northern Great Plains Aquifer System; AA = Alluvial aquifer; NHPAQ = Northern High Plains Aquifer
[b] Yields are reported at gallons per minute.

The proposed Project would include two proposed pump stations in Kansas, both of which would be situated upon alluvial aquifers. The pump station in Clay County is located within the alluvium of the Republican River, and the pump station in Butler County is situated on the alluvium associated with the East Branch of the Whitewater River.

The stream valley alluvial aquifers in eastern Kansas consist mostly of Holocene and Pleistocene sand and gravel deposits with an average thickness of 90 to 100 feet, but locally can be as much as 160 feet thick. The saturated thickness within these alluvial aquifers is typically 50 to 80 feet, and aquifer conditions are usually unconfined. Well yields of up to 3,000 gpm are reported from

[6] *Transmissivity* is a volumetric measure of the rate of horizontal groundwater flow through an aquifer, generally equal to the product of the aquifer hydraulic conductivity and the aquifer saturated thickness. *Storativity* is a volumetric measure of the rate of groundwater extraction from an aquifer corresponding to a given decrease in the fluid level within the aquifer per unit area of the aquifer. *Hydraulic conductivity* is a velocity measure of rate of fluid flow through a porous soil or rock material under a hydraulic gradient (slope of fluid surface) of distances of 1 vertical :1 horizontal.

stream valley alluvial aquifers in Kansas, and transmissivity values range from 8,000 to 80,000 square feet per day (Whitehead 1996).

Northern High Plains Aquifer

The NHPAQ extends across portions of eight states from southern South Dakota to the Texas panhandle, and is an important groundwater resource across nearly the entire overlying area. The NHPAQ stores approximately 3.25 billion acre-feet of groundwater, and provides water to over 170,000 wells. The NHPAQ in the vicinity of the proposed Project consists of Tertiary rocks of the Ogallala Formation, Arikaree Group, and Brule Formation, as well as overlying and associated alluvial sediments. The Ogallala Formation is present beneath portions of the proposed Project area in southern South Dakota and Nebraska where the formation is primarily underlain by the Pierre Shale, a regional confining layer. The Arikaree Group and Brule Formation are not present directly beneath the proposed Project area. In southern South Dakota and Nebraska, the NHPAQ system is typically described to include groundwater-bearing Quaternary and recent aeolian, fluvial, and glacial alluvium overlying and adjacent to the Ogallala Formation; therefore, descriptions of the NHPAQ conditions overlap somewhat with the alluvial aquifers described above (Gutentag et al. 1984).

The Ogallala Formation consists primarily of unconsolidated to semi-consolidated gravel, sand, silt, and clay deposited by an extensive network of easterly flowing rivers and streams that drained the ancestral Rocky Mountains. Depth to groundwater in the Ogallala Formation in the proposed pipeline area ranges from near the surface to greater than 200 feet bgs. Thickness of the water-bearing units in this formation can be up to 900 feet or more, but are typically much thinner in the formation’s easternmost portions crossed by the proposed pipeline route, where saturated thicknesses of more than 300 feet are uncommon. Typical recharge rates to the Ogallala Formation and associated alluvial aquifers range from 0.5 to 5 inches per year along the proposed route, with the highest recharge rates in the areas of the aquifer associated with the Sand Hills Unit. Groundwater generally flows toward the east at an average of 1 foot per day (Gutentag et al. 1984). Transmissivity of the Ogallala Formation in the Project corridor typically ranges from approximately 2,000 to 10,000 square feet per day (University of Nebraska 1998).

Where present, the Ogallala Formation and associated alluvial aquifers are a primary source of groundwater for agricultural, domestic, commercial/industrial, and potable use along much of the proposed Project area in southern South Dakota and Nebraska.

Great Plains Aquifer

The GPA consists of sedimentary rocks deposited in the Cretaceous Period across much of Nebraska, Kansas, Colorado, and smaller parts of New Mexico, Oklahoma, Texas, South Dakota, and Wyoming (Miller and Appel 1997). The two primary sub-units of the aquifer are the Maha and Apishapa aquifers, which both consist of loosely cemented, fine- to medium-grained sandstone separated by a shale confining unit. A less extensive aquifer system, the Niobrara/Codell aquifer sub-unit, is present in the study area and is stratigraphically within the GPA. Along the proposed route, the GPA lies underneath the NHPAQ, including the Ogallala formation (Figure 3.3.2-1).

Of the two primary sub-units, only the Maha aquifer (Dakota Sandstone) is present beneath the proposed Project area across southern South Dakota and Nebraska. Rocks and conditions that correlate to both aquifer sub-units are present beneath the proposed Project area north of the

Nebraska-South Dakota border. Across that area, however, the depth to water, high dissolved solids content (salinity), and other water quality issues typically make the aquifer sub-units unsuitable for irrigation or potable use. Also within Nebraska, much of the GPA has limited use because of high salinity, except where the formations that compose the aquifer are near the surface in the eastern portion of the state.

The formation thickness of the Maha aquifer sub-unit is approximately 600 feet beneath Keya Paha County, Nebraska, and generally decreases along the proposed route to less than 200 feet in thickness at Steele City, Nebraska (Miller and Appel 1997). Depth to the top of the Maha is reported as 1,000 feet bgs or less along the proposed route; the Dakota Sandstone is near the surface in the southern portion of the proposed Project area in Nebraska, but typically covered with alluvium. Transmissivity of the Maha aquifer beneath the proposed Project area is estimated to range from greater than 1,000 to over 10,000 square feet per day.

The Niobrara/Codell aquifer sub-unit is a regional groundwater aquifer that stratigraphically falls within the GPA system and is present across much of Nebraska and southern South Dakota. The aquifer is present in Late Cretaceous sandy chalk, limestone, shale, and sandstone rocks overlying the Maha aquifer sub-unit. Water quality in this aquifer is generally better than the underlying Maha, but is still somewhat saline across much of the aquifer extent. In scattered areas where water quality is good, however, the aquifer is used as a minor source of domestic, municipal, and irrigation water (Korus and Joeckel 2011).

Recharge of the GPA across most of the proposed Project area in Nebraska may be from groundwater in the overlying Ogallala Formation; however, in the areas of downward hydraulic gradient between the Ogallala and the GPA that the proposed route would cross, the GPA is typically saline and not used for groundwater withdrawal (Miller and Appel 1997). Additionally, most of the NHPAQ in the area is underlain by the Pierre Shale, which forms an aquitard that limits hydraulic connectivity between the NHPAQ and GPA across most of the area where the two aquifers are present along the proposed route.

Where the GPA is present beneath the proposed Project area, no wells were identified that extract groundwater from this aquifer within 1 mile of the proposed Project corridor centerline based on a review of available water well logs for Nebraska and South Dakota.

Western Interior Plains Aquifer

The WIPA consists of Mississippian to Cambrian Age dolomite, limestone, and sandstone across most of Kansas, eastern Nebraska, and parts of Missouri (Miller and Appel 1997). In eastern Montana and South Dakota, this sequence grades laterally into the NGPAS and is typically deeply buried and contains very saline water, except in areas where uplift brings the formations close to the surface, such as the vicinity of the Black Hills. There are no such uplift areas present within the proposed Project area, and the WIPA lies underneath the GPA (Figure 3.3.2-1).

Along the proposed pipeline route in eastern Nebraska, the aquifer thickness is approximately 1,500 feet at Steele City, Nebraska, generally decreasing to the north and pinching out[7] a few miles south of the South Dakota border in Keya Paha County (Miller and Appel 1997). Little, if

[7] A pinch-out is the termination or end of a stratum of geologic material that narrows or thins progressively in a given direction until it disappears and the rocks it once separated are in contact.

any, water is withdrawn from the WIPA in Nebraska in the vicinity of the proposed pipeline area because the aquifer is deeply buried (at least several hundred feet bgs) and very saline (Korus and Joeckel 2011).

Where the WIPA is present beneath the proposed Project area, no wells that extract groundwater from this aquifer were identified within 1 mile of the proposed Project corridor centerline. In addition, the WIPA is separated from the overlying GPA by aquitards that limit hydraulic connectivity between the WIPA and GPA across the proposed Project area.

Northern Great Plains Aquifer System

The NGPAS in eastern Montana, northern Wyoming, western North Dakota, and northwestern South Dakota consists of early Cenozoic, Mesozoic, and Paleozoic rocks, some of which, further to the southeast, are subdivided into the GPA and WIPA (Whitehead 1996). This aquifer system also includes Tertiary and Late Cretaceous rocks that do not have correlative aquifer units in southern South Dakota and Nebraska. Although several separate aquifers and intervening aquitards are present within the NGPAS, the separate aquifers share similar conditions and exhibit at least some degree of hydraulic connectivity on a local and regional scale.

The Tertiary and Late Cretaceous formations that are included in the NGPAS (Fort Union Group, Hell Creek Formation, and Fox Hills Sandstone) are present at or near the surface across most of the proposed Project area through northwestern South Dakota and Montana (Whitehead 1996). Beneath these Tertiary formations and exposed at the surface along the eastern and western periphery of those rocks units, Early Cretaceous rocks of the Inyan Kara Group, the next deepest primary aquifer in the NGPAS, are present. Paleozoic rocks containing aquifers similar to or directly correlated to those in the WIPA are present beneath the Inyan Kara Group; however, these rocks do not approach the surface in the vicinity of the proposed Project area.

The thickness of the rock units comprising the NGPAS are tens of thousands of feet thick in aggregate, and individual water-bearing units can be several thousand feet thick. For example, the Fort Union Formation is up to 3,600 feet thick in the Powder River Basin. Similarly, aquitard units between the aquifer units are of variable thickness and are commonly absent in some areas.

Regional groundwater recharge into the NGPAS is typically from water infiltration at higher altitudes, along the shallow dip of the NGPAS aquifers, and then upward into overlying aquifer units (Whitehead 1996). Local recharge does occur through precipitation migration into Tertiary rocks and downward into the underlying older aquifers. Groundwater in the aquifer system typically moves from the highest elevations in the southern and western portions of the system toward the northeast in the Williston Basin (western North Dakota) and to the north in the Powder River Basin (northeastern Wyoming and southeastern Montana). Net groundwater flow between aquifer units is typically upward across the NGPAS. Groundwater quality is commonly slightly to very saline in the aquifer system’s Early Cretaceous portions, and is commonly at least slightly saline in the Late Cretaceous and Tertiary aquifers. The salinity in these aquifers is related to recharge from the underlying saline Paleozoic aquifer units.

Although the salinity in the groundwater from the uppermost NGPAS aquifer units makes the groundwater unsuitable for irrigation, the Tertiary and Late Cretaceous aquifers are commonly used for livestock watering and domestic and municipal water supply in western North Dakota and eastern Montana, including areas in the vicinity of the proposed Project corridor (Whitehead 1996).

Regarding the planned pipe yard[8] and rail siding in Bowman County, North Dakota, groundwater is located within the Lower Tertiary Fort Union Formation, which consists of sandstone and shale beds within interbedded coal in some areas. This unit is part of the NGPAS, and extends into Montana where the proposed Project area crosses the unit. Wells extracting groundwater from this unit in North Dakota are typically greater than 300 feet deep and yield up to 100 gallons per minute (Whitehead 1996).

3.3.2.2 Proposed Pipeline Area Hydrogeologic Conditions

This section includes a summary of the shallow groundwater encountered along the proposed pipeline area, followed by a more detailed summary of specific hydrogeologic conditions and major aquifers encountered along the pipeline area organized by state, including the following descriptions:

- Key aquifers;
- Nearby public water supply wells and private water wells;
- Depth to groundwater; and
- Water quality.

Deeper aquifers are excluded from evaluation except in areas where there may be potential groundwater quality impacts to those aquifers from pipeline construction or operation. The proposed project does not cross any sole-source aquifers (as designated by U.S. Environmental Protection Agency [USEPA] Region 8 [USEPA 2012]); however, the aquifers crossed potentially do represent up to 65 percent of potable water in Montana, up to 50 percent in South Dakota, and up to 83 percent in Nebraska. The NHPAQ in the vicinity of the proposed Project includes the Ogallala Formation and overlying and adjacent alluvial sediments. In total, the NHPAQ stores approximately 3.25 billion acre-feet of water, 66 percent of which is within Nebraska. Groundwater from the aquifer is extensively extracted for potable use, irrigation, livestock watering, and industrial use, including in the vicinity of the proposed Project (Gutentag et al. 1984). Water bearing zones less than 50 feet bgs were identified where possible by examining available well data obtained from each state for wells situated along the proposed pipeline area. These data typically include static water level and depth of wells within 1 mile of the proposed Project corridor centerline. The results of this evaluation are presented in Table 3.3-2.

[8] The pipe yard and rail siding would be a storage area used for equipment and material during pipeline construction.

Table 3.3-2 Water-Bearing Zones Less than 50 Feet Below Ground Surface Beneath the Proposed Pipeline Right-of-Way

State/County	Approximate Milepost (MP) or Range[a]	Approximate Depth to Groundwater (feet bgs[b])	Formation/Aquifer	Regional Aquifer Group[c]
Montana				
Phillips	2	8	Cretaceous Bearpaw Shale	NGPAS
Phillips	6	0	Cretaceous Bearpaw Shale	NGPAS
Phillips/Valley	25-26	<50	Frenchman Creek alluvium	AA
Valley	27	0-45	Late-Cretaceous Judith River Formation	NGPAS
Valley	38-41	0-9	Rock Creek glacial/alluvial sediments	AA
Valley	47	6	Late-Cretaceous Judith River Formation	NGPAS
Valley	55-57	40-43	Late-Cretaceous Bearpaw Shale and Buggy Creek alluvium	NGPAS
Valley	66-72	7-63	Cherry Creek glacial/alluvial sediments	AA
Valley	77-85	10-40	Porcupine Creek and Milk River alluvium	AA
Valley	88	7-22	Milk River/Missouri River alluvial sediments	AA
McCone	94	15	Late-Cretaceous Fox Hills Formation	NGPAS
McCone	99	26	Late-Cretaceous Hell Creek Formation	NGPAS
McCone	109	0	Late-Cretaceous Hell Creek Formation	NGPAS
McCone	119	20-30	Fort Union sands and Flying V Creek alluvium	NGPAS/AA
McCone	122-123	<50	Figure Eight Creek alluvium	AA
McCone	133-153	10-45	Fort Union sands; Redwater River alluvium; Buffalo Springs Creek alluvium; glacial drift	NGPAS/AA
Dawson	159-160	10-50	Fort Union sands	NGPAS
Dawson	166-180	10-45	Clear Creek alluvium	AA
Dawson	186-195	4-38	Clear Creek alluvium; Yellowstone River alluvium	AA
Prairie	201-205	0-15	Cabin Creek alluvium	AA
Prairie	209-214	18-40	Alluvium of merging creeks	AA
Fallon	227	<50	Dry Fork Creek alluvium	AA
Fallon	231-234	0	Glacial drift/alluvium	AA
Fallon	235-238	18-45	River alluvium of Dry Creek and its tributaries	AA
Fallon	242-250	5-26	Sandstone Creek and Butte Creek alluvium	AA
Fallon	257-262	0-37	Hidden Water Creek; Little Beaver Creek alluvium	AA
Fallon	264-272	0	Mud Creek and Soda Creek alluvium	AA
Fallon	275-279	0	North and South Coal Bank Creek alluvium	AA
Fallon	281-282	<50	Box Elder Creek alluvium	AA

State/County	Approximate Milepost (MP) or Range[a]	Approximate Depth to Groundwater (feet bgs[b])	Formation/Aquifer	Regional Aquifer Group[c]
South Dakota				
Harding	289-290	<50	Shaw Creek alluvium	AA
Harding	291-292	<50	Little Missouri River alluvium	AA
Harding	298-301	<50	Various creeks -alluvium	AA
Harding	304-306	<50	Jones Creek alluvium	AA
Harding	317-319	15-40	South Fork Grand River alluvium	AA
Harding	322-324	<50	Buffalo Creek/Clarks Fork Creek alluvium	AA
Harding	329	<50	West Squaw Creek alluvium	AA
Harding	339	20	Red Butte Creek alluvium	AA
Harding/Butte	351-355	<50	North Fork Moreau River alluvium	AA
Meade	380-387	15-45	Tertiary or alluvial	NGPAS/AA
Meade	390-394	25	Tertiary or alluvial	NGPAS/AA
Meade	399	18	Sulphur Creek alluvium	AA
Meade	403-404	14-44	Spring Creek alluvium	AA
Meade	407-408	14	Red Owl Creek alluvium	AA
Meade	411	3	Narcelle Creek alluvium	AA
Meade	425	5	Cheyenne River alluvium	AA
Pennington/ Haakon	432-437	<50	Alluvial	AA
Haakon	442	12	Alluvial	AA
Haakon	475	37	Alluvial	AA
Haakon	478-481	14-25	Bad River alluvium	AA
Jones	518-519	6	Alluvial	AA
Lyman	535-536	6	White River alluvium	AA
Tripp[d]	539	23	Ogallala Formation	NHPAQ
Tripp[d]	561-564	3-9	Ogallala Formation	NHPAQ
Tripp[d]	570 -595	6-25	Ogallala Formation	NHPAQ
Nebraska *North Central Tableland Groundwater Region*[e]				
Keya Paha	614-617	20-50	Keya Paha River alluvium	AA
Boyd	617-622	20-50	Keya Paha River alluvium	AA
Boyd	623-626	20-50	Various creeks—alluvial	AA
Holt	626-627	20-50	Various creeks—alluvial	AA
Holt	628-632	20-50	Tablelands alluvium	NHPAQ/AA
Holt	632-633	10-15	Various creeks—alluvial	AA
Holt	633	15-20	Various creeks—alluvial	AA
Holt	633-634	20-50	Tablelands alluvium	NHPAQ/AA
Holt	634.5	15-20	Tablelands alluvium	NHPAQ/AA
Holt	635.5-637	20-50	Tablelands alluvium	NHPAQ/AA
Holt	637-638	20-50	Tablelands alluvium	NHPAQ/AA
Holt	638.5	15-20	Tablelands alluvium	NHPAQ/AA
Holt	638.5-641	10-15	Tablelands alluvium	NHPAQ/AA
Holt	641.5	15-20	Tablelands alluvium	NHPAQ/AA
Holt	641.5-650	20-50	Tablelands alluvium	NHPAQ/AA
North Central Tableland/Sand Hills Groundwater Region[e]				
Holt	651	20-50	Tablelands alluvium	NHPAQ/AA

State/County	Approximate Milepost (MP) or Range[a]	Approximate Depth to Groundwater (feet bgs[b])	Formation/Aquifer	Regional Aquifer Group[c]
Sand Hills Groundwater Region[e]				
Holt	651.5-655	20-50	Tablelands alluvium	NHPAQ/AA
Holt	655-657	20-50	Tablelands alluvium	NHPAQ/AA
Holt	657-658	20-50	Tablelands alluvium	NHPAQ/AA
Holt	658.5	15-20	Tablelands alluvium	NHPAQ/AA
Holt	658.5-659	15-20	Tablelands alluvium	NHPAQ/AA
Holt	659.5	15-20	Tablelands alluvium	NHPAQ/AA
Holt	659.5-660	20-50	Tablelands alluvium	NHPAQ/AA
Holt	660-661	20-50	Tablelands alluvium	NHPAQ/AA
Holt	661-663	20-50	Tablelands alluvium	NHPAQ/AA
Holt	663-665	20-50	Various creeks - alluvial	AA
Holt	665-666	20-50	Various creeks - alluvial	AA
Holt	666-667	15-20	Tablelands alluvium	NHPAQ/AA
Holt	667.5	20-50	Tablelands alluvium	NHPAQ/AA
Holt	667.5-672	20-50	Tablelands alluvium	NHPAQ/AA
Holt	676-677	20-50	Tablelands alluvium	NHPAQ/AA
Antelope	680-682	20-50	Tablelands alluvium	NHPAQ/AA
East Central Dissected Plains Groundwater Region[e]				
Antelope	710-718	20-50	Tablelands alluvium/Elk Horn River alluvium	NHPAQ/AA
Boone	742-745	20-50	Various creeks—alluvial	AA
Boone	745-746	20-50	Tablelands alluvium	NHPAQ/AA
Boone	747-749	20-50	Tablelands alluvium/various creeks alluvium	NHPAQ/AA
Platte River Valley Groundwater Region[e]				
Nance	761-762	20-50	Loup River alluvium	AA
Nance	762-763	15-20	Loup River alluvium/various river alluvium	AA
Nance	763-765	5-10	Loup/Platte River alluvium	AA
Nance	765-766	5-10	Loup/Platte River alluvium	AA
Nance	766.5	10-15	Loup/Platte River alluvium	AA
Nance	767	5-10	Loup/Platte River alluvium	AA
Merrick	767.5	5-10	Loup/Platte River alluvium	AA
Merrick	767.5-771.5	10-15	Loup/Platte River alluvium	AA
Merrick	771.5-774	5-10	Loup/Platte River alluvium	AA
Merrick	774-775	10-15	Platte River alluvium	AA
Polk	775.5	10-15	Platte River alluvium	AA
Polk	778	20-50	Platte River alluvium	AA
Southeast Nebraska Glacial Drift Groundwater Region[e]				
Saline	840-844	20-50	Glacial drift alluvium	AA

Sources: Based on available well data from NDNR 2012, SDDENR 2012a, and Montana Bureau of Mines and Geology 2012

[a] MPs for the proposed Project start at 0.0 at the Canada/Montana border, and increase toward the south along the pipeline route.
[b] bgs = below ground surface.
[c] AA = Alluvial aquifer; NHPAQ = Northern High Plains Aquifer; NGPAS = Northern Great Plains Aquifer System.
[d] MP distances are approximate.
[e] State Groundwater Regions from University of Nebraska 1998.

Information on groundwater occurrence, depth to groundwater, and groundwater use (wells) along the proposed pipeline area has been collected and summarized in this section to provide context for understanding potential impacts to groundwater quality that may occur during the construction and operation phases of the proposed Project. The analysis of local aquifer and groundwater use along the proposed Project area includes information on the likely occurrence of relatively shallow potable groundwater and water wells within 1 mile of the proposed Project corridor centerline. This information was compiled using publicly available and searchable databases maintained by water resource agencies within each of the affected states.

The databases were searched for domestic, irrigation, and public water supply well data. The analysis of impacts on water supplies for human consumption also applies to water intakes for industrial and municipal use. Data accessed included well location, well total depth, and depth to first water (if available) or static water level. Because the screened intervals of the wells (depth at which the screen is placed) are not typically recorded in the well data obtained from the states, it is not possible in all cases to correlate static water level to likely depth to first water. In other words, it could not be determined whether the aquifers tapped by the individual wells are confined or unconfined. To provide the most conservative well data evaluation, groundwater in each of the aquifers intercepted by the wells is considered present under unconfined conditions; therefore, depth to water measured in the wells is assumed to be equal to the depth of first water.

Water well data compiled within 1 mile of the proposed Project corridor centerline are shown in Figures 3.3.2-2, 3.3.2-3, and 3.3.2-4, respectively. Given the available data limitations and variations in data quality from state to state, the following five general categories that relate well depth and reported water levels (first water or static water level) to likely water depth were created. Water wells without recorded total depths or depth to water were excluded for use in generating the following categories:

- Category A: Very shallow water depth likely with reported water level less than or equal to 10 feet bgs and total well depth less than or equal to 50 feet bgs;
- Category B: Shallow water depth likely with reported water level between 10 and 50 feet bgs and total well depth less than or equal to 50 feet bgs;
- Category C: Water depth unclear, but potentially very shallow because reported water level is less than or equal to 10 feet bgs and total well depth is greater than 50 feet bgs (reported water level could indicate very shallow water depth if well screened in upper 50 feet or deep water depth if well screened at deeper interval under artesian conditions);
- Category D: Water depth unclear, but potentially shallow because reported water level is between 10 and 50 feet bgs and total well depth is greater than 50 feet bgs (reported water level could indicate shallow water depth if well screened in upper 50 feet or deep water depth if well screened at deeper interval under artesian conditions); and
- Category E: Deep water depth likely with reported water level greater than 50 feet bgs and total well depth greater than 50 feet bgs.

The following subsections present, by state, more detailed information on key shallow aquifers that the proposed Project area would cross, a summary of wells near the proposed Project area, additional information on depth to groundwater, and a summary of water quality in the shallow aquifers.

Montana

Key Aquifers

The bedrock aquifers beneath the proposed Project area in Montana are part of the NGPAS (Whitehead 1996). Along the proposed Project area in Montana, most aquifers used for water supply consist of unconsolidated fluvial and/or glacial alluvial aquifers, and Tertiary- and Late Cretaceous-aged aquifers of the NGPAS. Figure 3.3.2-2 shows the distribution of these aquifers in the study area of Montana.

In Phillips and Valley counties in northern Montana, up to 100 feet of relatively impermeable glacial till acts as a confining layer above the Cretaceous-aged Bearpaw Shale, Judith River Formation, and Clagett Formation (Whitehead 1996). Well data indicate groundwater in the Bearpaw Shale, where present, is typically shallow-to-moderate depth (0 to 45 feet bgs) and no information regarding well yields is presented. The water table in the Judith River Formation is present at approximately 150 to 500 feet bgs in this area and wells from the formation typically yield 5 to 20 gpm (see Table 3.3-1). Additionally, the glacial till contains local permeable zones of coarse glacial outwash less than 50 feet bgs that provide irrigation water. Most groundwater use in Valley County comes from shallow alluvial aquifers along major river drainages such as the Milk River and Missouri River (Whitehead 1996).

In McCone County, the proposed pipeline area crosses the Late Cretaceous Hells Creek/Fox Hills aquifer and the Tertiary Fort Union aquifer. Permeable sandstones of the Hells Creek/Fox Hills aquifer yield 5 to 20 gpm; most wells are drilled to depths of 150 to 500 feet bgs (Whitehead 1996). The Tertiary Fort Union aquifer consists of interbedded sandstones, mudstones, shale, and coal seams. Water-bearing zones are found in the sandstone layers and the aquifer is confined in most areas. Well yields are typically 15 to 25 gpm; most wells are drilled to depths of 50 to 300 feet bgs (Lobmeyer 1985); water depths typically range from 100 to 150 feet bgs (Swenson and Durum 1955).

Beneath the proposed pipeline area in Dawson, Prairie, and Fallon counties lies the Lower Yellowstone aquifer system which contains groundwater in the Tertiary Fort Union Formation. The Lower Yellowstone aquifer system is a shallow bedrock aquifer that is used as a groundwater resource in these three counties. The Yellowstone River contains abundant alluvial material along its banks, which contain shallow aquifers within the unconsolidated alluvium that are often used for water supply. Well yields in these shallow alluvial aquifers along the Yellowstone River range from 50 to 500 gpm (see Table 3.3-1) (LaRocque 1966). Additionally, shallow alluvial aquifers are also present at stream crossings including Clear Creek, Cracker Box/Timber Creek, Cabin Creek, Sandstone Creek, and Butte Creek.

Nearby Public Water Supply Wells and Private Water Wells

No public water supply (PWS) wells or source water protection areas (SWPA) are located within 1 mile of the proposed Project corridor in Montana. A total of six private water wells are located within approximately 100 feet of the proposed Project corridor within McCone, Dawson, Prairie, and Fallon counties. All identified wells within 1 mile of the proposed Project corridor in Montana are included on Figure 3.3.2-2.

Sources: Montana Bureau of Mines and Geology 2012, Esri 2013

Figure 3.3.2-2 Montana Water Wells Within 1 Mile of Proposed Pipeline Route

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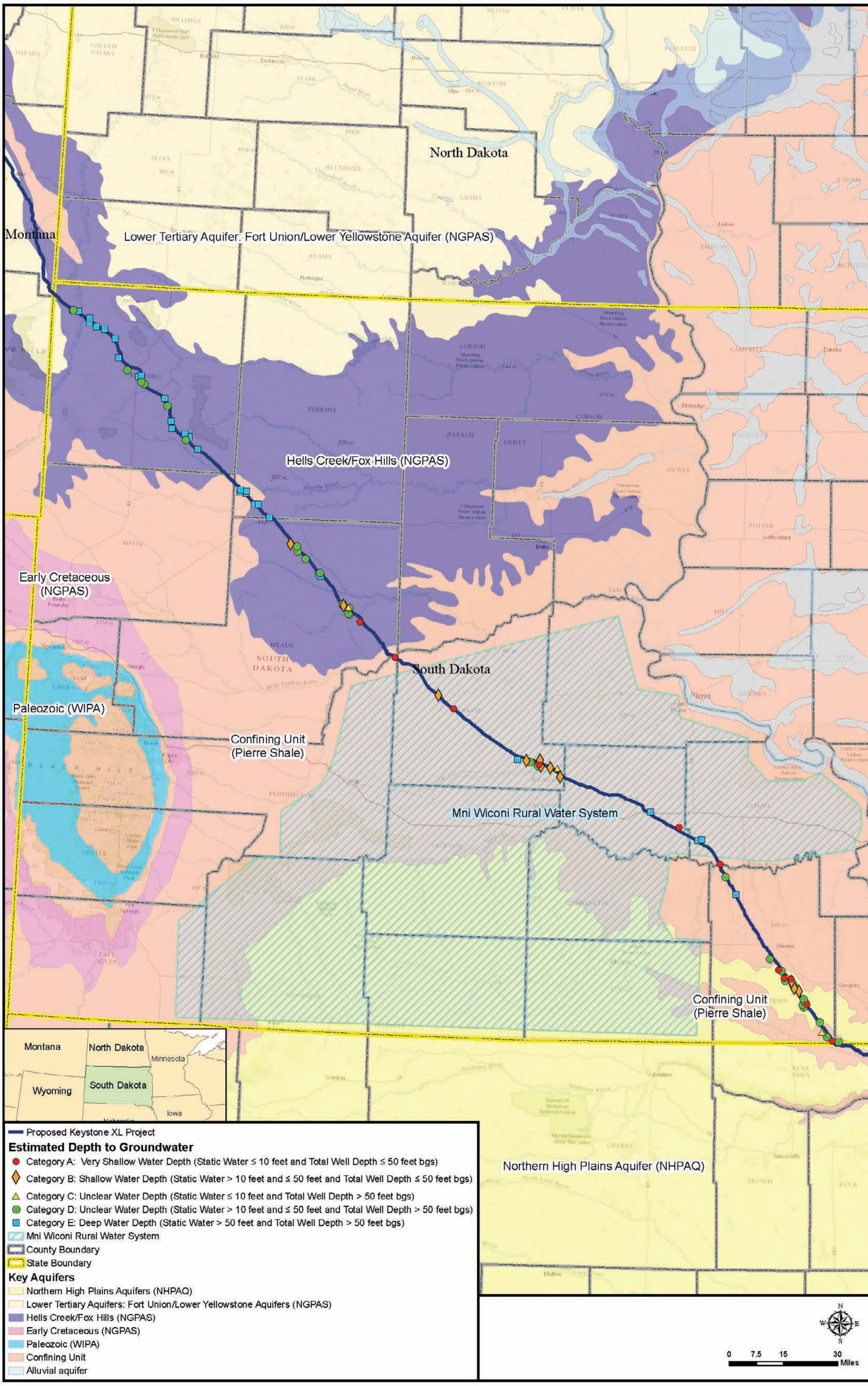

Sources: SDDENR 2012a, Esri 2013

Figure 3.3.2-3 South Dakota Water Wells Within 1 Mile of Proposed Pipeline Route

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Sources: Nebraska Department of Natural Resources 2012a, Esri 2013

Figure 3.3.2-4 Nebraska Water Wells Within 1 Mile of Proposed Pipeline Route

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Depth to Groundwater

Depths to groundwater reported on well logs for well locations within 1 mile of the proposed Project corridor in Montana are provided in Figure 3.3.2-2. The number of wells within 1 mile of the proposed Project corridor by groundwater depth category is as follows:

- Category A (very shallow)—118
- Category B (shallow)—52
- Category C (unclear but potentially very shallow)—114
- Category D (unclear but potentially shallow)—101
- Category E (deep)—138

Water Quality

Available water quality information for several aquifers present along the proposed Project area in Montana is included in Table 3.3-3. Available studies and reports indicate that water within these aquifers exhibits moderate to high TDS concentrations that are typically related to high salinity and dissolved carbonates. The overall upward gradient and resulting upward movement of groundwater from deeper, more saline aquifers into the overlying aquifers is a primary source of TDS in shallow groundwater in the proposed Project area in Montana. In general, aquifer systems that are deep and occur in older rock formations have high TDS.

Table 3.3-3 Groundwater Quality of Select Subsurface Aquifers

Aquifer	Regional Aquifer Group[a]	State	County	Total Dissolved Solids (mg/L)[b,c]	Other Water Quality Information
Judith River Formation	NGPAS	MT	Phillips, Valley	500-10,000	Sodium chloride rich in Valley County
Missouri River Alluvium	AA	MT	Valley	800-2,700	Not available
Hells Creek/Fox Hills	NGPAS	MT	McCone	500-1,800	Sodium bicarbonate rich
Fox Hills	NGPAS	MT	Dawson, Prairie, Fallon	500-2,500	Sodium bicarbonate rich
Fort Union	NGPAS	MT	McCone, Dawson, Prairie, Fallon	500-5,000	Sodium bicarbonate rich
Yellowstone R. Alluvium	AA	MT	Dawson, Prairie, Fallon	1,000-1,500	Calcium bicarbonate rich
Hells Creek/Fox Hills	NGPAS	SD	Harding, Perkins, Meade	1,000-3,000	Sodium bicarbonate rich
Ogallala Formation	NHPAQ	SD	Tripp	<500	Sodium bicarbonate rich
Pleistocene River Terrace	AA	SD	Tripp	30-4,000	Not available
White River Alluvium	AA	SD	Tripp	287-688	Sodium bicarbonate rich
Ogallala Formation	NHPAQ	NE	Keya Paha	100-250	Not available

Aquifer	Regional Aquifer Group[a]	State	County	Total Dissolved Solids (mg/L)[b,c]	Other Water Quality Information
Sand Hills Unit	NHPAQ/ AA	NE	Rock-Greeley	<500	Not available
Ogallala Formation	NHPAQ	NE	Greeley-Nance	<500	Not available
Platte River Unit	NHPAQ/ AA	NE	Merrick	<500	Not available
Eastern Nebraska Unit	NHPAQ/ AA	NE	Merrick-Jefferson	<500	Not available

Sources: Lobmeyer 1985, Swenson and Drum 1955, Smith et al. 2000, LaRocque 1966, Whitehead 1996, Rich 2005, Hammond 1994, Cripe and Barari 1978, Newport and Krieger 1959, Stanton and Qi 2007

[a] NGPAS = Northern Great Plains Aquifer System; AA = Alluvial aquifer; NHPAQ = Northern High Plains Aquifer
[b] mg/L = milligrams per liter
[c] Total Dissolved Solids are classified as a secondary contaminant by the Environmental Protection Agency with a non-mandatory standard of 500 mg/L.

South Dakota

Key Aquifers

In northwestern South Dakota, bedrock aquifers beneath the proposed Project area are part of the NGPAS (Whitehead 1996), and along the southern border with Nebraska, the proposed Project area passes through an area underlain by the Ogallala Formation of the NHPAQ. The distribution of key aquifers in South Dakota is shown in Figure 3.3.2-3. These aquifers include the Late Cretaceous Fox Hills and Hells Creek aquifers in Harding, Perkins, and Meade counties. The town of Bison uses groundwater from the Fox Hills aquifer to meet water supply demands.

These municipal wells are 565 to 867 feet deep and yield up to 50 gpm (Steece 1981). Shallow alluvial aquifers are also present at stream crossings including the Little Missouri River, South Fork Grand River, Clarks Fork Creek, Moreau River, Sulphur Creek, Red Owl Creek, Narcelle Creek, and Cheyenne River.

In Haakon, Jones, and Lyman counties, major water-producing aquifers are not present, as the proposed Project through this area is underlain by the aquitard-forming rocks of the Late Cretaceous Pierre Shale, and groundwater below the Pierre shale in the rocks of the NGPAS and the GPA is typically very saline. In this area, the floodplains of the Bad River and the White River contain shallow alluvial aquifers that are used for water supply.

Beneath a short segment of the proposed Project area in Tripp County, groundwater is present within the Ogallala Formation of the NHPAQ and in Pleistocene-aged river terrace aquifers (Whitehead 1996). Tertiary-aged aquifers in the vicinity also include Brule and Arikaree Formations, but the proposed Project area does not cross these formations. The Ogallala Formation's depth to groundwater is typically 10 to 70 feet bgs (Hammond 1994) in this area with wells yielding 250 to 750 gpm (see Table 3.3-1).

Nearby Public Water Supply Wells and Private Water Wells

One PWS well (associated with the Colome SWPA) is identified within 1 mile of the proposed Project corridor in Tripp County. This PWS well is screened at a relatively shallow depth (reportedly less than 54 feet bgs) within the Tertiary Ogallala Formation. The proposed Project area would pass through the Colome SWPA in Tripp County. No private water wells are located within approximately 100 feet of the proposed Project corridor in South Dakota. All identified wells within 1 mile of the proposed Project corridor in South Dakota are included on Figure 3.3.2-3.

The Mni Wiconi Rural Water Supply System (MWRWSS) brings surface water from the Missouri River to the Pine Ridge Indian Reservation and other parts of western South Dakota. This project consists of hundreds of shallow municipal and private wells in southwestern South Dakota, some of which are near or within the proposed Project area (see Figure 3.3.2-3). The MWRWSS operates a water intake on the Missouri River to provide potable water to the MWRWSS and to replace the poor water quality of shallow wells within the area. Those individuals on the Pine Ridge Reservation that are not connected to the MWRWSS will likely be served by community water systems or individual wells. The MWRWSS is discussed in more detail in Section 3.3.3.2, South Dakota Surface Water.

Depth to Groundwater

Depths to groundwater reported on well logs for well locations within 1 mile of the proposed Project corridor in South Dakota are provided in Figure 3.3.2-3. The number of wells within 1 mile of the proposed Project corridor by groundwater depth category is as follows:

- Category A (very shallow)—11
- Category B (shallow)—12
- Category C (unclear but potentially very shallow)—1
- Category D (unclear but potentially shallow)—51
- Category E (deep)—30

Water Quality

Available water quality information for several aquifers present along the proposed Project area in South Dakota is shown in Table 3.3-3. Available studies and reports indicate that, in general, water within the NGPAS aquifers and some younger aquifer areas exhibit moderate levels of TDS. The overall upward gradient of groundwater from deeper, more saline aquifers into the upper aquifers is a primary source of TDS in the shallow groundwater in the proposed Project area in South Dakota. In the area of the MWRWSS where the NHPAQ is present as the Ogallala Formation or Quaternary alluvium, elevated concentrations of nitrate are common in shallow groundwater. Hammond (1994) reports nitrate concentrations up to 67.3 milligrams per liter (mg/L) in wells near the proposed Project area. The USEPA Maximum Contaminant Level for nitrate in drinking water is 10 mg/L. A primary driver in the development of the MWRWSS was to provide alternate water sources to areas with groundwater quality concerns (BOR [undated]). Where the NHPAQ or outlying smaller alluvial aquifers are not present, groundwater yields are typically low because the area is underlain by the fine-grained Pierre Shale.

Nebraska

Key Aquifers

Much of the proposed Project area in Nebraska overlies the NHPAQ system, which supplies 78 percent of the public water supply and 83 percent of irrigation water in Nebraska (Emmons and Bowman 2000). In Nebraska, the NHPAQ system includes six main hydrogeologic units, including the Tertiary Brule Formation, Arikaree Group, and Ogallala Formation, and Quaternary/Recent alluvium of the Eastern Nebraska Unit, the Platte River Valley Unit, and the Sand Hills Unit. The distribution of these aquifers in the proposed Project area is illustrated on Figure 3.3.2-4. The proposed Project would extend 274 linear miles through areas underlain by the NHPAQ system. The pipeline would immediately overlie 98 miles of the Eastern Nebraska Unit, 88 miles of the Ogallala Formation, 16 miles of the Platte River Valley Unit, and 72 miles of the Sand Hills Unit (see Figure 3.3.2-4).

In the High Plains Aquifer, which includes the NHPAQ system, hydraulic conductivity (a measurement of the rate of movement of water through a porous medium such as an aquifer at a hydraulic gradient of 1:1) ranges from 25 to 100 feet per day (ft/d) and averages 60 ft/d (Weeks et al. 1988). In general, groundwater in the High Plains Aquifer flows from west to east at a velocity (which also takes into account the hydraulic gradient, i.e., slope of the water table) of 1 ft/d (Luckey et al. 1986). The slope of the water (gradient) table will locally and regionally impact the rate that water (conductivity) will move through the aquifers, resulting in wide variation in the groundwater velocities. Should a spill or release reach groundwater, groundwater velocities will be an important consideration in determining when and if wells or springs will be impacted.

The soils of the Sand Hills Unit of the NHPAQ system are derived primarily from aeolian dune sands and are characterized by very low organic and clay/silt fractions. According to the U.S. Geological Survey (USGS), the hydraulic conductivity of the NHPAQ is relatively low, particularly in the Sand Hills north of the Platte River (Gutentag et al. 1984, Luckey et al. 1986). The aquifer material in this region is composed mainly of fine sands and silts with low hydraulic conductivity that underlie the typically unsaturated dune sands (Luckey et al. 1986).

Hydraulic conductivity estimates for the Sand Hills Unit of the NHPAQ system are variable, with a high of 50 ft/d (Gutentag et al. 1984) and a low of 10 ft/d (Bleed and Flowerday 1998). Assuming an average groundwater gradient of 0.002 in the eastern portion of the Sand Hills Unit of the NHPAQ system in Nebraska (from Bleed and Flowerday 1998), and assuming the maximum estimated hydraulic conductivity of 50 ft/d, the groundwater flow velocity in that portion of the NHPAQ system averages around 0.1 ft/d. Hydraulic conductivity is a specific property of each aquifer and describes how easily groundwater can move through an aquifer’s available pore space. Groundwater flow velocity is dependent on the gradient of the groundwater table within the aquifer and takes both this gradient or slope of the water table and hydraulic conductivity specific to the aquifer to determine the speed by which groundwater is moving through the aquifer (i.e., velocity equals hydraulic conductivity times the gradient).

Along the proposed Project area south of the Sand Hills Unit, much of the soils originate in part from glacial loess and drift deposits. The fine-grained loess deposits can be as thick as 200 feet and can locally restrict water flow where fractures are absent (Stanton and Qi 2007, Johnson 1960).

Certain areas within the Ogallala Formation of the NHPAQ system contain soils or lithologic zones that inhibit downward migration (Gurdak et al. 2009). In these areas, transport of dissolved chemicals from the land surface to the water table is slower, taking decades to centuries (Gurdak et al. 2009). Even in these areas, however, localized preferential flow paths do exist that could enable dissolved chemicals to move at an increased rate through the unsaturated zone to the water table. These units with lower permeability are more likely to be present beneath topographic depressions where precipitation or surface water collects as a result of the lower infiltration rates through these units. These areas within the Ogallala Formation of the NHPAQ system consist of geologic units composed of unconsolidated sand, gravel, clay, and silt along with layers of calcium carbonate and siliceous cementation (Stanton and Qi 2007). According to the USGS water quality report, a zone of post-deposition cementation is present in many of these areas near the top of the Ogallala Formation, creating an erosion-resistant ledge. The Ogallala Formation also contains localized ash beds. These cementation zones and ash layers would serve as localized aquitards within the Ogallala Formation and would tend to inhibit vertical migration.

The water quality in the NHPAQ system is suitable for drinking and as irrigation water, but impacts from farming operations are present in areas of shallow groundwater (Stanton and Qi 2007). In areas where crop irrigation occurs and shallow groundwater is present, elevated levels of fertilizers, pesticides, and herbicides, including nitrate and atrazine, have been reported. Concentrations of these constituents are generally higher in the near-surface groundwater (Stanton and Qi 2007).

In Keya Paha County (northern Nebraska), wells yielding 100 to 250 gpm (see Table 3.3-1) are reported drawing from the NHPAQ and alluvial aquifers present in the Keya Paha and Niobrara River valleys (Newport and Krieger 1959). The Niobrara River, which receives groundwater recharge from surrounding aquifers, is also used as a source of irrigation and municipal water supply.

In Boyd County, the proposed pipeline area is underlain by the Ogallala Formation, the aquitard Pierre Shale, and alluvial aquifers present in the Keya Paha and Niobrara River valleys. In northern Holt County and through most of Nance County, the proposed pipeline area is again underlain by the NHPAQ system (Sand Hills Unit over the Ogallala Formation). The Sand Hills Unit typically has a water table aquifer and a depth to groundwater of less than 30 feet bgs (Stanton and Qi 2007), as is reflected in the shallow aquifer inventory in Table 3.3-2. Alluvial aquifers are also present along the Elkhorn River and tributaries of the Loup River and in areas of the Sand Hills Unit, which in this area consists of mixed aeolian and fluvial deposits mantling the upper Ogallala Formation.

In southernmost Nance County, the proposed pipeline area is underlain by undivided Tertiary and Quaternary/Recent alluvial sediments of the NHPAQ system (Eastern Nebraska Unit). At the Nance/Merrick County line, the proposed pipeline area enters the Platte River alluvium, which includes alluvium accumulated in the valleys of the Platte and Loup Rivers, used for irrigation, domestic, and municipal water supply in the area.

The proposed pipeline route exits the Platte River alluvium in Polk County and re-enters the Eastern Nebraska Unit of the NHPAQ system, which is used for irrigation, domestic, and municipal water supply. The public water supply for Hordville, approximately 7 miles west of the proposed pipeline route, comes from wells screened within this aquifer at depths ranging from 160 to 262 feet bgs (Keech 1962).

From York to Jefferson counties, the depth to groundwater averages 80 feet bgs within the Eastern Nebraska Unit of the NHPAQ system (Stanton and Qi 2007). Additionally, the proposed pipeline area crosses alluvial aquifers along Beaver Creek, the West Fork of the Big Blue River, and the alluvial floodplain of the South Fork Turkey Creek.

Nearby Public Water Supply Wells and Private Water Wells

A total of 38 known PWS wells are present within 1 mile of the proposed pipeline area in Boone, York, Fillmore, Saline, and Jefferson counties. The nine SWPAs within 1 mile of the proposed pipeline area include those for the towns of St. Edward, Bradshaw, York, McCool Junction, Exeter, Western, Jansen, and Steele City, and the Rock Creek State Park. The only SWPA traversed by the proposed pipeline area in Nebraska is in Steele City, Jefferson County. A total of 14 private water wells are located within approximately 100 feet of the proposed Project corridor within Antelope, Polk, York, Fillmore, and Jefferson counties. All identified wells within 1 mile of the proposed Project corridor in Nebraska are included on Figure 3.3.2-4.

The Clarks wellhead protection area along the Platte River is described as containing 30 feet or less of shallow alluvial materials in the Platte River valley. This thin alluvial material is underlain by the Pierre Shale which acts as a confining layer for the wellhead protection area. The proposed Project is approximately 3.5 miles downgradient of the wellhead protection area.

A previous proposed Project alignment intersected the SWPA for the town of Western, Nebraska. The Western Alternative was developed to avoid the wellhead protection area near the city of Western, and the current proposed Project alignment is now located at least 0.5 mile upgradient of the Western SWPA near the city of Western.

Depth to Groundwater

Depths to groundwater reported on well logs for existing well locations within 1 mile of the proposed Project corridor in Nebraska are provided in Figure 3.3.2-4. The number of wells within 1 mile of the proposed Project corridor by groundwater depth category is as follows:

- Category A (very shallow)—296
- Category B (shallow)—93
- Category C (unclear but potentially very shallow)—114
- Category D (unclear but potentially shallow)—612
- Category E (deep)—1,283

Additionally, a USGS analysis suggests that depth to groundwater in the NHPAQ system can be variable, with depths observed ranging from 0 to 272 feet bgs (Stanton and Qi 2007). However, the median depths to groundwater in the NHPAQ units that would be crossed by the proposed Project area in Nebraska are listed for each formation:

- Ogallala Formation—110 feet bgs
- Eastern Nebraska Unit—79 feet bgs
- Sand Hills Unit—20 feet bgs
- Platte River Valley Unit—5 feet bgs

The well locations where estimated groundwater depth falls within Categories A and C can be used to estimate the distance along the proposed Project area in Nebraska where water depths less than or equal to 10 feet bgs could be encountered. These data suggest that approximately 16 miles of the proposed Project area in Nebraska could encounter groundwater at depths less than or equal to 10 feet bgs (see Figure 3.3.2-4). Most of these areas are present in the Sand Hills Unit and the Platte River Valley Unit and overlie the deeper Ogallala Formation.

Water Quality

Available water quality information for several aquifers present along the proposed Project area in Nebraska is included in Table 3.3-3. Available studies and reports indicate that, in general, water within the NHPAQ and alluvial aquifers in the state exhibit low concentrations of TDS, making the water in the shallow aquifers generally suitable for irrigation, potable, and industrial uses. Groundwater in deeper aquifers in Nebraska (GPA and WIPA) is typically moderately to highly saline and generally is not extracted for use in the vicinity of the proposed Project area.

Of the over 96,000 groundwater quality samples collected from Nebraska wells between 1974 to 2010, 33 percent contained over 10 mg/L nitrate (the federal drinking water standard), and 15 percent of the samples contained over 20 mg/L nitrate. Sample 2007 data distribution indicate that groundwater in wells along much of the proposed Project area in Nebraska contains nitrate at concentrations greater than 10 mg/L (Nebraska Department of Environmental Quality [NDEQ] 2011).

3.3.3 Surface Water

This section describes the streams and rivers the proposed Project would cross by state, including their water quality use classifications and impairments. Surface water features classified as either open water or riverine are addressed in the wetlands portion of this Final Supplemental EIS document (see Sections 3.4 and 4.4, Wetlands). Additionally, waterbodies within 10 miles[9] downstream of waterbody crossings along the proposed route are documented in Appendix D, Waterbody Crossing Tables and Required Crossing Criteria for Reclamation Facilities, for reference, as are surface drinking water supplies within 1 mile of the proposed pipeline right-of-way (ROW). Potential impacts due to ancillary features such as access roads or valve locations are described by state. A pipe yard and rail siding in North Dakota would not impact any surface water features. Spill modeling criteria for spills to surface water and related to the distance a plume may travel from the spill source are discussed in Section 4.13.3.2, Spill Propagation. This distance could be affected by the local environmental conditions present in the area surrounding the leak (e.g., if a leak occurred at the top of a hill, it could flow over a greater distance and affect more resources). Maximum buffer zones (i.e., the estimated maximum distance that oil from a spill would be expected to travel) were developed for surface waterbodies (10 miles) and stream crossings (500 feet); additional reference regarding spill propagation is available in Appendix P, Risk Assessments.

The proposed pipeline improvements include two proposed pump stations in Kansas. Analysis of preliminary facility locations indicated no significant or impaired waterbodies would be affected.

[9] Based on the analysis and modeling provided in Section 4.13, Potential Releases, a crude oil plume migration is very unlikely to travel more than 10 miles from the spill source.

3.3.3.1 Montana Surface Water

The proposed pipeline ROW would traverse a physiographic region commonly referred to as the northern Great Plains Province, which includes a glaciated section of the Missouri Plateau and is characterized by generally treeless, gently rolling terrain broken by buttes and a network of young perennial[10] and intermittent[11] streams, and small isolated mountain ranges (Wiken et al. 2011). North of the Missouri River, the proposed pipeline route traverses the southern extent of glaciation by continental ice sheets associated with the late Wisconsin stage approximately 35,000 to 11,150 years ago (Fullerton et al. 2004). The relatively young glacial terrain is characterized by ground and frontal moraines and a mosaic of small lakes (kettles) and prairie potholes. Moving southward past Fort Peck Reservoir through McCone County marks the beginning of the non-glaciated portion of the Missouri Plateau. Here, the terrain consists of more deeply entrenched stream networks cutting through mostly older sedimentary formations of the late Cretaceous and Tertiary period.

In eastern Montana, the wettest month of the year is typically June. Flooding occurs primarily in May and June when the effects of rains are multiplied by runoff from snow melt in the mountains (USGS 2012c). Flooding is sometimes caused by ice jam blockage or gorging in the winter; flash floods, triggered by large convective thunderstorms in the summer, are also typical in the area.

Waterbodies Crossed

There are 459 waterbody crossings along the proposed pipeline route in Montana, as presented in Appendix D, Waterbody Crossing Tables and Required Crossing Criteria for Reclamation Facilities, Table 1. Of the 459 crossings, nine are perennial streams, 424 are intermittent streams, 20 are canals, and six waterbodies are identified as either artificial or natural lakes, ponds, or reservoirs. Based on stream width, adjacent topography, adjacent infrastructure, best management practices, permitting, and sensitive environmental areas, four HDD constructed crossings are proposed to avoid disturbing the waterbodies listed below:

- Frenchman River in Phillips County (also known as Frenchman Creek) (approximately 135 feet wide, MP 25);
- Milk River in Valley County (approximately 100 feet wide, MP 83);
- Missouri River in Valley and McCone counties (approximately 1,000 feet wide, MP 90); and
- Yellowstone River in Dawson County; this HDD crossing includes a man-made channel tributary (30 feet), and a Yellowstone River side channel (75 feet) combined with the main Yellowstone River channel (approximately 780 feet wide, MP 198).

The remaining 454 waterbodies would be crossed using one of several non-HDD methods described in the Construction, Mitigation, and Reclamation Plan (CMRP) (see Appendix G). The crossing method for each waterbody would be depicted on construction drawings, but would ultimately be determined in consultation with MDEQ and other agencies and be based on site-

[10] A perennial stream, river, pond, or lake exhibits continuous flow in its stream bed or a volume of open water including a frozen surface all year round during periods of normal precipitation.
[11] An intermittent or seasonal stream, river, pond, or lake exists for longer periods, but not year-round and may be influenced by groundwater contributions.

specific conditions at the time of crossing. Qualified individuals,[12] including geologists or engineers, would provide modeling and analysis on behalf of the applicant and on behalf of reviewing agencies during the permitting process to ensure proper identification of channel migration zones and to further aid in selecting the appropriate crossing method, burial depth, and seasonal timing. In addition to the 459 waterbodies crossed by the proposed pipeline, six waterbodies are within the ROW but not crossed by the pipeline. Figure 3.3.3-1 illustrates the major watersheds in Montana and significant river and stream waterbodies within those watersheds that are crossed by the proposed Project. Wild and Scenic River-designated segments are shown as well.

Generally all flowing waterbodies in watersheds crossed by the proposed Project flow into or are entirely in the United States. There are transboundary watersheds that flow from headwaters in Montana through Canada and eventually back to Montana or flow from headwaters in Canada into Montana. These waterbodies are significantly upstream from and not impacted by the proposed Project. From MP 0 to MP 1, the proposed Project parallels an intermittent stream (USGS stream ID# 10050011009778) that turns east-northeast and flows into the Canadian province of Alberta. This stream is protected by the U.S./Canada Boundary Waters Treaty of 1909, Article IV. Additionally this stream is anticipated to be at low risk of spill impact from the detailed analysis of spill risk to intermittent streams based on modeling of spills to surface water and estimates of the distance a potential plume may travel from the spill source (see Section 4.13.3.2, Spill Propagation).

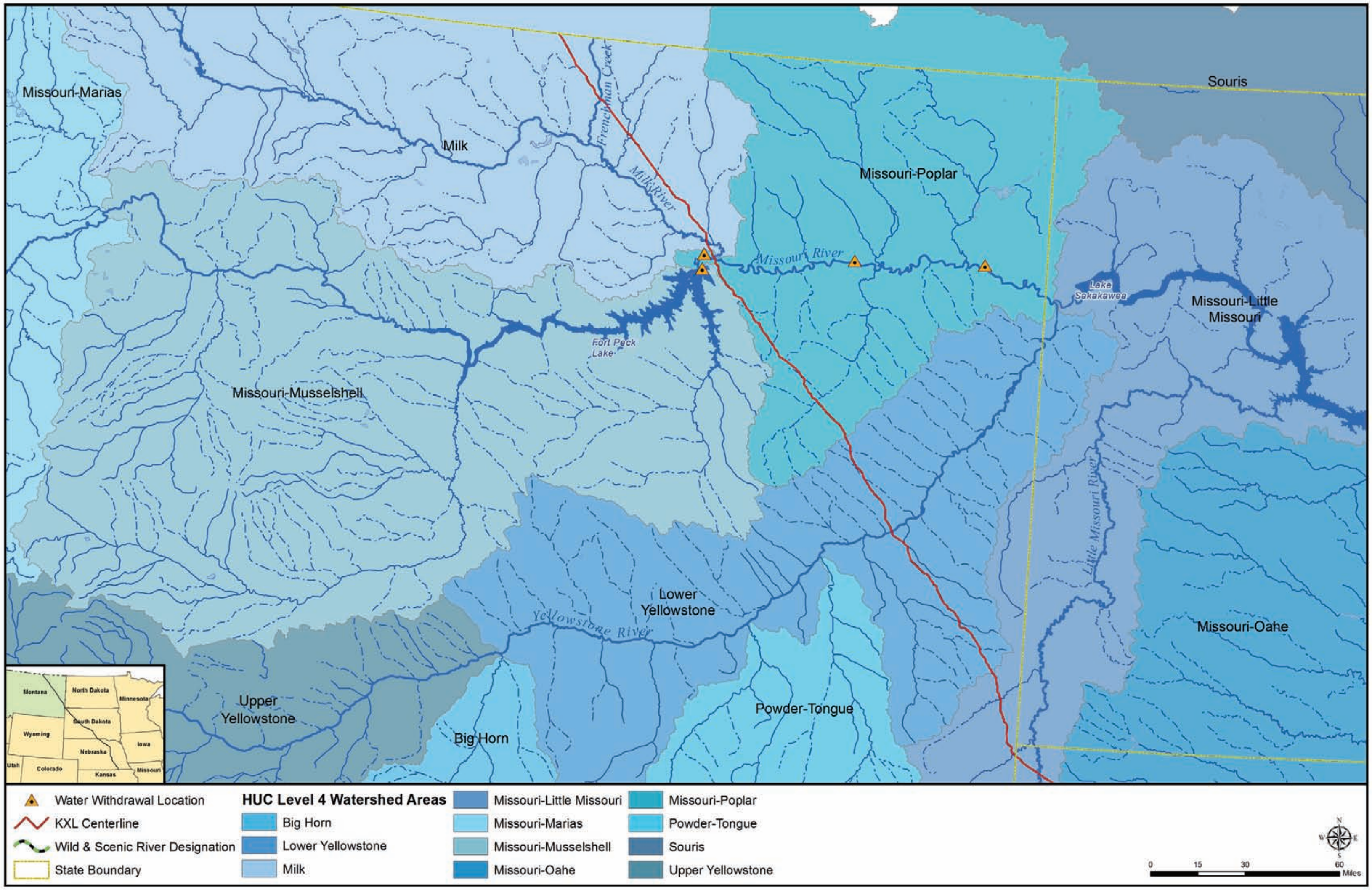
Several route variations have been proposed to either reduce impacts at a crossing or to address landowner concerns. These route variations include crossings of federally managed water distribution systems. There are six proposed BOR facility crossings anticipated for the project in Montana. Three are associated with the Milk River Project in Valley County near MP 85:

- Vandalia South Canal—Section 12, Township 27N, Range 41E (MP 86);
- Vandalia South Canal, Main Drain No. VW22—Section 12 T27N, R41E (MP 85); and
- Vandalia South Canal, Toe Drain for Lateral V-235—Section 12 T27N, R41E (MP 85).

Three are associated with the Buffalo Rapids Project in Dawson County near MP 196 and MP 197:

- Glendive Main Canal, Buffalo Rapids Unit—Section 10 Township 13N, Range 53E (MP 196);
- Glendive Main Canal, Buffalo Rapids Unit, Drain Ditch—Section 14 T13N, R53E (MP 197); and
- Glendive Main Canal, Buffalo Rapids Unit, Lateral 4.7—Section 14 T13N, R53E (MP 197).

[12] The definition of qualified personnel is in 29 CFR 1926.32(l): *Qualified* means one who, by possession of a recognized degree, certificate, or professional standing, or who by extensive knowledge, training, and experience, has successfully demonstrated his ability to solve or resolve problems relating to the subject matter, the work, or the project.



Sources: Esri 2013, USGS 2012b, MDEQ 2013, USGS 2013

Figure 3.3.3-1 Montana Watersheds Crossed by the Proposed Project Route

These facilities were reserved by the federal government by 1890 Canal Act easements (see Appendix D, Waterbody Crossing Tables and Required Crossing Criteria for Reclamation Facilities). For these crossings, Keystone would apply general design requirements consistent with BOR facility crossing criteria as specified in Appendix G, CMRP. The BOR's revised *TransCanada Keystone XL Pipeline: Required Crossing Criteria for Reclamation Facilities* document dated April 2013 is included in Appendix D, Waterbody Crossing Tables and Required Crossing Criteria for Reclamation Facilities.

Waterbodies Classifications

The proposed pipeline ROW would cross a number of streams and rivers with state water quality use descriptions based on their surface water classification or on waterbody type. There are 15 waterbodies with *Surface Water Classifications* or *Use Attainment Assessments* for the proposed route in Montana. Table 3.3-4 presents the names of these waterbodies, organized by county from north to south, and includes their state water quality use designations and use attainment assessment values (MDEQ 2012). The State of Montana has set its water quality standards as a means to define the water quality necessary to protect the defined water uses and to prevent degradation of the water resource. The primary goal is to prevent and remove pollutants; however, Montana has additional protections that are intended to prevent adverse hydrologic effects to the waters of the state.

Table 3.3-4 Streams and Rivers Crossed by Proposed Pipeline in Montana with State Water Quality Designations or Use Designations

Waterbody Name	County	Use Class Description	Use Attainment Assessment[a,b,c]			
			AqL	AG	DW	Rec
Frenchman River	Phillips	Drinking Water; Recreation; Warm Water Non-Salmonid Fishes and associated Aquatic Life; Agricultural/Industrial	P	P	F	P
Rock Creek	Valley	Non-Salmonid	ND	ND	ND	ND
Willow Creek	Valley	Non-Salmonid	ND	ND	ND	ND
Buggy Creek	Valley	Drinking Water; Recreation; Warm Water Non-Salmonid Fishes and associated Aquatic Life; Agricultural/Industrial	P	F	F	F
Cherry Creek	Valley	Drinking Water; Recreation; Warm Water Non-Salmonid Fishes and associated Aquatic Life; Agricultural/Industrial	F	F	F	F
Milk River	Valley	Drinking Water; Recreation; Warm Water Non-Salmonid Fishes and associated Aquatic Life; Agricultural/Industrial	ND	F	N	N
Missouri River	Valley	Drinking Water; Recreation; Cold Water Salmonid Fishes and associated Aquatic Life; Agricultural/Industrial	P	F	F	F
Middle Fork Prairie Elk Creek	McCone	Recreation; Warm Water Non-Salmonid Fishes and associated Aquatic Life; Agricultural/ Industrial; Degradation Prohibited	P	ND	ND	ND
East Fork Prairie Elk Creek	McCone	Recreation; Warm Water Non-Salmonid Fishes and associated Aquatic Life; Agricultural/ Industrial; Degradation Prohibited	P	ND	ND	ND
Redwater River	McCone	Recreation; Warm Water Non-Salmonid Fishes and associated Aquatic Life; Agricultural/ Industrial; Degradation Prohibited	P	ND	ND	F

Waterbody Name	County	Use Class Description	Use Attainment Assessment[a,b,c]			
			AqL	AG	DW	Rec
Yellowstone River	Dawson	Drinking Water; Recreation; Warm Water Non-Salmonid Fishes and associated Aquatic Life; Agricultural/Industrial	P	F	ND	ND
Pennel Creek	Fallon	Recreation; Warm Water Non-Salmonid Fishes and associated Aquatic Life; Agricultural/ Industrial; Degradation Prohibited	P	ND	ND	F
Sandstone Creek	Fallon	Recreation; Warm Water Non-Salmonid Fishes and associated Aquatic Life; Agricultural/Industrial; Degradation Prohibited	P	ND	ND	F
Little Beaver Creek	Fallon	Recreation; Warm Water Non-Salmonid Fishes and associated Aquatic Life; Agricultural/ Industrial; Degradation Prohibited	ND	ND	ND	ND
Boxelder Creek	Fallon	Recreation; Warm Water Non-Salmonid Fishes and associated Aquatic Life; Agricultural/ Industrial; Degradation Prohibited	ND	ND	ND	ND

Sources: USGS 2012, MDEQ 2012

[a] F = Full Support; P = Partial Support; N = Not Supporting; ND = No Data
[b] Where the Montana 2012 Integrated Report Appendix A contains a value of X and where there are no entries or blank columns, this table denotes those conditions as ND = No Data.
[c] AqL = Aquatic Life; AG = Agriculture; DW = Drinking Water; Rec = Recreation

Impaired or Contaminated Waterbodies

Contamination or impairments have been documented in nine sensitive or protected waterbodies that would be crossed by the proposed pipeline in Montana (see Appendix D, Waterbody Crossing Tables and Required Crossing Criteria for Reclamation Facilities, Table 4). Contamination in these waterbodies includes at least one of the following parameters of concern: iron, *E. coli*, lead, mercury, nitrogen (total), phosphorus (total), total Kjeldahl[13] nitrogen (TKN), TDS, dissolved solids, nitrate/nitrite (nitrite + nitrate as N). Impairments in these waterbodies include: temperature, hydrostructure flow regulation or modification, fish-passage barriers, alteration in stream-side or littoral[14] vegetative cover, chlorophyll-a, low flow alteration, and physical substrate habitat alteration. See Table 3.3-5.

Table 3.3-5 Impaired or Contaminated Waterbodies in Montana

Waterbody Name	Parameters of Concern
Middle Fork Prairie Elk Creek	Alteration in stream-side or littoral vegetative covers, nitrogen (total), phosphorus (total), physical substrate habitat alterations, TKN
East Fork Prairie Elk Creek	Alteration in stream-side or littoral vegetative covers, nitrogen (total), phosphorus (total), physical substrate habitat alterations, TKN
Missouri River	Alteration in stream-side or littoral vegetative covers, other flow regime alterations, temperature, water

[13] TKN is the sum of organic nitrogen, ammonia, and ammonium in the chemical analysis of soil or water as determined with the Kjeldahl method of analysis. This measurement is a required metric in regulatory reporting.
[14] Defined for lake shore environments as the vegetated zone that extends from the maximum water surface elevation to shoreline areas that are permanently submerged. Littoral vegetation is typically defined as emergent and anchored to the benthic strata, effective in preventing erosion.

Waterbody Name	Parameters of Concern
Frenchman River	Alteration in stream-side or littoral, vegetative covers, chlorophyll-a, low-flow alterations
Milk River	*E. coli*, lead, mercury
Yellowstone River	Fish-passage barrier
Buggy Creek	Iron
Sandstone Creek	Nitrate/nitrite (nitrite + nitrate as N), nitrogen (total)
Pennel Creek	TDS

Sources: USGS 2012a, MDEQ 2012

Water Supplies

Along the proposed pipeline ROW in Montana, municipal water supplies are largely obtained from groundwater sources and are described in Section 3.3.2, Groundwater. No intake or diversion sources for municipal surface water supplies are known to be located within 1 mile of the proposed Project ROW.

The Fort Peck Assiniboine & Sioux Rural Water Supply System (ASRWSS) operates a surface water withdrawal from the Missouri River near Poplar, Montana. The diversion is approximately 77 river miles downstream of the proposed Project crossing of the Missouri River, and it supplies raw water to the ASRWSS water treatment plant in Poplar. This system provides potable water to the Fort Peck Indian Reservation through the ASRWSS and to the residents of portions of Valley, Daniels, Sheridan, and Roosevelt counties through the Dry Prairie Rural Water Association. The ASRWSS replaces previous groundwater supplies that are no longer in use. The proposed pipeline ROW does not cross any ASRWSS-related infrastructure. The Fort Peck-Montana Compact indicates that multiple water rights and withdrawals are allotted on the Missouri River in Montana`.

There are 178 lakes, ponds, or reservoirs, located within 10 miles downstream of a proposed water crossing in Montana, which have the potential for one or all of the following uses: recreation, livestock watering, or agricultural water supply (see Appendix D, Waterbody Crossing Tables and Required Crossing Criteria for Reclamation Facilities, Table 7). Named waterbodies with a surface area in excess of 10 acres and within the 10-mile downstream range include Lindsay Reservoir and Salsbery Reservoir. Additionally, there are four waterbodies that are unnamed on the NHD with surface areas of 10 acres or larger within the 10-mile downstream range.

3.3.3.2 South Dakota Surface Water

The proposed pipeline ROW traverses the non-glaciated Missouri Plateau physiographic region of South Dakota, which is characterized by rolling plains of shale and sandstone interrupted by occasional buttes. The rolling surface of the non-glaciated Missouri Plateau has many low scarps (very steep slopes often created by erosion), indicating a geologically old landscape, in contrast to a mantle of glacial till and geologically young landscapes to the north. Some areas resemble dissected, badland terrain and deeply entrenched river breaks (Hogan 1995). Streams are mostly ephemeral[15] and intermittent with a few larger perennial rivers that cross the region from the

[15] An ephemeral stream, river, pond, or lake is that which only flows or is present for a short period following precipitation or snowmelt.

western mountains (Malo 1997). Many small impoundments along intermittent streams store surface runoff and are used for stock water and/or irrigation water and control. Non-regulated streams and rivers maintain a high sediment load of fine-grained alluvium. Natural surface water flows have been altered by man-made structures creating a significant change in the surface water characteristics. These changes may affect stream bank and bed conditions on which various habitats are based. Flooding occurs primarily in May and June, but peak flows may occur between March and July on many streams depending on seasonal fluctuations in snowpack, precipitation, temperature, and subsequent snow melt (USGS 2012b).

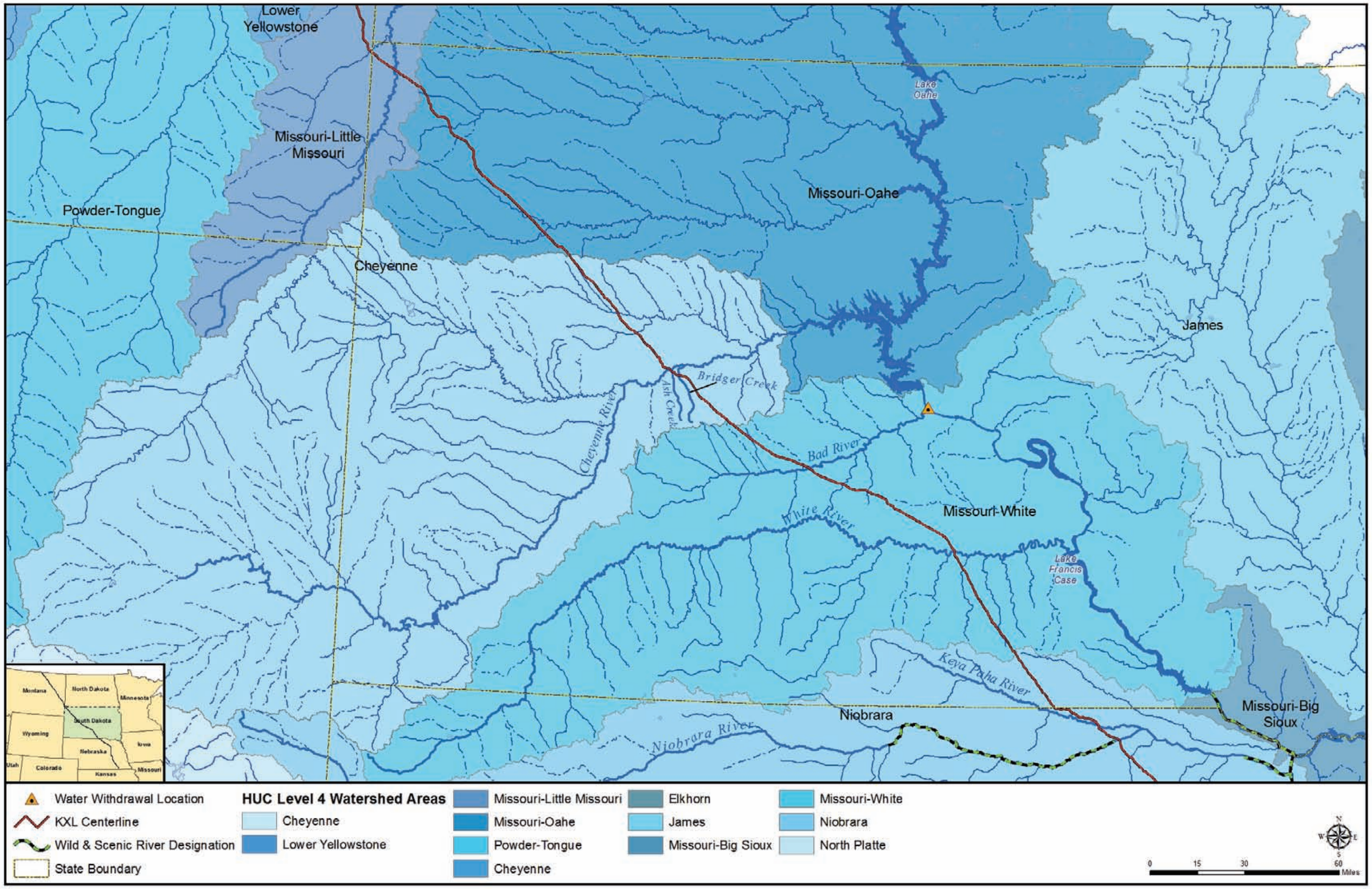
Waterbodies Crossed

There are 333 waterbody crossings along the proposed Project route in South Dakota, which includes 16 perennial streams, 313 intermittent streams, and four man-made impoundments (Appendix D, Waterbody Crossing Tables and Required Crossing Criteria for Reclamation Facilities, Table 3). Based on stream width, adjacent topography, adjacent infrastructure, best management practices, permitting, and sensitive environmental areas, five waterbodies in South Dakota would be crossed using the HDD method:

- Little Missouri River in Harding County (approximately 385 feet wide, MP 295);
- Cheyenne River in Meade and Pennington counties (approximately 1,600 feet wide, MP 430);
- Bridger Creek in Haakon County (approximately 75 feet wide, MP 434);
- Bad River in Haakon County (approximately 145 feet, MP 486); and
- White River in Lyman and Tripp counties (approximately 500 feet wide, MP 541).

The remaining 328 waterbodies would be crossed using one of several non-HDD methods described in the CMRP (see Appendix G). The crossing method for each waterbody would be depicted on construction drawings, but would ultimately be determined in consultation with the South Dakota Department of Environment and Natural Resources (SDDENR) and other agencies and be based upon site-specific conditions at the time of crossing. Qualified individuals would be involved in the permitting process to ensure proper identification of channel migration zones to further aid in selecting the appropriate crossing method, burial depth, and seasonal timing. In addition to the 333 waterbodies crossed by the centerline of the proposed Project, three waterbodies are present within the ROW for which there is no inlet or outlet indicated by the NHD; these may be potholes[16] or other similar features. Figure 3.3.3-2 illustrates the major watersheds in South Dakota and significant river and stream waterbodies within those watersheds that are crossed by the proposed Project. Wild and Scenic River-designated segments are shown as well.

[16] Potholes, also referred to as kettles, are fluvioglacial landforms resulting from blocks of ice calving from the front of a receding glacier and becoming partially to wholly buried by glacial outwash sediment. Typically these depressions fill with water on a seasonal or intermittent cycle.



Sources: USGS 2012b and 2013, Esri 2013

Figure 3.3.3-2 South Dakota Watersheds Crossed by the Proposed Project Route

The Final EIS stated that BOR water canal crossings would include one crossing in Haakon County near MP 467 and one in Jones County near MP 510 (see Appendix D, Waterbody Crossing Tables and Required Crossing Criteria for Reclamation Facilities). According to the data sources used to prepare this Final Supplemental EIS (USGS 2012), no artificial surface waterbodies would be intersected by the proposed Project for these counties. The BOR supplied a letter and revised the *TransCanada Keystone XL Pipeline: Required Crossing Criteria for Reclamation Facilities* document (dated April 2013), which is included in Appendix D, Waterbody Crossing Tables and Required Crossing Criteria for Reclamation Facilities. In the South Core Pipeline Crossing Criteria of that revision, BOR indicates a Mni Wiconi Core Pipeline crossing in Jones County. Further clarification supplied by BOR lists a total of two BOR pipeline crossings by the proposed Project that would be necessary in South Dakota:

- Oglala Sioux Rural Water System, North Coreline—Section 8 Township 2N, Range 23E (MP 472); and
- Oglala Sioux Rural Water System, South Coreline—Section 36 Township 1S, Range 29E (MP 515).

These facilities are managed by BOR through easements held in trust. Prior to construction, Keystone would consult with the canal owner/operator regarding the crossing of any canal infrastructure. Keystone would apply general design requirements consistent with canal owner/operator facility crossing criteria for all canal crossings as specified in Appendix G, CMRP.

Waterbodies Classifications

The proposed pipeline would cross 10 streams and rivers with state water quality use descriptions based on their surface water classification or waterbody type. Table 3.3-6 presents the names of these waterbodies, organized by county from north to south, and includes their state water quality designations.

Table 3.3-6 Streams and Rivers Crossed by the Proposed Pipeline in South Dakota with State Water Quality Designations or Use Designations

Waterbody Name	County	Designated Use	Use Support
Little Missouri River	Harding	Fish/Wildlife Propagation, Recreation, Stock, Irrigation Waters; Limited Contact Recreation; Warm Water Semipermanent Fish Life	Full; Full; Full; Non-supporting
South Fork Grand River	Harding	Fish/Wildlife Propagation, Recreation, Stock, Irrigation Waters; Limited Contact Recreation; Warm Water Semipermanent Fish Life	Full; Non-supporting; Full; Full
Clarks Fork Creek	Harding	Warm water Marginal Fish Life Propagation Waters; Limited Contact Recreation Waters.	Not Assessed
North Fork Moreau River	Butte	Warm water Marginal Fish Life Propagation Waters; Limited Contact Recreation Waters.	Not Assessed

Waterbody Name	County	Designated Use	Use Support
South Fork Moreau River	Perkins	Fish/Wildlife Propagation, Recreation, Stock, Irrigation Waters; Limited Contact Recreation; Warm water Marginal Fish Life	Non-supporting; Non-supporting; Full; Full
Pine Creek	Meade	Warm water Marginal Fish Life Propagation Waters; Limited Contact Recreation Waters	Not Assessed
Cheyenne River	Meade	Fish/Wildlife Propagation, Recreation, Stock; Immersion Recreation; Irrigation Waters; Limited Contact Recreation; Warm water Permanent Fish Life.	Full; Non-supporting; Full; Non-supporting; Non-supporting
Bad River	Haakon	Warm water Marginal Fish Life Propagation Waters; Limited Contact Recreation Waters	Not Assessed
Williams Creek	Jones	Fish/Wildlife Propagation, Recreation, Stock, Irrigation Waters	Insufficient Data; Insufficient Data
White River	Tripp	Fish/Wildlife propagation, Recreation, Stock; Irrigation Waters; Limited Contact Recreation; Warm water Semi-permanent Fish Life	Full; Full; Non-supporting Full

Sources: USGS 2012d, SDDENR 2012b

In addition to the streams listed in this Table 3.3-6, all streams in South Dakota are assigned the beneficial uses of fish and wildlife propagation, recreation, and stock watering (SDDENR 2012b).

Impaired or Contaminated Waterbodies

Contamination or impairment has been documented in five of these sensitive or protected waterbodies in South Dakota. Table 3.3-7 provides the names of the waterbodies and the contaminant or impairment (see also Appendix D, Waterbody Crossing Tables and Required Crossing Criteria for Reclamation Facilities, Table 6). Contamination or impairment in these waterbodies includes unacceptable levels of at least one of the following parameters: total suspended solids, total dissolved solids, salinity, specific conductance*, E. coli,* and fecal coliform.

Table 3.3-7 Impaired or Contaminated Waterbodies in South Dakota

Waterbody Name	Impairment
Little Missouri River	Suspended Solids
South Fork Grand River	Salinity and Specific Conductance
South Fork Moreau River	Total Dissolved Solids, Specific Conductance
Cheyenne River	*E. Coli* and Fecal Coliform, Total Suspended Solids
White River	*E. Coli*

Sources: USGS 2012d, SDDENR 2012b

Water Supplies

Along the proposed ROW in South Dakota, municipal water supplies are largely obtained from groundwater sources and are described in Section 3.3.2, Groundwater. No intake or diversion sources for municipal surface water supplies are known to be located within 1 mile of the proposed Project ROW.

The MWRWSS withdraws surface water from the Missouri River in Pierre, South Dakota, to provide potable water to the MWRWSS for rural water users in southwestern South Dakota. The BOR holds easements and is responsible for the protection of Indian trust assets, with which Mni Wiconi infrastructure is associated. The proposed pipeline ROW would cross Mni Wiconi water distribution infrastructure at various locations within the MWRWSS. BOR, in conjunction with its tribal partners, has specific requirements and conditions for energy pipeline crossings. Prior to construction, Keystone would consult with the water system owner/operator regarding the crossing of any water system infrastructure. Keystone would apply general design requirements consistent with BOR facility or infrastructure interfaces and crossings.

The MWRWSS intake withdraws water from the Missouri River in Pierre, South Dakota. The proposed Project route would cross several tributaries to the Missouri River with the potential to affect the Missouri River. The Cheyenne River crossing is approximately 57 river miles upstream of Lake Oahe, a reservoir on the Missouri River, and approximately 110 river miles upstream of Pierre. The Bad River crossing is approximately 44 river miles upstream of the Missouri River confluence. Spills or releases into surface waters could travel through these tributary systems and could potentially result in impacts to affect the Missouri River, aquatic habitats, as well as the MWRWSS.

Waterbodies and reservoirs located within 10 miles downstream of a proposed water crossing in South Dakota have the potential for one or all of the following uses: recreation, livestock watering, or agricultural water supply are summarized in Appendix D, Waterbody Crossing Tables and Required Crossing Criteria for Reclamation Facilities, Table 9. The larger of these waterbodies (those greater than 10 acres) include Lake Gardner and 18 other reservoirs that are unnamed on the USGS 2012 NHD. The analysis identified approximately 304 additional waterbodies located within 10 miles downstream of a proposed crossing that were less than 10 acres.

3.3.3.3 Nebraska Surface Water

The proposed pipeline ROW would enter north-central Nebraska near the edge of the northern NDEQ-identified Sand Hills Region and the northern High Plains, which are subdivisions of the Great Plains province. The High Plains are remnants of a former fluviatile (produced by rivers) plane that stretched from the Rocky Mountains to the Central Lowlands physiographic province to the east (Leighty 2001). Streams are typically overloaded with fine-grained sediment, mostly silt and sand with smaller quantities of gravel. Nebraska's rivers of the central High Plains typically flow through broad, flat valleys and deposit and rework sediments forming dynamic and unstable braided channel and transient depositional bars within relatively flat and broad valleys (Wiken et al. 2011). In northern and central Nebraska, the formation of sand dunes has taken place during the later stages of physiographic evolution. Sand dunes occur in many places in the High Plains, but mostly on the leeward sides of rivers, which derive their sand from the braided channels of local and adjacent stream channels. During periods of low water, the surface soils become dry and winds are capable of entraining and transporting loess to adjacent uplands (Leighty 2001).

The proposed pipeline would cross five major river basins in Nebraska: Niobrara, Elkhorn, Loup, Middle Platte, and the Kansas. Some of these basins may have either fully or over appropriated surface water supplies. There may be additional restrictions on surface water withdrawals for water use in the proposed Project's temporary potable water systems associated with construction camps, construction applications, and pipeline testing, all of which may require permitting.

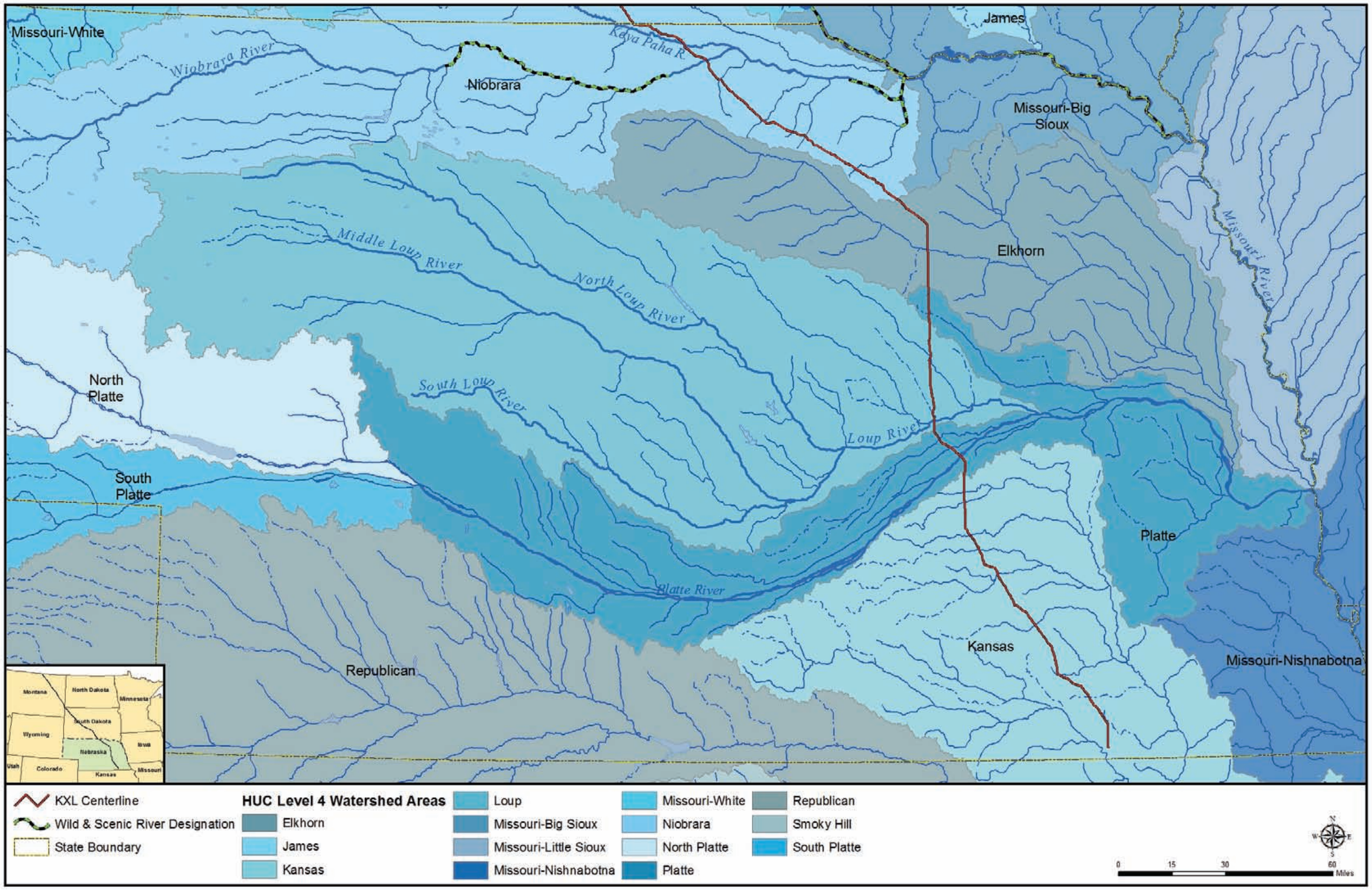
Similar to Montana and South Dakota, flooding in Nebraska typically occurs during spring (April-June); however, ice jams, rapid snowmelt, and intense rainfall have all contributed to major flooding in the recent past (USGS 2012d). Blockage of channels by ice jams in some of the larger braided rivers such as the Elkhorn and Platte are triggered by relatively abrupt weather changes in mid or late winter (Mason and Joeckel 2007), and have the potential to cause significant lateral channel migration.

Waterbodies Crossed

There are 281 waterbody crossings along the proposed Project route in Nebraska, including 31 perennial streams, 237 intermittent streams, eight canals, and five artificial or natural lakes, ponds, or reservoirs (Appendix D, Waterbody Crossing Tables and Required Crossing Criteria for Reclamation Facilities, Table 2). Based on stream width, adjacent topography, adjacent infrastructure, best management practices, permitting, and sensitive environmental areas, five rivers in Nebraska would be crossed using the HDD method:

- Keya Paha River in Boyd County (approximately 300 feet wide, MP 618);
- Niobrara River in Boyd and Holt counties (approximately 1,250 feet wide, MP 626);
- Elkhorn River in Antelope County (approximately 775 feet wide, MP 713);
- Loup River in Nance County (approximately 1,200 feet wide, MP 762); and
- Platte River in Merrick County (approximately 2,000 feet wide, MP 775).

The remaining 276 waterbodies would be crossed using one of several non-HDD methods described in the CMRP (see Appendix G). The crossing method for each waterbody would be depicted on construction drawings but would ultimately be determined based on site-specific conditions at the time of the crossing. Qualified individuals would be involved in the permitting process to ensure proper identification of channel migration zones to further aid in selecting the appropriate crossing method. In addition to the 281 waterbodies crossed by the centerline of the proposed pipeline, there are seven waterbodies within the ROW that would not be crossed by the proposed pipeline. Figure 3.3.3-3 illustrates the major watersheds in Nebraska and significant river and stream waterbodies within those watersheds that are crossed by the proposed Project. Wild and Scenic River-designated segments are shown as well.



Sources: USGS 2012b and 2013, Esri 2013

Figure 3.3.3-3 Nebraska Watersheds Crossed by the Proposed Project Route

Waterbodies Classifications

The proposed pipeline would cross a number of streams and rivers with state water quality use designations based on their surface water classification or by waterbody type. There are 40 classified streams that would be crossed by the proposed pipeline in Nebraska. Table 3.3-8 presents the names of these waterbodies, organized by county from north to south, and includes their state water quality designations.

Table 3.3-8 Streams and Rivers Crossed by Proposed Pipeline in Nebraska with State Water Quality Designations or Use Designations

Waterbody Name	County	Designated Use	Use Support/Attainment[a]
Unnamed Tributary to Buffalo Creek	Keya Paha	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Dry Creek	Keya Paha	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Wolf Creek	Keya Paha	Cold Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Spotted Tail Creek	Keya Paha	Cold Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Alkali Creek	Keya Paha	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Keya Paha River	Boyd	Primary contact Recreation; Warm Water Aquatic Live (Class A); Agricultural Water Supply; Aesthetics	Impaired; Supported; Supported; Supported
Big Creek	Boyd	Cold Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Niobrara River	Holt	Primary Contact Recreation; Warm Water Aquatic Live (Class A*); Agricultural Water Supply; Aesthetics	Impaired; Supported; Supported; Supported
Beaver Creek	Holt	Cold Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Big Sandy Creek	Holt	Primary Contact Recreation; Warm Water Aquatic Life (Class A); Agricultural Water Supply; Aesthetics	No Data; No Data; No Data; No Data
Unnamed Tributary to Brush Creek	Holt	Cold Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Brush Creek	Holt	Cold Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data

Waterbody Name	County	Designated Use	Use Support/Attainment[a]
North Branch Eagle Creek	Holt	Primary Contact Recreation; Cold Water Aquatic Life (Class B); Agricultural Water Supply; Aesthetics	No Data; No Data; No Data; No Data
Middle Branch Eagle Creek	Holt	Primary Contact Recreation; Cold Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; Supported; No Data; No Data
East Branch Eagle Creek	Holt	Cold Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Honey Creek	Holt	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Blackbird Creek	Holt	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Redbird Creek	Holt	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Unnamed Tributary to Redbird Creek	Holt	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Middle Branch Verdigre Creek	Holt	Cold Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
South Branch Verdigre Creek	Holt	Primary Contact Recreation; Cold Water Aquatic Life (Class B); Agricultural Water Supply; Aesthetics	No Data; No Data; No Data; No Data
Big Springs Creek	Antelope	Cold Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Unnamed Tributary to Big Springs Creek	Antelope	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Hathoway Slough	Antelope	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Al Hopkins Creek	Antelope	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Elkhorn River	Antelope	Primary Contact Recreation; Warm Water Aquatic Life (Class A); Agricultural Water Supply; Aesthetics	Impaired; Supported; Supported; Supported
Ives Creek	Antelope	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Beaver Creek	Boone	Primary Contact Recreation; Warm Water Aquatic Life (Class A); Agricultural Water Supply—Class A; Aesthetics	Impaired; Impaired; Supported; Supported

Waterbody Name	County	Designated Use	Use Support/Attainment[a]
Bogus Creek	Boone	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Plum Creek	Nance	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	No Data; No Data; No Data
Loup River	Nance	Primary Contact Recreation; Warm Water Aquatic Life (Class A); Agricultural Water Supply—Class A; Aesthetics	Impaired; Supported; Supported; Supported
Prairie Creek	Nance	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	Impaired; Supported; Supported
Platte River	Polk	Primary Contact Recreation; Warm Water Aquatic Life (Class A*); Agricultural Water Supply—Class A; Aesthetics	Supported; Supported; Supported; Supported
Big Blue River	Polk	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	Impaired; Supported; Supported
Lincoln Creek	York	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	Impaired; No Data; No Data
Beaver Creek	York	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	Impaired; No Data; No Data
West Fork Big Blue River	York	Primary Contact Recreation; Warm Water Aquatic Life (Class A); Agricultural Water Supply—Class A; Aesthetics	Impaired; Impaired; Supported; Supported
Turkey Creek	Fillmore	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	Supported; No Data; No Data
South Fork Swan Creek	Jefferson	Warm Water Aquatic Life (Class B); Agricultural Water Supply—Class A; Aesthetics	Supported; No Data; No Data
Cub Creek	Jefferson	Warm Water Aquatic Life (Class A); Agricultural Water Supply—Class A; Aesthetics	Supported; No Data; No Data

Sources: USGS 2012c, NDEQ 2012a and 2012b

[a] The "No Data" designation in this table represents NDEQ surface water assessment outcomes of Not Assessed for assigned beneficial uses as defined in Section 4.0 of the NDEQ 2012 Water Quality Integrated Report.

Impaired or Contaminated Waterbodies

Contamination or impairment has been documented in 2012 Water Quality Integrated Report, NDEQ, Water Quality Division, April 1, 2012, for 10 of these sensitive or protected waterbodies that would be crossed by the proposed pipeline in Nebraska. Table 3.3-9 provides the names of the waterbodies and the contaminant or impairment (see also Appendix D, Waterbody Crossing Tables and Required Crossing Criteria for Reclamation Facilities, Table 5). Contamination in these waterbodies includes unacceptable levels of at least one of the following parameters:

E. coli, dissolved oxygen, and atrazine. In some cases, the listed impairment is an impaired aquatic community.

Table 3.3-9 Impaired or Contaminated Waterbodies in Nebraska

Waterbody Name	Impairment
Keya Paha River	E. coli
Niobrara River	E. coli
Elkhorn River	E. coli
Beaver Creek	E. coli
Loup River	E. coli
Prairie Creek	Low dissolved oxygen
Big Blue River	Low dissolved oxygen, atrazine
Lincoln Creek	Impaired aquatic community
Beaver Creek	Impaired aquatic community
West Fork Big Blue River	*E. coli*, May–June atrazine, impaired aquatic community

Sources: USGS 2012c, NDEQ 2012a and 2012b

Additionally, the proposed Project would cross the central Platte River using the HDD method at MP 775. Activities associated with project in that area include water withdrawal for drilling fluids and hydrostatic testing. Water withdrawals from the Platte River would have the potential to adversely affect the river ecosystem through flow depletions. The state of Nebraska in cooperation with the U.S. Fish and Wildlife Service (USFWS) has developed plans to manage water depletions in conjunction with Section 7 Endangered Species Act consultations (USFWS 2009a). Water withdrawals that qualify as temporary uses such as hydrostatic testing would likely be consistent with the Platte River species depletions consultations *de minimus* threshold as provided by USFWS (USFWS 2009). The *de minimus* text states "temporary withdrawals of water (e.g., for hydrostatic pipeline testing) that return all the water to the same drainage basin within 30 days' time are considered to have no effect, and do not require consultation."

The NDEQ has indicated Keystone would in many cases need to secure a surface water right from Nebraska Department of Natural Resources (NDNR) to withdraw water for construction from sources along the pipeline alignment. These permits or water rights for specific use locations, purposes, and/or quantity and may include seasonal stipulations. A number of river basins or portions of rivers in Nebraska have been identified by NDNR as being either fully appropriated or over-appropriated. In these locations Keystone would need to comply with any plan or program implemented to protect existing water uses in the affected basins.

In an effort to avoid or minimize impacts to sensitive waterbodies, Keystone has conducted consultations with the cooperating agencies during the proposed Project's planning phase. Additional consultation may be required in accordance with additional regulatory and permitting review during the final design and permitting phases.

Water Supplies

Along the proposed pipeline route in Nebraska, municipal water supplies are largely obtained from groundwater and are described in Section 3.3.2, Groundwater. No intake or diversion sources for municipal surface water supplies are known to be located within 1 mile of the proposed Project ROW.

Waterbodies and reservoirs located within 10 miles downstream of a proposed water crossing in Nebraska have the potential for one or all of the following uses: recreation, livestock watering, or agricultural water supply are summarized in Appendix D, Waterbody Crossing Tables and Required Crossing Criteria for Reclamation Facilities, Table 8. The larger of these waterbodies (those greater than 10 acres) include Cub Creek Reservoir 14C, Cub Creek Reservoir 13C, Recharge Lake, Big Indian Creek Reservoir 8-E, Big Indian Creek Reservoir 10-A, and six unnamed reservoirs (unnamed according to the USGS 2012 NHD [USGS 2012b]). The analysis identified an additional 68 waterbodies or reservoirs located within 10 miles downstream of a proposed crossing that were less than 10 acres in size.

3.3.4 Floodplains

Floodplains are areas of land adjacent to rivers and streams that convey overflows during flood events. Floodwater energy is dissipated as flows spread out over a floodplain, and significant storage of floodwaters can occur through infiltration and surficial storage in localized depressions on a floodplain. Floodplains form where overbank floodwaters spread out laterally and deposit fine-grained sediments. The combination of rich soils, proximity to water, riparian forests, and the dynamic reworking of sediments during floods creates a diverse landscape with high habitat quality. Floodplains typically support a complex mosaic of wetland, riparian, and woodland habitats that are spatially and temporally dynamic.

Changing climatic and land use patterns in much of the west-central United States has resulted in region-wide incision of many stream systems. Stream systems cutting channels deeper into the surrounding floodplain cause high floodplain terraces to form along valley margins. These floodplain terraces are common along the proposed pipeline route and receive floodwaters less frequently than the low floodplains adjacent to the streams.

From a policy perspective, the Federal Emergency Management Agency (FEMA) defines floodplain as being any land area susceptible to being inundated by water from any source (FEMA 2012a). FEMA prepares Flood Insurance Rate Maps (FIRMs) that delineate flood hazard areas, such as floodplains, for communities. These maps are used to administer floodplain regulations and to reduce flood damage. Typically, these maps indicate the locations of 100-year floodplains, which are areas with a 1 percent chance of flooding occurring in any single year.

Executive Order 11988, Floodplain Management, states that actions by federal agencies are to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplain development wherever there is a practicable alternative. Each agency is to provide leadership and shall take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out its responsibilities for the following:

- Acquiring, managing, and disposing of federal lands and facilities;
- Providing federally undertaken, financed, or assisted construction and improvements; and
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.

Both state-administered and FEMA-designated floodplains as well as some undesignated floodplain areas, crossed by the proposed route in Montana, South Dakota, and Nebraska are listed in Tables 3.3-10, 3.3-11, and 3.3-12, respectively. The proposed route crosses 12 floodplains in Montana, while four are crossed in South Dakota, and 74 are crossed in Nebraska. Significant portions of the proposed route do not have FEMA or state emergency management mapping of floodplains. Pump Station 24 in Nance County Nebraska may be inaccessible during periods of flood. Most if not all access roads to Pump Station 24 cross significant flood plain areas associated with the Loup River and Prairie Creek systems; if both are experiencing flood events, Pump Station 24 could be inaccessible.

Table 3.3-10 Designated Floodplain Areas Crossed by the Proposed Pipeline Route in Montana

County	Approximate MPs	Waterbody Associated with Floodplain
Valley	59	Grass Coulee Creek
Valley	60	Spring Creek
Valley	62	Morgan Creek
Valley	60	Cherry Creek
Valley	68	Foss Coulee
Valley	70	Spring Coulee
Valley	70	Hawk Coulee
Valley	72	East Fork Cherry Creek
Valley	83-86	Milk River
Valley/McCone	90-91	Missouri River
McCone	148-149	Redwater River
Dawson	197-198	Yellowstone River

Sources: FEMA 2012b, 2011 Final EIS Table 3.3.1.3-1 (for Redwater River and Yellowstone River).

Note: Due to rounding, some waterbodies may be listed with the same milepost.

Table 3.3-11 Designated[a] Floodplain Areas Crossed by the Proposed Pipeline Route in South Dakota

County	Approximate MPs	Waterbody Associated with Floodplain
Harding	295	Little Missouri River
Meade/Pennington	430	Cheyenne River
Haakon	486	Bad River
Lyman/Tripp	541-542	White River

Source: FEMA 2012b

[a] The proposed pipeline does not cross any South Dakota state, county, or FEMA-designated floodplains. Floodplains listed denote those identified in the 2011 Final EIS and are updated with current proposed Project MP data.

Table 3.3-12 Designated Floodplain Areas Crossed by the Proposed Pipeline Route in Nebraska

County[a]	Approximate MPs	Waterbody Associated with Floodplain
Boyd	618	Keya Paha River
Boyd	621	Big Creek
Boyd	626	Niobrara
Antelope	683	Big Springs Creek
Antelope	685	Unnamed Tributary to Big Springs Creek
Antelope	708	Al Hopkins Creek
Antelope	713-714	Elkhorn River

County[a]	Approximate MPs	Waterbody Associated with Floodplain
Antelope	719	Saint Clair Creek
Boone	725	North Shell Creek
Boone	730	Unnamed Tributary to Shell Creek
Boone	731	Shell Creek
Boone	731	Unnamed Tributary to Shell Creek
Boone	731	Unnamed Tributary to Shell Creek
Boone	733	Unnamed Tributary to Shell Creek
Boone	736	Unnamed Tributary to Vorhees Creek
Boone	737	Vorhees Creek
Boone	738	Unnamed Tributary to Vorhees Creek
Boone	739	Unnamed Tributary to Vorhees Creek
Boone	739	Unnamed Tributary to Vorhees Creek
Boone	739	Unnamed Tributary to Vorhees Creek
Boone	740	Unnamed Tributary to Vorhees Creek
Boone	740	Vorhees Creek
Boone	741	Unnamed Tributary to Vorhees Creek
Boone	744	Beaver Creek
Boone	745	Unnamed Beaver Creek
Boone	746	Unnamed Beaver Creek
Boone	748-749	Bogus Creek
Boone	749	Unnamed Tributary to Bogus Creek
Boone	750-751	Unnamed Tributary to Bogus Creek
Nance	753	Unnamed Tributary to Skeedee Creek
Nance	760	Plumb Creek
Nance	760	Unnamed Tributary to Plumb Creek
Nance	761-762	Loup River
Nance	765-766	Unnamed Tributary to Prairie Creek
Nance	766	Prairie Creek
Nance	766-767	Prairie Creek
Merrick	768-769	Prairie Creek
Merrick	770-774	Silver Creek
Merrick	775	Platte River
Polk	775-776	Platte River
Polk	777	Unnamed Tributary to Platte River
Polk	785	Unnamed Tributary to Prairie Creek
Polk	786	Prairie Creek
Polk/York	789	Big Blue River
York	798	Lincoln Creek
York	801-802	Unnamed Tributary to Beaver Creek
York	803	Beaver Creek
York	810	Unnamed Tributary to West Fork Big Blue River
York	810	Unnamed Tributary to West Fork Big Blue River
York	811	Unnamed Tributary to West Fork Big Blue River
York	813	West Fork Big Blue River
Fillmore	818	Indian Creek
Fillmore	828	Unnamed Tributary to Turkey Creek
Fillmore	831	Unnamed Tributary to Turkey Creek
Fillmore	831-832	Turkey Creek
Saline	833	Unnamed Tributary to Turkey Creek
Saline	836	Unnamed Tributary to North Fork Swan Creek
Saline	837	Unnamed Tributary North Fork Swan Creek
Saline	837	Unnamed Tributary North Fork Swan Creek

County[a]	Approximate MPs	Waterbody Associated with Floodplain
Saline	838	Unnamed Tributary North Fork Swan Creek
Saline	839	Unnamed Tributary North Fork Swan Creek
Saline	840	Unnamed Tributary North Fork Swan Creek
Saline	845	Unnamed Tributary South Fork Swan Creek
Saline	846	Unnamed Tributary South Fork Swan Creek
Jefferson	848	Unnamed Tributary South Fork Swan Creek
Jefferson	848	South Fork Swan Creek
Jefferson	853	Unnamed Tributary South Fork Swan Creek
Jefferson	853	Unnamed Tributary South Fork Swan Creek
Jefferson	859	Cub Creek
Jefferson	860	Unnamed Tributary to Cub Creek
Jefferson	860	Unnamed Tributary to Cub Creek
Jefferson	861	Unnamed Tributary to Cub Creek
Jefferson	869	Unnamed Tributary to Big Indian Creek
Jefferson	871	Unnamed Tributary to Big Indian Creek

Sources: FEMA 2012b, NDNR 2012b, FIRM maps provided by Jefferson County floodplain administrator

[a] Holt County does not have any FIRMs (based on conversation with Holt Colt Planning and Zoning Officer).
Note: Due to rounding, some waterbodies may be listed with the same milepost.

The U.S. Department of the Interior (DOI), through the National Wild and Scenic River System, has a duty to protect designated river environments. The DOI has noted several potential impacts due to floodplain activities of the proposed Project. In an effort to avoid or minimize impacts to DOI assets, it is recommended that National Park Service criteria relating to Wild and Scenic Rivers be considered when designing crossings of tributaries to and upstream of the Niobrara National Scenic River and Missouri National Recreational River segments (DOI 2012). Based on resource protection requirements in the Wild and Scenic Rivers Act and related Presidential Directives, the U.S. Army Corps of Engineers and other federal agencies will, as part of their normal environmental review process, consult with the National Park Service prior to taking actions that could effectively foreclose wild, scenic, or recreational river status on rivers in the inventory.

3.3.5 Connected Actions[17]

There are three connected actions of the proposed Project, including:

- Bakken Marketlink Project;
- Big Bend to Witten 230-kilovolt Transmission Line; and
- Electrical Distribution Lines and Substations.

These connected actions would be constructed in areas similar to the proposed Project. Further discussion regarding connected actions and water resources is provided in Section 4.3.5, Connected Actions.

[17] Connected actions are those that 1) automatically trigger other actions which may require environmental impact statements, 2) cannot or will not proceed unless other actions are taken previously or simultaneously, 3) are interdependent parts of a larger action and depend on the larger action for their justification.

3.3.5.1 Bakken Marketlink Project

Construction and operation of the Bakken Marketlink Project would consist of a 16-inch pipeline approximately 5 miles in length, additional piping, booster pumps, meter manifolds, and two 250,000-barrel tanks that would be used to store crude from connecting third-party pipelines and terminals. The Bakken Marketlink Project facilities would be located within private land currently used as pastureland and hayfields.

3.3.5.2 Big Bend to Witten 230-kV Transmission Line

The Big Bend to Witten 230-kV Transmission Project is located in Lyman and Tripp counties in south-central South Dakota. The project would consist of replacing the existing Big Bend-Fort Thompson No. 2 230-kV Transmission Line Turning Structure on the south side of the Big Bend Dam on Lake Sharpe; constructing a new double-circuit 230-kV transmission line for approximately 1 mile southwest of the dam; and constructing a new Lower Brule Substation south of the dam. The existing Witten Substation would be expanded immediately to the northeast to accommodate the new 230-kV connection.

3.3.5.3 Electrical Distribution Lines and Substations

Multiple private power companies or cooperatives would construct distribution lines to deliver power to 20 pump stations located along the length of the pipeline in the United States. These distribution lines would range in length from approximately 0.1-mile to 62 miles, with the average being 13 miles long, and are estimated to extend about 377 miles combined. The distribution lines would range in capacity from 69 kV to 240 kV, but the majority would have a capacity of 115 kV. The lines would be strung on a single-pole and/or on H-frame wood poles.

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