3.1 GEOLOGY

3.1.1 Introduction

This section discusses geological resources in the proposed Project area. The description of geological 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 reroute in Nebraska. The information that is provided here builds on the information provided in the Final 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 in this section from the 2011 document:

- Revised information is presented regarding physiographic ecoregions crossed in Nebraska, as well as the number of miles crossed with potential for fossil-bearing geologic formations, fossil fuel and mineral resources, and geologic hazards;
- Additional details pertaining to geologic hazards have been documented, including information about frost line, epicenters of earthquakes relative to the proposed route, and potential for subsidence due to presence of karst geology; and
- Results of supplemental paleontological field surveys and reports conducted in 2011 and 2012 in Montana and South Dakota have been added to tables in Section 3.1.2.2.

3.1.2 Environmental Setting

3.1.2.1 Geological Resources

Montana

The proposed Project route would enter the United States at Morgan, Montana, and would traverse the Great Plains physiographic province (Fenneman 1928), which is characterized by badlands, buttes, and mesas, and includes the Black Hills mountain range. In northern Montana, the route would cross the Glaciated Missouri Plateau, which is covered in glacial deposits and represents the southern-most extent of the last ice age. In the vicinity of Circle, Montana, the proposed Project route enters the Unglaciated Missouri Plateau. Surface elevations across the proposed Project route in Montana average around 3,000 feet above mean sea level (amsl). The frost line across the proposed Project route in Montana averages between 5 to 5.7 feet below ground surface (bgs) (NOAA 1978). The route would cross six U.S. Environmental Protection Agency (USEPA) Level IV Ecoregions, each with a distinct physical geography (Omernik 2009). Table 3.1-1 presents the regional geographic characteristics within Montana.

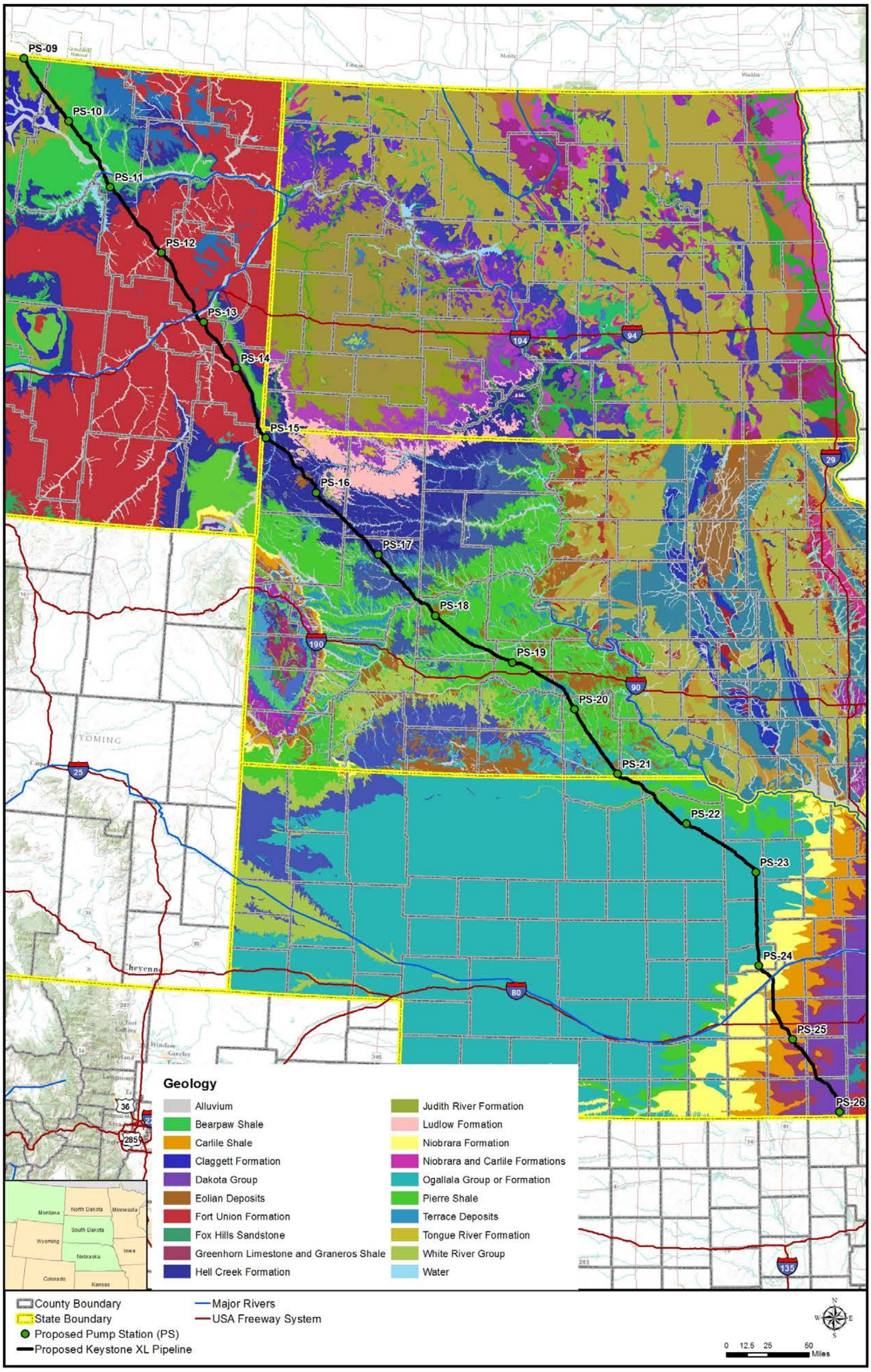
Table 3.1-1 Physiographic Characteristics of Ecoregions Crossed in Montana by the Proposed Project Route

MP Range	Physiographic Description	Elevation Range (ft[a] amsl)	Local Relief (ft)	Surface Geology	Bedrock Geology
Northwestern Glaciated Plains—Southern River Breaks[b]					
0–8	Glaciated, undulating to strongly sloping topography containing bouldery knolls, gravelly ridges, kettle lakes, and wetlands. Prominent end moraine.	2,300–3,600	50–375	Quaternary drift.	Cretaceous Bearpaw/Pierre Shale, Judith River Formation.
Northwestern Glaciated Plains—Glaciated Northern Grasslands[b]					
8–90, 110–119	Glaciated, dissected, rolling to strongly rolling drift plains.	1,990–4,000	50–600	Quaternary glacial drift deposits.	Cretaceous Bearpaw Shale, Judith River Formation, Claggett Formation, Hell Creek Formation, Fox Hills Formation, Tongue River Member of Fort Union Formation, and Flaxville Gravels.
Northwestern Great Plains—River Breaks[b]					
90–109, 194–200	Unglaciated, rugged, very highly dissected terrain adjacent to rivers.	1,900–3,450	200–500	Erodible, clayey soils; gravelly soils on slopes.	Tongue River, Lebo, Slope, and Tullock members of the Tertiary Fort Union Formation, Hell Creek Formation, Fox Hills Sandstone, and Pierre Shale.
Northwestern Great Plains—Central Grassland[b]					
109–110, 119–133, 200–248	Unglaciated, dissected rolling plains containing buttes. Areas of gravel, clinker, and salt flats. Streams are intermittent.	2,200–5,000	125–600	Quaternary terrace deposits and alluvium along channels.	Tertiary Fort Union, Hell Creek Formation, Pierre Shale.
Northwestern Great Plains—Missouri Plateau[b]					
133–194	Unglaciated rolling hills and gravel-covered benches. Some areas are subject to wind erosion.	2,000–3,550	50–500	Quaternary terrace deposits.	Tongue River and Slope members of the Tertiary Fort Union Formation, Tertiary Flaxville Gravels.
Northwestern Great Plains—Sagebrush Steppe[b]					
284–285	Unglaciated, level to rolling plains. Landscape contains buttes, badlands, scoria mounds, and salt pans.	2,300–4,200	50–600	Quaternary alluvium along channels. Upper Cretaceous sandstone and shale.	Colorado Group, Pierre Shale, Hell Creek Formation, Fox Hills Sandstone, and Fort Union Formation.

Source: Omernik 2009.

[a] feet (ft)
[b] EPA Level III-IV Ecoregion name.

Geological surface materials (see Figure 3.1.2-1) are composed of Quaternary alluvium, colluvium, and glacial till that consist of sand, gravel, and clay. Bedrock consists of Tertiary (Fort Union Formation) and Late Cretaceous-aged (Hell Creek/Fox Hills Formation, Bearpaw Formation/Pierre Shale, Judith River Formation, and Claggett Shale) rocks.



Source: USDA 2007.

Figure 3.1.2-1 Surface Geology of Proposed Project Route

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The Judith River Formation (approximately 16 miles crossed between Milepost [MP] 1 and MP 45) consists of sandstone, siltstone, mudstone, shale, and coal. The Claggett Shale (MP 39 to MP 41) consists of shale and siltstone with beds of bentonite, and the Bearpaw/Pierre Shale (approximately58 miles crossed between MP 4 and MP 90) consists of bentonitic mudstone and shale. The proposed Project route crosses the Ludlow, Tongue River, Lebo, and Tullock members of this formation. The Tongue River and Tullock members also contain thin coal beds. The Hell Creek/Fox Hills Formation (approximately 40 miles crossed between MP 91 and MP 116 and between MP 256 and MP 275) forms badland topography and consists of shale, mudstone, and lenticular coal beds. The Fort Union Formation (approximately 138 miles crossed between MP 113 and MP 286) consists primarily of sandstone, siltstone, mudstone, carbonaceous shale, and lignite. In eastern Montana, the proposed Project route would cross a major structural feature, the Williston Basin (Peterson and MacCary 1987). Regionally, the Williston Basin is a structural basin that contains sedimentary bedrock to an approximate depth of 15,000 feet bgs.

South Dakota

The proposed Pipeline route in South Dakota is located in the Unglaciated Missouri Plateau within the Great Plains physiographic province. Surface elevations range from 3,000 feet amsl in northwest South Dakota to 1,800 feet amsl in the White River Valley. The frost line across the proposed Project route in South Dakota averages between 5 to 5.7 feet bgs (NOAA 1978). The route would cross eight USEPA Level IV Ecoregions, each with a distinct physiography (Bryce et al. 1996). Table 3.1-2 presents regional physiographic characteristics in South Dakota.

Table 3.1-2 Physiographic Characteristics of Ecoregions Crossed in South Dakota by the Proposed Route

MP Range	Physiographic Description	Elevation Range (ft amsl)	Local Relief (ft)	Surface Geology	Bedrock Geology
Northwestern Great Plains—Sagebrush Steppe[a]					
285–340	Unglaciated, level to rolling plains. Landscape contains buttes, badlands, scoria mounds, and salt pans.	3,000–3,475	50–350	Quaternary alluvium along channels. Upper Cretaceous sandstone and shale.	Ludlow Member of Fort Union Formation, Hell Creek Formation and Pierre Shale.
Northwestern Great Plains—Moreau Prairie[a]					
340–390	Unglaciated, level to rolling plains. Landscape contains buttes, badlands, and salt pans.	2,100–3,200	120–250	Upper Cretaceous sandstone and shale.	Hell Creek Formation.
Northwestern Great Plains—Missouri Plateau[a]					
390–420	Unglaciated, moderately dissected level to rolling plains. Contains sandstone buttes.	1,750–3,300	50–500	Tertiary sandstone, shale, and coal.	Fox Hills Formation.
Northwestern Great Plains—Subhumid Pierre Shale Plains[a]					
435–480, 493–498, 500–540, 550–575	Unglaciated, undulating plain. Terrain contains incised, steep-sided stream channels.	1,700–2,800	50–500	Cretaceous shale.	Pierre Shale.

MP Range	Physiographic Description	Elevation Range (ft amsl)	Local Relief (ft)	Surface Geology	Bedrock Geology
Northwestern Great Plains—River Breaks[a]					
420–435, 480–493, 498–500, 540–550	Unglaciated, highly dissected hills, and uplands. Ecoregion borders major rivers, and alluvial plains.	1,300–2,700	200–500	Cretaceous shale.	Pierre Shale.
Northwestern Great Plains—Keya Paha Tablelands[a]					
575–580	Unglaciated, level to rolling sandy plains. Topography is dissected near streams.	2,250–3,600	20–800	Aeolian and alluvial sand and silt.	Ogallala Formation.
Northwestern Glaciated Plains—Ponca Plains[a]					
580–595	Unglaciated, level to gently rolling plains. Topography formed by stream drainage (preglacial).	1,900–2,350	80–140	Miocene soft sandstone and cretaceous shale.	Pierre Shale.
Northwestern Glaciated Plains—Southern River Breaks[a]					
595- 601	Unglaciated dissected hills and canyons. Topography contains slopes of high relief bordering major rivers and alluvial plains.	1,250–2,000	250–700	Cretaceous shale.	Pierre Shale.

Source: Bryce et al. 1996.

[a] EPA Level III-IV Ecoregion name.

Surficial geological materials (see Figure 3.1.2-1) are composed of Quaternary alluvium, colluvium, alluvial terraces, and aeolian deposits. The majority of bedrock in South Dakota consists of Upper Cretaceous rocks (Hell Creek/Fox Hills Formation, Pierre Shale), while Tertiary-aged rocks (Ogallala Group and Ludlow Member of the Fort Union Formation) are present beneath the proposed Project route in the southern portion of South Dakota. The Ludlow Member of the Fort Union Formation (less than 1 mile between MP 285 and 286) consists primarily of sandstone, siltstone, mudstone, carbonaceous shale, and lignite. The Hell Creek/Fox Hills Formation (MP 285 to MP 420) forms badland topography and consists of shale, mudstone, and lenticular coal beds. The Pierre Shale (MP 403 to MP 575) consists of bentonitic mudstone and shale. The Ogallala Group (MP 575 to 593) consists of well-to-poorly consolidated sandstone and conglomerate with occasional bentonite layers.

The proposed Project route would cross several major structural features in South Dakota. The Williston Basin covers northwest South Dakota and eastern Montana, as stated above (Peterson and MacCary 1987). South of the Williston Basin, the Sioux Arch is a buried ridge that extends east to west from Minnesota through southeast South Dakota (Gries 1996). South of the White River, the proposed pipeline route would cross into the Salina Basin, a sedimentary basin that underlies southern South Dakota and the majority of eastern Nebraska.

Nebraska

The majority of the proposed Project route in Nebraska lies in the High Plains portion of the Great Plains Physiographic Province. Surface elevations range from 2,200 feet amsl in northern Nebraska to 1,750 feet amsl at the Kansas state line. The frost line across the proposed Project route in Nebraska averages between 4-5 feet bgs in the northern portion of the state, and between

3-4 feet bgs in the southern portion of the state (NOAA 1978). The proposed Project route would cross nine USEPA Level IV Ecoregions, each with a distinct physiography (Chapman et al. 2001). Regional physiographic characteristics in Nebraska are presented in detail in Table 3.1-3. Geological surface materials (see Figure 3.1.2-1) consist of Tertiary-aged Ogallala Group (approximately 133 miles crossed between MP 601 and MP 760) and Cretaceous sedimentary rocks (Pierre Shale, Niobrara Formation, Carlisle Shale, Greenhorn Limestone and Graneros Shale, and Dakota Group). The Pierre Shale (approximately 26 miles crossed between MP 605 to MP 640) is exposed in Northern Nebraska and is composed of fissile clay shale, claystone, shaly sandstone, and sandy shale. This formation is prone to slumping and is especially weak where layers of volcanic ash are present. The Niobrara Formation (approximately 27 miles crossed between MP 760 and MP 801), Carlisle Shale (approximately 42 miles crossed between MP 783 and MP 845), and Greenhorn Limestone and Graneros Shale (approximately 13 miles crossed between MP 820 to MP 847) contain varying amounts of limestone that potentially contain karst formations, causing surface subsidence. The Dakota Group (approximately 35 miles crossed between MP 823 to MP 875) consists of sandstone and shale.

Table 3.1-3 Physiographic Characteristics of Ecoregions Crossed in Nebraska by the Proposed Project Route

MP Range	Physiographic Description	Elevation Range (ft amsl)	Local Relief (ft)	Surface Geology	Bedrock Geology
Northwestern Glaciated Plains—Southern River Breaks[a]					
601- 619	Unglaciated dissected hills and canyons. Topography contains slopes of high relief bordering major rivers and alluvial plains.	1,250–2,000	250–700	Cretaceous shale.	Pierre Shale.
Northwestern Great Plains—Keya Paha Tablelands[a]					
619- 625	Unglaciated, level to rolling sandy plains. Topography is dissected near streams; contains isolated gravelly buttes	1,900–2,400	20–400	Aeolian and alluvial sand and silt.	Ogallala Sandstone.
Northwestern Great Plains—Niobrara River Breaks[a]					
625–627	Unglaciated, dissected canyons. Contains slopes of high relief adjacent to river.	1,700–2,700	200–600	Sandy residuum.	Miocene soft sandstone over Pierre Shale.
Northwestern Glaciated Plains, Holt Tablelands[a]					
627–698	Unglaciated. Tablelands with directed slopes.	1,500–2,000	50–475	Eolian sand, alluvial sand and gravel, and lacustrine sand and silt.	Ogallala Sandstone.
Western Corn Belt Plains, Transitional Sandy Plain[a]					
698- 715	Level to rolling plains.	1,400-2,000	5-150	Alluvial sand, gravel and lacustrine silt and sediments.	Ogallala Sandstone.
Western Corn Belt Plains, Northeastern Nebraska Loess Hills[a]					
715- 734	Glaciated. Rolling low hills. Perennial streams.	1,100-1,900	100-300	Calcareous loess.	Ogallala Sandstone.

MP Range	Physiographic Description	Elevation Range (ft amsl)	Local Relief (ft)	Surface Geology	Bedrock Geology
Central Great Plains—Central Nebraska Loess Plains[a]					
734- 762	Rolling dissected plains with deep layer of loess. Contains perennial and intermittent streams.	1,600–3,100	50–275	Calcareous loess, alluvial sand, gravel, and lacustrine sand and silt.	Ogallala Sandstone.
Central Great Plains—Platte River Valley[a]					
762 778	Flat, wide alluvial valley. Contains shallow, interlacing streams on a sandy bed.	1,300–2,900	2–75	Alluvial, sand, silt, clay, and gravel deposits.	Quaternary and Tertiary unconsolidated sand and gravel.
Central Great Plains—Rainwater Basin Plains[a]					
778–875	Flat to gently rolling loess covered plains. Historical rainwater basins and wetlands.	1,300–2,400	5–100	Loess and mixed loess and sandy alluvium.	Ogallala Sandstone, Niobrara Formation, and Carlisle Shale.

Source: Chapman et al. 2001.

[a] EPA Level III-IV Ecoregion name.

Kansas

In Kansas, two new pump stations would be constructed along the Cushing Extension of the previously permitted TransCanada Keystone Pipeline, LP (Keystone) pipeline. These pump stations (Pump Station 27 and Pump Station 29) are located in Clay and Butler counties at Cushing Extension MP 49.7 and MP 144.5, respectively. The Flint Hills Ecoregion contains outcrops of Permian sedimentary rocks. Elevations in this area range from 1,150 to 1,400 feet amsl. Surficial materials in the vicinity of the Clay County pump station include thick deposits of loess (greater than 30 feet) (Frye and Leonard 1952). In the vicinity of the Butler County pump station, surficial deposits consist of alluvium, colluvium, and cherty gravels in upland areas (KGS 1999). Karst is not present in either of these locations (Davies et al. 1984).

North Dakota

During construction activities, a pipe yard stockpile site would be needed for on-site storage of pipes in North Dakota. The yard would be located in Bowman County. Geological surface materials in this area consist of the Tongue River Member of the Fort Union Formation and, to a lesser extent, the Niobrara and Carlile Formations. The pipe yard and rail siding are existing facilities that were previously built for other users and would be used by the proposed Project for the purpose of equipment and materials storage. The area consists primarily of sandstones, shales, and coal beds.

3.1.2.2 Paleontological Resources

Paleontological resources (fossils) are physical remains of floral and faunal species that have mineralized into or have left impressions in solid rock. The study of fossils across geological time and the evolutionary relationships between taxonomies are important elements of paleontological science. Due to the possibility of finding fossils in both surface geologic deposits, as well as in bedrock deposits of the units located along the proposed pipeline route, the

potential for the disturbance of paleontological resources during pipeline construction was evaluated (Murphey et al. 2010).

3.1.2.3 Potential Fossil-Bearing Geologic Formations

The Potential Fossil Yield Classification (PFYC) system is a survey tool developed by the Bureau of Land Management (BLM) that classifies the fossil-bearing potential of geological formations from very low (Class 1) to very high (Class 5) (BLM 1998, 2007, 2008). The PFYC system provides a baseline for predicting, assessing, and mitigating paleontological resources. The PFYC system and other BLM field survey and monitoring procedures were used to help identify the potential for the presence of important paleontological resources that could be vulnerable to disturbance from construction activities (BLM 1998, 2007, 2008).

As reported by Keystone, Montana geological formations that are designated as PFYC Class 4 (high) or PFYC Class 5 (very high) include the following:

- Judith River Formation (sporadically between MP 3.0 to MP 46.5) for vertebrates;
- Hell Creek Formation (sporadically between MP 93 to MP 117) for plants, vertebrates, and invertebrates;
- Tullock Member of the Fort Union Formation (sporadically between MP 106.8 to MP 128.0) for invertebrates and vertebrates;
- Lebo Member of the Fort Union Formation (sporadically between MP 119.7 to MP 129.0) for mammals;
- Tongue River Member of the Fort Union Formation (MP 129.0 to MP 200.9; MP 203.6 to MP 240.7) for plants, mammals, and mollusks; and
- Ludlow Member of the Fort Union Formation (occurs sporadically between MP 200.9 to MP 285) for mammals.

As reported by Keystone, South Dakota geological formations that are designated as PFYC Class 4 (high) or PFYC Class 5 (very high) include the following:

- Ludlow Member of the Fort Union Formation (MP 285 to MP 286) for mammals, plants, and invertebrates, and
- Hell Creek Formation (MP 285 to MP 390) for reptiles (including dinosaurs) and mammals.

At the time of this report, no field survey reports were available to verify PFYC designations in Nebraska. However, based on the PFYC system, the following formations in Nebraska have fossil potential and are designated as PFYC Class 3 (moderate or unknown), 3a (moderate potential), and 5 (very high); there were no formations along the proposed pipeline route designated 4 (high):

- Upper Cretaceous Pierre Shale (Classes 3a and 5), Niobrara (Class 5), Carlisle (Class 3), Greenhorn Limestone (Classes 3 and 5), and Graneros Shale Formations (Classes 3 and 5) (sporadically between MP 604 to MP 846) for plants, trace fossils, ammonites, gastropods, bivalves, mosasaurs, fish, mollusks, sea turtles, plesiosaurs, pterosaurs, and sharks;

- Tertiary (Miocene and Pliocene) Ogallala Group (Class 5) (occurs sporadically from MP 610 to MP 759) for horses, rhinoceroses, proboscideans, mammoths, and other ruminants. Pleistocene unconsolidated sediments also contain mammoth fossil potential; and
- Lower Cretaceous Dakota Group (Class 3) (occurs sporadically from MP 822 to MP 875) for invertebrates (mollusks, insects), flowering plants, and rare vertebrates (fragmentary dinosaurs and fish).

Field Surveys

The approach undertaken to evaluate paleontological resources was dependent upon the requirements of individual state regulatory bodies. In Montana, South Dakota, and Nebraska, paleontological research was performed using museum records and current U.S. Geological Survey (USGS) information. In Montana and South Dakota, field surveys were also conducted along the proposed Project route, potential reroutes, access roads, and at proposed ancillary facility locations (e.g., access roads, pump stations, and construction camps) on federal, state, and privately owned lands where site access was available, to identify the presence of exposed and visible surface fossils and potentially fossiliferous outcrops of bedrock. Montana and South Dakota have specific regulatory requirements involving paleontological resources, and required field surveys were conducted in 2008 and 2010 following BLM guidelines (BLM 2007, 2008). Additional field surveys were conducted in 2011 and 2012 in Montana and South Dakota to assess the minor route modifications to the proposed pipeline in these two states. Reports of the field studies conducted in 2012 are pending. A paleontological analysis of the proposed pipeline route in Nebraska is ongoing. Field surveys for Nebraska are proposed and are tentatively scheduled to begin Fall 2012/Spring 2013.

Paleontological resources identified during surveys along the proposed Project corridor were classified using BLM guidelines as follows:

- Significant Fossil Localities (SFL) are those localities containing specimens that are field identifiable, of outstanding preservation, or otherwise scientifically significant.
- Non-significant Fossil Occurrences (NFO) are those localities that typically consist of highly weathered or unidentifiable bone or tooth fragments, unidentifiable plant fossils, fossils of common occurrence (such as turtle shell), or fragments of silicified wood.

Montana surveys were conducted consistent with existing BLM and State of Montana regulations and Montana Department of Environmental Quality requirements using BLM guidelines (BLM 2007, 2008). Prior to field surveys, background research was completed at the Montana State Historic Preservation Office to identify potential surface exposures of fossiliferous formations. The field methodology consisted of pedestrian surveys of PFYC 4/5 geologic units along the proposed Project right-of-way (ROW) on BLM and state lands and on private lands where access was granted. PFYC 3 geologic units were spot-checked. In PFYC 1 and 2 areas, geologic maps and aerials were used to identify potential fossil-bearing rock outcrops. The survey area generally included a 300-foot-wide corridor (150 feet on either side of centerline). The access road survey area included a 100-foot-wide corridor (50 feet on either side of centerline). The survey area buffer for the ancillary facilities (e.g., access roads, pump stations, and construction camps) was variable, depending on the facility. A total of 30.9 acres of PFYC Class 3 geologic units and 97.4 acres of PFYC Class 5 geologic units were included in the survey in Montana. An additional 42.8 acres of PFYC Class 2 geologic units were surveyed

because these represent areas that had to be walked in order to reach PFYC Classes 3 through 5 units (SWCA 2012).

South Dakota surveys were conducted consistent with South Dakota Public Utilities Commission and South Dakota State Land Commission requirements using BLM guidelines (BLM 2007, 2008). Prior to field surveys, background research was completed at the South Dakota Museum of Geology and at the South Dakota School of Mines and Technology to determine any surface exposure of potentially fossiliferous formations. The field methodology consisted of pedestrian surveys of PFYC 4/5 geologic units along the proposed Project ROW on BLM and state lands and on private lands where access was granted. PFYC 3 geologic units were spot-checked. In PFYC 1 and 2 areas, geologic maps and aerials were used to identify potential fossil bearing-rock outcrops. Table 3.1-4 identifies field surveys conducted in Montana and South Dakota.

Table 3.1-4 Paleontological Surveys and Reports

Date of Report	Date(s) of Survey	State	Title
October 28, 2008	July 14-22, 2008; August 15-26, 2008	Montana	Paleontological Assessment of BLM Lands along the Steele City Segment of the Keystone XL Project, Montana
May 26, 2009	July 14-22, 2008; August 15-26, 2008	Montana	Paleontological Assessment of BLM Lands along the Steele City Segment of the Keystone XL Project, Montana: Addendum 1
April 23, 2010	July 14-22, 2008; August 15-26, 2008	Montana	Paleontological Assessment of BLM Lands along the Steele City Segment of the Keystone XL Project, Montana: Addendum 2
September 20, 2010	May 17, 2010–August 27, 2010	Montana	Paleontological Survey Report: BLM Lands along Steele City Segment of the Keystone XL Project, Montana: Addendum 3
September 20, 2010	May 17, 2010–August 27, 2010	Montana	Paleontological Survey Report: State Lands along Steele City Segment of the Keystone XL Project, Montana
September 20, 2010	May 17, 2010–August 27, 2010	Montana	Paleontological Survey Report: Private Lands along Steele City Segment of the Keystone XL Project, Montana
March 2, 2012	June 9-23; July 7-12; October 4-13	Montana	Paleontological Survey Report: Federal Lands along the Keystone XL Project, Montana
March 2, 2012	June 9-23; July 7-12; October 4-13	Montana	Paleontological Survey Report: Private Lands along the Keystone XL Project, Montana: Addendum 1
March 2, 2012	June 9-23; July 7-12; October 4-13	Montana	Paleontological Survey Report: State and County Lands along the Keystone XL Project, Montana
TBD	June 28, 2012–August 8, 2012	Montana	Titles Pending Report Completion
April 23, 2010	None given	South Dakota	Paleontological Assessment of BLM Lands along the Steele City Segment of the Keystone XL Project, South Dakota
April 23, 2010	September 9-22, 2009, September 28, 2009–October 3, 2009	South Dakota	Paleontological Assessment of State Lands along the Steele City Segment of the Keystone XL Project, South Dakota
September 3, 2010	Through June 25, 2010	South Dakota	Paleontological Survey Report: State Lands along Steele City Segment of the Keystone XL Project, South Dakota

Date of Report	Date(s) of Survey	State	Title
September 3, 2010	Through July 10, 2010	South Dakota	Paleontological Survey Report: Private Lands along Steele City Segment of the Keystone XL Project, South Dakota-Volume 1
September 3, 2010	Through July 10, 2010	South Dakota	Paleontological Survey Report: Private Lands along Steele City Segment of the Keystone XL Project, South Dakota-Volume 2
November 22, 2010	August 5-November 6, 2010	South Dakota	Paleontological Survey Report Addendum: State and Harding Lands along the Keystone XL Project, South Dakota
November 22, 2010	August 5-November 6, 2010	South Dakota	Paleontological Survey Report Addendum: Private Lands along the Keystone XL Project, South Dakota
March 2, 2012	June 20, 2011	South Dakota	Paleontological Survey Report: BLM Lands along the Keystone XL Project, South Dakota: Addendum 1
March 2, 2012	June 7-20, 2011; October 15-26, 2011	South Dakota	Paleontological Survey Report: Private Lands along the Keystone XL Project, South Dakota: Addendum 3
March 2, 2012	June 7-20, 2011; October 15-16, 2011	South Dakota	Paleontological Survey Report: State and County Lands along the Keystone XL Project, South Dakota: Addendum 2
To be determined	June 28, 2012 – July 31, 2012	South Dakota	Titles Pending Report Completion

There is a possibility of finding fossils in both surface geologic deposits, as well as in bedrock deposits of the units located along the proposed Pipeline route in Nebraska. All of the surface deposits along the alignment are from the Quaternary Period, the most recent of the Cenozoic Era. As indicated above, paleontological surveys are scheduled to begin in the Fall 2012/Spring 2013 and are not available. If the results of the surveys become available during the preparation of the Final SEIS, they would be incorporated in final report.

Field Survey Results

The paleontological surveys identified 27 SFL and 40 NFO sites in Montana and four SFL and 21 NFO sites in South Dakota (Table 3.1-5). Information is pending on sites in Nebraska and will be included in the Final Supplemental EIS, as available.

Table 3.1-5 Paleontological Resources Identified Along Proposed Project Corridor in Montana and South Dakota

State	Ownership	Parcel	Fossil Type	SFL/NFO	Geology	Recommendation[c]
MT[a]	State	ML-MT-VA-00190	Vertebrate, Invertebrate	SFL	Claggett	Monitor
MT	State	ML-MT-MC-00158	Plant	SFL	Fort Union	Monitor
MT	BLM	ML-MT-MC-00010	Invertebrate	SFL	Bear Paw	Monitor
MT	BLM	PS09-MT-PH10160	Vertebrate	SFL	Judith River	Avoidance
MT	BLM	ML-MT-MC-00010	Invertebrate	SFL	Bearpaw	Spot-check
MT	BLM	ML-MT-MC-00010	Invertebrate	SFL	Bearpaw	Spot-check
MT	BLM	ML-VT-VA-00155	Vertebrate	SFL	Judith River	Monitor
MT	BLM	ML-MT-MC-00010	Invertebrate	SFL	Bearpaw	Spot-check

State	Ownership	Parcel	Fossil Type	SFL/NFO	Geology	Recommendation[c]
MT	BLM	ML-MT-MC-00233	Vertebrate	SFL	Hell Creek	Monitor
MT	BLM	ML-MT-MC-00233	Vertebrate	SFL	Hell Creek	Monitor
MT	BLM	ML-MT-MC-00233	Vertebrate	SFL	Hell Creek	Monitor
MT	BLM	ML-MT-MC-00233	Vertebrate	SFL	Hell Creek	Monitor
MT	BLM	ML-MT-MC-00233	Vertebrate	SFL	Hell Creek	Monitor
MT	BLM	ML-MT-MC-00233	Vertebrate	SFL	Hell Creek	Monitor
MT	BLM	ML-MT-MC-00233	Vertebrate	SFL	Hell Creek	Monitor
MT	BLM	ML-MT-MC-00233	Vertebrate	SFL	Hell Creek	Monitor
MT	BLM	ML-MT-MC-00233	Vertebrate	SFL	Hell Creek	Monitor
MT	BLM	ML-MT-MC-00233	Vertebrate	SFL	Hell Creek	Monitor
MT	BLM	ML-MT-MC-00260	Vertebrate	SFL	Fort Union	Monitor
MT	BLM	Ml-MT-PR-00140	Vertebrate	SFL	Fort Union	Monitor
MT	Private	ML-MT-MC00100	Vertebrate	SFL	Hell Creek	Avoidance
MT	Private	ML-MT-MC-00100	Vertebrate	SFL	Hell Creek	Surface collect & monitor
MT	Private	ML-MT-MC-00100	Vertebrate	SFL	Hell Creek	Surface collect & monitor
MT	Private	ML-MT-MC-00195	Vertebrate	SFL	Hell Creek	Surface collect & monitor
MT	Private	ML-MT-MC-00400	Plant	SFL	Fort Union	Monitor
MT	Private	ML-MT-FA-00560	Vertebrate	SFL	Fort Union	Surface collect & monitor
MT	Private	MTV16-MT-FA-00040	Vertebrate	SFL	Hell Creek	Avoidance
MT	BLM	ML-MT-PH_00120	Invertebrate	NFO	Bear Paw	Monitor
MT	BLM	ML-MT-PH-00145	Invertebrate	NFO	Bear Paw	Monitor
MT	BLM	ML-MT-VA-00265	Invertebrate	NFO	Bear Paw	Monitor
MT	BLM	ML-MT-MC-00142	Vertebrate	NFO	Hell Creek	Monitor
MT	BLM	ML-MT-MC-00010	Invertebrate	NFO	Bear Paw	Monitor
MT	BLM	ML-MT-MC-00010	Invertebrate	NFO	Bear Paw	Spot-check
MT	BLM	PS09-MT-PH-10100	Invertebrate	NFO	Claggett	Spot-check
MT	BLM	ML-MT-MC-00010	Vertebrate	NFO	Fort Union	Monitor
MT	BLM	ML-MT-PR-165	Plant	NFO	Bearpaw	Monitor
MT	BLM	ML-MT-PH-00105	Invertebrate	NFO	Bearpaw	Spot-check
MT	BLM	ML-MT-PH-00105	Invertebrate	NFO	Bearpaw	Spot-check
MT	BLM	ML-MT-PH-00105	Invertebrate	NFO	Bearpaw	Spot-check
MT	BLM	ML-MT-VA-00135	Invertebrate	NFO	Bearpaw	Spot-check
MT	BLM	ML-MT-VA-00135	Invertebrate	NFO	Bearpaw	Spot-check
MT	BLM	ML-MT-VA-00155	Invertebrate	NFO	Judith River	Monitor
MT	BLM	ML-MT-VA-00185	Plant	NFO	Judith River	Monitor
MT	BLM	ML-MT-VA-00355	Invertebrate	NFO	Bearpaw	Spot-check
MT	BLM	ML-MT-VA-00355	Invertebrate	NFO	Bearpaw	Spot-check
MT	BLM	ML-MT-VA-00355	Invertebrate	NFO	Bearpaw	Spot-check
MT	BLM	ML-MT-MC00010	Invertebrate	NFO	Bearpaw	Spot-check
MT	BLM	ML-MT-MC00010	Invertebrate	NFO	Bearpaw	Spot-check
MT	BLM	ML-MT-MC00010	Invertebrate	NFO	Bearpaw	Spot-check
MT	BLM	ML-MT-MC00010	Invertebrate	NFO	Bearpaw	Spot-check
MT	BLM	ML-MC-MC-00233	Vertebrate	NFO	Hell Creek	Monitor
MT	BLM	ML-MC-MC-00233	Vertebrate	NFO	Hell Creek	Monitor
MT	BLM	ML-MC-MC-00233	Vertebrate	NFO	Hell Creek	Monitor
MT	BLM	ML-MC-MC-00233	Vertebrate	NFO	Hell Creek	Monitor

State	Ownership	Parcel	Fossil Type	SFL/NFO	Geology	Recommendation[c]
MT	BLM	ML-MT-MC-00260	Vertebrate	NFO	Fort Union	Monitor
MT	BLM	ML-MT-MC-00260	Vertebrate, Plant	NFO	Hell Creek	Monitor
MT	Private	MTV1-MT-MC-00320	Vertebrate	NFO	Judith River	Monitor
MT	Private	MTV1-MT-PH-00310	Invertebrate	NFO	Claggett	Monitor
MT	Private	ML-MT-VA-00015	Invertebrate	NFO	Judith River	Monitor
MT	Private	ML-MT-MC-00100	Plant	NFO	Hell Creek	Monitor
MT	Private	ML-MT-MC-00109	Vertebrate	NFO	Hell Creek	Monitor
MT	Private	ML-MT-MC-00106	Plant	NFO	Hell Creek	Monitor
MT	Private	ML-MT-MC-00100	Vertebrate	NFO	Hell Creek	Monitor
MT	Private	ML-MT-FA-00040	Plant	NFO	Fort Union	Monitor
MT	Private	ML-MT-FA-00720	Vertebrate	NFO	Hell Creek	Monitor
MT	Private	Ml-MT-FA-00730	Vertebrate	NFO	Hell Creek	Monitor
MT	Private	ML-MT-PR-00070	Plant	NFO	Fort Union	Monitor
MT	BLM	080720-GEK-01	Vertebrate	SFL	Fort Union	Not Available
MT	Private	100602-MHM-01	Plant, Vertebrate	SFL	Hell Creek	Not Available
MT	Private	100602-SLJ-01	Vertebrate	SFL	Hell Creek	Not Available
MT	State of Montana	100605-WLS-01	Plant	SFL	Fort Union	Not Available
MT	Private	100607-WLS-01	Plant	SFL	Fort Union	Not Available
MT	Private	100609-AMS-01	Vertebrate	SFL	Fort Union	Not Available
MT	BLM	100824-AMS-02	Invertebrate	NFO	Bearpaw	Not Available
MT	Private	F1-100602-01	Plant	NFO	Hell Creek	Not Available
MT	Private	F1-100603-01	Vertebrate	NFO	Hell Creek	Not Available
MT	Private	F1-100603-02	Plant	NFO	Hell Creek	Not Available
MT	BLM	F1-100604-01	Vertebrate	NFO	Hell Creek	Not Available
MT	Private	F1-100715-01	Plant	NFO	Fort Union	Not Available
MT	BLM	F13-090826-01	Invertebrate	NFO	Claggett	Not Available
MT	BLM	F2-080714-01	Invertebrate	NFO	Bearpaw	Not Available
MT	BLM	F2-080714-03	Invertebrate	NFO	Bearpaw	Not Available
MT	BLM	F2-080716-01	Invertebrate	NFO	Bearpaw	Not Available
MT	BLM	F2-080716-02	Invertebrate	NFO	Bearpaw	Not Available
MT	BLM	F2-080716-03	Invertebrate	NFO	Bearpaw	Not Available
MT	Private	F5-110609-01	Plant	NFO	Fort Union	Not Available
MT	Private	F5-110610-01	Plant	NFO	Fort Union	Not Available
MT	Private	F5-120706-01	Plant	NFO	Fort Union	Not Available
MT	Private	F5-120731-01	Invertebrate	NFO	Pierre	Not Available
MT	Private	F5-120731-02	Invertebrate	NFO	Pierre	Not Available
MT	Private	F5-120801-01	Invertebrate	NFO	Pierre	Not Available
MT	BLM	080715-GEK-01	Vertebrate	SFL	Judith River	Not Available
MT	BLM	080717-GEK-01	Invertebrate	SFL	Bearpaw	Not Available
MT	BLM	080718-GEK-01	Vertebrate	SFL	Hell Creek	Not Available
MT	BLM	080718-GEK-02	Vertebrate	SFL	Hell Creek	Not Available
MT	BLM	080718-GEK-03	Vertebrate	SFL	Hell Creek	Not Available
MT	BLM	080718-GEK-04	Vertebrate	SFL	Hell Creek	Not Available
MT	BLM	080718-LSB-01	Vertebrate	SFL	Hell Creek	Not Available
MT	BLM	080718-PCM-01	Vertebrate	SFL	Hell Creek	Not Available
MT	BLM	080718-PCM-02	Vertebrate	SFL	Hell Creek	Not Available

State	Ownership	Parcel	Fossil Type	SFL/NFO	Geology	Recommendation[c]
MT	BLM	080718-PCM-03	Vertebrate	SFL	Hell Creek	Not Available
MT	BLM	080719-LSB-01	Vertebrate	SFL	Hell Creek	Not Available
MT	BLM	080722-GEK-01	Vertebrate	SFL	Hell Creek	Not Available
MT	BLM	080722-GEK-02	Vertebrate	SFL	Hell Creek	Not Available
MT	BLM	080818-GEK-01	Plant, Vertebrate	SFL	Hell Creek	Not Available
MT	BLM	080818-GEK-02	Vertebrate	SFL	Hell Creek	Not Available
MT	BLM	080821-PCM-01	Invertebrate	SFL	Bearpaw	Not Available
MT	BLM	090508-WLS-01	Invertebrate	SFL	Bearpaw	Not Available
MT	BLM	090826-PCM-01	Vertebrate	SFL	Judith River	Not Available
MT	State of Montana	100522-GEK-01	Invertebrate, Vertebrate	SFL	Claggett	Not Available
MT	Private	100602-SLJ-02	Vertebrate	SFL	Hell Creek	Not Available
MT	Private	100605-SLJ-01	Vertebrate	SFL	Hell Creek	Not Available
MT	Private	100609-AMS-02	Vertebrate	SFL	Hell Creek	Not Available
MT	Private	F1-100519-01	Vertebrate	NFO	Judith River	Not Available
MT	Private	F1-100521-01	Invertebrate	NFO	Claggett	Not Available
MT	Private	F1-100521-02	Trace	NFO	Judith River	Not Available
MT	BLM	F1-100528-01	Invertebrate	NFO	Bearpaw	Not Available
MT	Private	F1-100528-02	Invertebrate	NFO	Bearpaw	Not Available
MT	BLM	F1-100529-01	Invertebrate	NFO	Bearpaw	Not Available
MT	Private	F1-100603-03	Vertebrate	NFO	Hell Creek	Not Available
MT	Private	F1-100720-01	Vertebrate	NFO	Hell Creek	Not Available
MT	Private	F1-100720-02	Vertebrate	NFO	Hell Creek	Not Available
MT	Private	F1-100819-01	Plant	NFO	Fort Union	Not Available
MT	BLM	F1-100824-01	Invertebrate	NFO	Bearpaw	Not Available
MT	USDI BLM	F1-111006-01	Invertebrate	NFO	Bearpaw	Not Available
MT	USDI Fish and Wildlife Service	F1-111006-02	Invertebrate	NFO	Bearpaw	Not Available
MT	USDI Fish and Wildlife Service	F1-111006-03	Vertebrate	NFO	Bearpaw	Not Available
MT	Fallon County	F1-111013-01	Invertebrate	NFO	Fort Union	Not Available
MT	BLM	F13-090827-01	Invertebrate	NFO	Bearpaw	Not Available
MT	BLM	F2-080714-02	Invertebrate	NFO	Bearpaw	Not Available
MT	BLM	F2-080715-01	Invertebrate	NFO	Bearpaw	Not Available
MT	BLM	F2-080715-02	Invertebrate	NFO	Bearpaw	Not Available
MT	BLM	F2-080715-03	Invertebrate	NFO	Judith River	Not Available
MT	BLM	F2-080715-04	Plant	NFO	Judith River	Not Available
MT	BLM	F2-080717-01	Invertebrate	NFO	Bearpaw	Not Available
MT	BLM	F2-080717-02	Invertebrate	NFO	Bearpaw	Not Available
MT	BLM	F2-080717-03	Invertebrate	NFO	Bearpaw	Not Available
MT	BLM	F2-080717-04	Invertebrate	NFO	Bearpaw	Not Available
MT	BLM	F2-080718-01	Vertebrate	NFO	Hell Creek	Not Available

State	Ownership	Parcel	Fossil Type	SFL/NFO	Geology	Recommendation[c]
MT	BLM	F2-080718-02	Vertebrate	NFO	Hell Creek	Not Available
MT	BLM	F2-080718-03	Vertebrate	NFO	Hell Creek	Not Available
MT	BLM	F2-080719-01	Vertebrate	NFO	Fort Union	Not Available
MT	BLM	F2-080719-02	Vertebrate	NFO	Hell Creek	Not Available
MT	BLM	F2-080722-01	Vertebrate	NFO	Hell Creek	Not Available
MT	BLM	F2-080818-01	Plant	NFO	Hell Creek	Not Available
MT	BLM	F2-080818-02	Vertebrate	NFO	Hell Creek	Not Available
MT	BLM	F2-080818-03	Vertebrate	NFO	Hell Creek	Not Available
MT	BLM	F3-080816-01	Vertebrate	NFO	Judith River	Not Available
MT	BLM	F3-080816-02	Vertebrate	NFO	Judith River	Not Available
MT	BLM	F3-080816-03	Vertebrate	NFO	Judith River	Not Available
MT	BLM	F3-080816-04	Vertebrate	NFO	Judith River	Not Available
MT	BLM	F3-080817-01	Invertebrate	NFO	Claggett	Not Available
MT	Private	F5-120629-01	Invertebrate	NFO	Judith River	Not Available
MT	Private	F5-120728-01	Invertebrate	NFO	Fort Union	Not Available
MT	Private	F5-120801-02	Invertebrate	NFO	Pierre	Not Available
MT	BLM	F9-090507-01	Vertebrate	NFO	Bearpaw	Not Available
SD[b]	Private	ML-SD-ME-00150	Vertebrate	SFL	Hell Creek	Surface collect & monitor
SD	Private	CAR-041	Vertebrate	SFL	Hell Creek	Surface Collect & monitor
SD	Private	CAR-041	Vertebrate	SFL	Hell Creek	Surface collect & monitor
SD	Private	ML-SD-PE-00360	Vertebrate	SFL	Hell Creek	Surface collect & monitor
SD	Private	CAR-048A	Vertebrate	NFO	Hell Creek	Monitor
SD	Private	CAR-048A	Vertebrate	NFO	Hell Creek	Monitor
SD	Private	ML-SD-ME-00230	Vertebrate	NFO	Hell Creek	Monitor
SD	Private	CAR-041	Vertebrate	NFO	Hell Creek	Monitor
SD	Private	CAR-041	Plant	NFO	Hell Creek	Monitor
SD	Private	CAR-041	Vertebrate	NFO	Hell Creek	Monitor
SD	Private	ML-SD-HA-01780	Vertebrate	NFO	Hell Creek	Monitor
SD	Private	ML-SD-HA-01780	Vertebrate	NFO	Hell Creek	Monitor
SD	Private	ML-SD-PE-00430	Vertebrate	NFO	Hell Creek	Monitor
SD	Private	ML-SD-PE-00360	Vertebrate, Plant	NFO	Hell Creek	Monitor
SD	Private	ML-SD-HK-11767	Invertebrate	NFO	Pierre Shale	Monitor
SD	Private	ML-SD-JO-10060	Invertebrate	NFO	Pierre Shale	Monitor
SD	Private	ML-SD-TR-11630	Vertebrate, Trace	NFO	Ogallala	Monitor
SD	State	PS-15	Plant	NFO	Fort Union	Monitor
SD	State	ML-SD-HA-13020	Vertebrate	NFO	Hell Creek	Monitor
SD	State	ML-SD-HA-13020	Vertebrate	NFO	Hell Creek	Monitor
SD	State	ML-SD-PE-00410	Vertebrate, Plant	NFO	Hell Creek	Monitor
SD	State	ML-SD-PE-00410	Vertebrate	NFO	Hell Creek	Monitor

State	Ownership	Parcel	Fossil Type	SFL/NFO	Geology	Recommendation[c]
SD	State	ML-SD-PE-00330	Vertebrate	NFO	Hell Creek	Monitor
SD	State	ML-SD-PE-00330	Vertebrate	NFO	Hell Creek	Monitor
SD	State	ML-SD-PE-00330	Vertebrate	NFO	Hell Creek	Monitor
SD	State	ML-SD-HA-02400	Vertebrate	NFO	Hell Creek	Monitor
SD	State	ML-SD-HA-02870	Vertebrate	NFO	Hell Creek	Monitor
SD	State	ML-SD-HA-03310	Vertebrate	NFO	Hell Creek	Monitor
SD	State	PS15-SD-HA-00335	Vertebrate	NFO	Hell Creek	Monitor
SD	State	PS16-SD-HA-10012	Plant	NFO	Hell Creek	Monitor
SD	State	PS16-SD-HA-10012	Vertebrate	NFO	Hell Creek	Monitor
SD	State	PS16-SD-HA-10014	Vertebrate	NFO	Hell Creek	Monitor
SD	Private	090910-BHIA-006	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	090910-BHIA-007	Plant, Vertebrate	NFO	Hell Creek	Not Available
SD	Private	090910-BHIB-002	Plant, Vertebrate	NFO	Hell Creek	Not Available
SD	Private	090917-BHIB-001	Vertebrate	SFL	Hell Creek	Not Available
SD	Private	100526-SML-01	Vertebrate	SFL	Hell Creek	Not Available
SD	Private	F0-100514-01	Vertebrate	NFO	Hell Creek	Not Available
SD	South Dakota School and Public Lands	F0-100526-04	Vertebrate	NFO	Hell Creek	Not Available
SD	Harding County	F0-101028-01	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	F0-101101-01	Vertebrate	NFO	Hell Creek	Not Available
SD	State of South Dakota	F0-101101-02	Vertebrate	NFO	Hell Creek	Not Available
SD	State of South Dakota	F1-090922-01	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	F4-110617-01	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	F6-120712-01	Vertebrate, Plant	NFO	Hell Creek	Not Available
SD	Private	F6-120712-02	Vertebrate, Plant	NFO	Hell Creek	Not Available
SD	Private	090909-BHIA-001	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	090909-BHIA-002	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	090909-BHIB-001	Vertebrate	SFL	Hell Creek	Not Available
SD	Private	090909-BHIB-002	Vertebrate	NFO	Quaternary	Not Available
SD	Private	090909-BHIB-003	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	090910-BHIB-003	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	090910-BHIB-004	Vertebrate	SFL	Hell Creek	Not Available
SD	Private	090911-BHIB-001	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	090911-BHIB-002	Vertebrate	SFL	Hell Creek	Not Available
SD	Private	090912-BHIA-011	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	090912-BHIA-012	Vertebrate	SFL	Hell Creek	Not Available
SD	Private	090912-BHIA-013	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	090930-LSB-01	Vertebrate	SFL	Hell Creek	Not Available
SD	Private	090930-LSB-02	Vertebrate	SFL	Hell Creek	Not Available
SD	Private	090930-LSB-03	Vertebrate	SFL	Hell Creek	Not Available
SD	Private	100515-DAH-01	Vertebrate	SFL	Hell Creek	Not Available

State	Ownership	Parcel	Fossil Type	SFL/NFO	Geology	Recommendation[c]
SD	Private	101104-TWT-01	Plant, Vertebrate	SFL	Hell Creek	Not Available
SD	Private	101105-TWT-01	Vertebrate	SFL	Hell Creek	Not Available
SD	Private	101105-TWT-02	Vertebrate	SFL	Hell Creek	Not Available
SD	Private	F0-100514-02	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	F0-100515-01	Vertebrate	NFO	Hell Creek	Not Available
SD	Harding County	F0-100517-01	Plant	NFO	Hell Creek	Not Available
SD	Private	F0-100518-01	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	F0-100519-03	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	F0-100519-04	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	F0-100522-01	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	F0-100605-01	Invertebrate	NFO	Pierre	Not Available
SD	Private	F0-100607-01	Invertebrate	NFO	Pierre	Not Available
SD	Private	F0-100622-01	Vertebrate	NFO	Ogallala	Not Available
SD	Private	F0-101103-01	Plant	NFO	Hell Creek	Not Available
SD	Private	F3-090930-01	Plant, Vertebrate	NFO	Hell Creek	Not Available
SD	Private	F3-090930-02	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	F3-090930-03	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	F3-090930-04	Vertebrate	NFO	Hell Creek	Not Available
SD	Private	F3-090930-05	Vertebrate	SFL	Hell Creek	Not Available
SD	Private	F4-110617-02	Plant	NFO	Hell Creek	Not Available
SD	Private	F4-110712-01	Vertebrate	SFL	Hell Creek	Not Available
SD	Private	F6-120629-01	Invertebrate	NFO	Pierre	Not Available
SD	Private	F6-120629-02	Invertebrate	NFO	Pierre	Not Available
SD	Private	F6-120705-01	Invertebrate	NFO	Pierre	Not Available
SD	Private	F6-120705-02	Invertebrate	NFO	Pierre	Not Available
SD	Private	F6-120713-01	Plant	NFO	Hell Creek	Not Available
SD	Private	090912-BHIA-014	Vertebrate	SFL	Hell Creek	Not Available

[a] Montana (MT)
[b] South Dakota (SD)
[c] Monitor—refers to the monitoring of excavations during construction to identify the presence of completely buried subsurface fossils; Spot-check—refers to the periodic on-site spot-checking of impacts to significant fossils during construction activities; Avoidance—refers to the complete avoidance of disturbance to the fossil-bearing unit of potential impact.

3.1.2.4 Fossil Fuel and Mineral and Resources

Montana

In the proposed Project area, oil, natural gas, and coal comprise the major fossil fuel resources (Montana Bureau of Mines and Geology 1963). There are nine oil and gas producing wells within one-quarter mile (1,320 feet) of the proposed ROW (Appendix L, Oil and Gas Wells Within 1320 ft of Proposed Right-of-Way). These Bakken crude oil wells are associated with the Williston Basin. The proposed Project route spans the Williston Basin through much of the state of Montana. The proposed Project route does not cross any coal (lignite) mines.

Sand, gravel, and bentonite are the principal mineral resources mined near the proposed Project route (Montana Bureau of Mines and Geology/USGS 2004), although the proposed Project route would not cross any aggregate mines. In the past, bentonite has been mined and processed south of the proposed Project route near Glasgow; however, bentonite is not currently being mined or processed in the proposed Project area (Montana Bureau of Mines and Geology/USGS 2004).

South Dakota

In the proposed Project area, sand and gravel comprise the major mineral resources, although little active mining is occurring (South Dakota Geological Survey/USGS 2005). One gravel pit is present approximately 0.5 miles from the proposed Project route, northeast of MP 554. The proposed pipeline route would traverse the Buffalo Field, an oil and gas producing area in Hardin County. Fifteen oil and gas producing wells are located within one-quarter mile of the proposed ROW (Appendix L, Oil and Gas Wells Within 1320 ft of Proposed Right-of-Way).

The proposed pipeline route would not cross any known coal mines. The proposed pipeline route would cross approximately 2 miles of coal-bearing formations (Fort Union Formation and Hell Creek Formation), but the potential for mining of these formations is low. According to the South Dakota State Historical Society, coal mining has never been a major industry in the state (South Dakota State Historical Society 2012).

Nebraska

There are no known active oil, natural gas, or coal mining operations along the proposed pipeline route in Nebraska. The main mineral resource in the proposed Project area is aggregate (sand and gravel) used for road and building construction. There are five active sand and/or gravel mining operations within 1 mile of the proposed Project route, which are situated in Keya Paha, Holt, and Jefferson counties. In southern Nebraska, near the proposed Project route, shales and clays have been mined for producing bricks. Near Tobias in Salina County, limestone has been mined for agricultural lime.

3.1.2.5 Geologic Hazards

At certain locations along the proposed Project route, seismic hazards and the potential for landslides, land subsidence, or flooding are possible.

Seismic Hazards

Seismic hazards include faults, seismicity, and ground motion hazards. Collectively, these three phenomena are associated with seismic hazard risk. Faults are defined as a fracture along which blocks of earth materials on either side of the fault have moved relative to each other. An active fault is one in which movement has taken place within the last 10,000 years (USGS 2008b). Seismicity refers to the intensity and the geographic and historical distribution of earthquakes. Ground motion hazards are defined as movement of the earth's surface as a result of earthquakes (USGS 2008a). According to the Federal Emergency Management Agency (FEMA) earthquake hazard zone maps, the entire proposed Project area is located in a low-risk earthquake zone. Historic earthquake activity in the vicinity of the proposed Project route was also reviewed using USGS's National Earthquake Information Center online database search. Records were available from 1973 to the present time. A map showing significant earthquakes occurring in the vicinity of the project area between 1973 and 2012 is provided as Figure 3.1.2-2. Based on this map of significant earthquakes, the majority of the epicenters in the immediate vicinity of the proposed pipeline route have historically been between 25 and 100 miles away from the proposed pipeline route. In general, for the largest magnitude earthquakes experienced in this part of the Western United States, significant impacts have historically been felt within a 120 mile radius. Shocks may be felt up to 200 miles away (USGS 2012).

Minor faults are present in the vicinity of the proposed pipeline route. In Montana, the Brockton-Froid Fault is mapped in the Weldon-Brockton fault zone approximately 50 miles east of the proposed Project route in Roosevelt County, just north of Culbertson, Montana (Wheeler 1999). Based on exploration and field data, there is no indication that this is an active fault (Wheeler 1999). Eastern Montana historically contains little earthquake activity. From 1973 to 2007, 14 earthquakes have been recorded in the eastern half of Montana with magnitudes 4.1 or less (USGS 2008b). Eight of these earthquakes are in the vicinity of the proposed Project area, as depicted on Figure 3.1.2-2. In South Dakota, 30 earthquakes with magnitudes 4.3 or less have been recorded since 1973 (USGS 2008b). None of the earthquakes occurred along or adjacent to the proposed Project route.

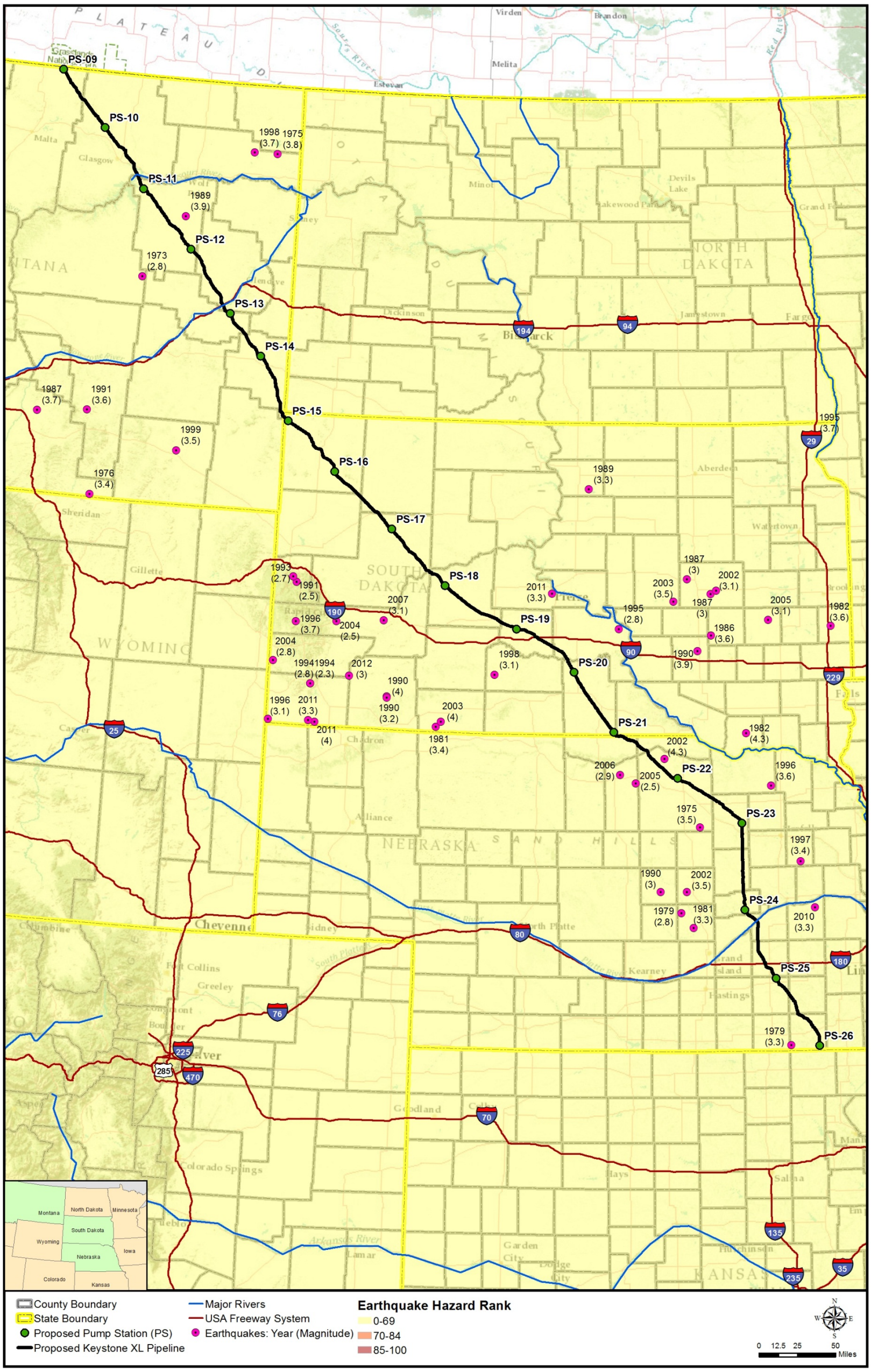
In the proposed Project area of eastern Nebraska, 12 earthquakes have been recorded since 1973, with magnitudes ranging from 2.5 to 4.3 (USGS 2012). These earthquakes are believed to be associated with either the Humboldt fault zone or deep-seated faults in the Salinas Basin. There are no active surficial faults along the proposed Project route; therefore, a low seismic hazard risk is anticipated (Crone and Wheeler 2000, USGS 2006).

Landslides

According to the classification of landslide slope movements, the widely accepted terms describing landslides include fall, topple, slide, spread, and flow. These slide classifications can be further modified with the descriptive terms *extremely rapid, very rapid, rapid, moderate, slow, very slow, and extremely slow* (Turner and Schuster 1996). The potential for an extremely rapid to rapid slide to occur is increased in areas that contain steep slopes (>20 percent grade); however, only approximately 4 miles of the terrain crossed by the proposed Project route contain steep slopes. Most of these steep sections are less than 0.1 mile in length and correspond to stream crossing locations. For this reason, it is unlikely that steep slopes would be the cause of any extremely rapid to rapid landslides in the vicinity of the proposed Pipeline route.

Landslides typically occur on steep terrain during conditions of partial or total soil saturation, or during seismic shaking. Given the low likelihood of a significant seismic event along the proposed Pipeline route, the earthquake-induced landslide potential is low.

Stream erosion and undercutting or undermining topography during the construction of roads or other structures can also cause instability leading to increased landslide potential. FEMA developed a landscape hazard ranking system (LSHR) that relies on existing data for swelling clays, landslide incidence, landslide susceptibility, and land subsidence. Using these criteria, the LSHR places landscapes into three general risk categories: low hazard, medium hazard, and high hazard. Areas along the proposed Project route that are within the FEMA LSHR high general risk category are summarized by state in Table 3.1-6.



Sources: FEMA, USGS Earthquake Hazards Program.

Figure 3.1.2-2 Seismic Hazards

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Table 3.1-6 Locations within LSHR High-Risk Category along the Proposed Project Corridor

State	Start (MP)	End (MP)	Length (miles)
Montana	0.2	25.5	25.3
Montana	25.5	89.2	63.7
Montana	89.2	102.0	12.8
South Dakota	308.3	313.5	5.2
South Dakota	355.6	358.1	2.5
South Dakota	358.1	370.9	12.8
South Dakota	389.5	425.9	36.4
South Dakota	425.9	426.3	0.4
South Dakota	426.3	485.1	58.8
South Dakota	485.1	525.2	40.1
South Dakota	525.2	537.1	11.9
South Dakota	537.1	571.5	34.4
Nebraska	601.5	605.3	3.8
Nebraska	606.8	637.5	30.7
Total			338.8

Sources: USGS 2009; PHMSA-NPMS 2007.

Low, medium, and high hazard areas are depicted on Figure 3.1.2-3. According to this ranking system, a total of 338.8 miles of the terrain crossed by the proposed Project have a high hazard risk for landslide potential due to erosion or undercutting.

In addition to steep terrain, certain formations are susceptible to increased landslide potential due to the makeup of the soil and/or geological materials. Along the proposed Project route, the Claggett, Bearpaw, Pierre Shale, Fort Union shales, and Hell Creek Formation may contain appreciable amounts of bentonite. Bentonite is soft, plastic, light-colored clay that expands when exposed to water and may cause soil and/or geologic formations to become unstable. Cretaceous and Tertiary rocks in the Missouri River Plateau have the potential for slumping due to high clay content. Along the proposed Project route, potentially unstable soils or geologic formations are present at the Missouri River, Willow Creek, Keya Paha River, and Niobrara River crossings. Additionally, the Montana Department of Environmental Quality has expressed concern about areas where slopes greater than 15 percent occur overlying Cretaceous shales. There are approximately 5 miles of sloping areas greater than 15 percent along the proposed Project route in Montana; roughly 0.6 miles in Phillips County; 1.7 miles in Valley County; 2.2 miles in McCone County; and 0.5 miles in Fallon County.

In summary, the following conditions that provide some potential for landslides are present along the proposed Pipeline route:

- Steep slopes (>20% grade)—low potential;
- Earthquake-induced landslide—low potential;
- Stream erosion and undercutting topography—low, medium, and high hazard areas are present along the proposed Project route; and
- Soil and geological makeup—potentially unstable soils or geologic formations are present at four river crossings along the proposed Project route.

Subsidence

Subsidence hazards along the proposed Pipeline route would most likely be caused by the presence of karst geology. National karst maps were reviewed to determine areas of potential karst terrain along the proposed Project area. The potential karst terrain was defined as fissures, tubes, and caves generally less than 1,000 feet long and less than 50 feet in vertical extent in gently dipping to flat-lying beds or carbonate rock beneath an overburden of noncarbonate material 10 to 200 feet thick (USGS-US National Atlas 2009). The National Atlas indicates that limestone areas with potential for karst features exist in Nebraska (see Table 3.1-7); however, because there are no appreciable limestone areas in Nebraska, it is unlikely that karst features would be encountered. Further, a professor at the University of Nebraska-Lincoln has unequivocally stated that there is an absence of karst geology in the state; while there are enlarged joints in Pennsylvanian and Cretaceous limestones, no caves, sinkholes, or other similar features exist. Therefore, there would be no karst features that might provide a hazard to the proposed Project in Nebraska (Joeckel 2012).

Table 3.1-7 Limestone Areas Crossed by the Proposed Project Corridor with the Potential for Karst Features

Location	Start (MP)	End (MP)	Length (miles)
Nance County, NE	759	767	8.0
Merrick County, NE	767	775	8.0
Polk County, NE	775	781	6.0
Polk County, NE	788	789	1.0
York County, NE	789	801	12.0
Proposed Project Total			**35.0**

Source: USGS—US National Atlas 2009.

Floods

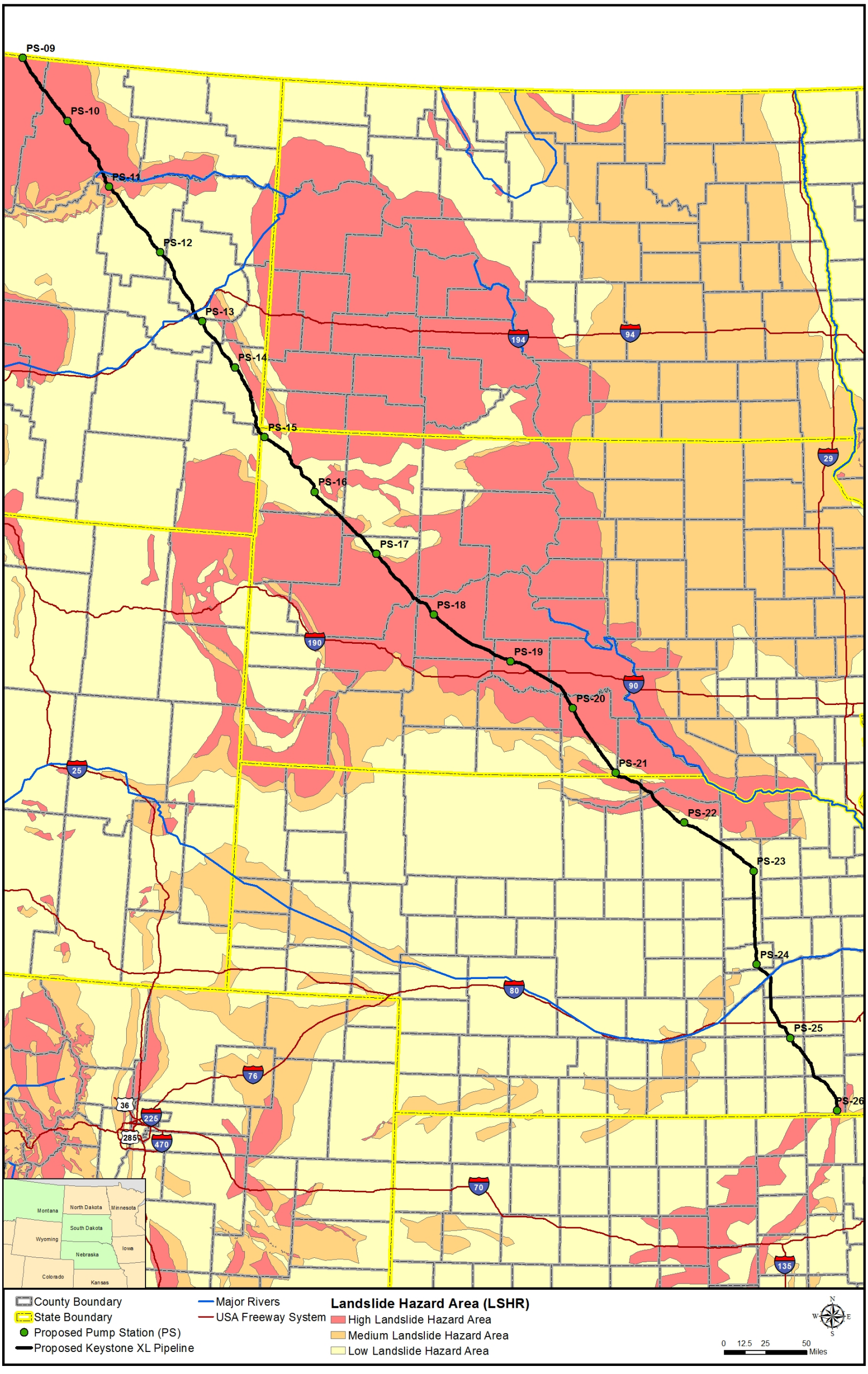
In general, seasonal flooding occurs in areas where the proposed Pipeline would cross active stream and river channels. In addition, the proposed Pipeline route could be subject to flash flooding in channels or intermittent drainages. Areas along the proposed Pipeline route that are classified by FEMA as being in a high flood risk category include Montana (23 miles); South Dakota (23 miles), and Nebraska (17 miles) (see Figure 3.1.2-4).

3.1.3 Connected Actions

This section describes the baseline conditions for geological, paleontological, fossil fuel, and mineral resources, as well as geologic hazards, affected by actions connected to the proposed Project.

3.1.3.1 Bakken Marketlink Project

The Bakken Marketlink Project would involve the construction of on-ramp facilities in Fallon County, Montana, including an approximately 5-mile-long pipeline, metering systems, three new storage tanks near Baker, Montana, and two new storage tanks within the boundaries of the proposed Cushing, Oklahoma tank farm. Geological surface materials and resources encountered within a 5-mile radius of the proposed pipeline route are similar to those described in Section 3.1.2.1, Geological Resources.



Source: FEMA.

Figure 3.1.2-3 Landslide Hazard Areas

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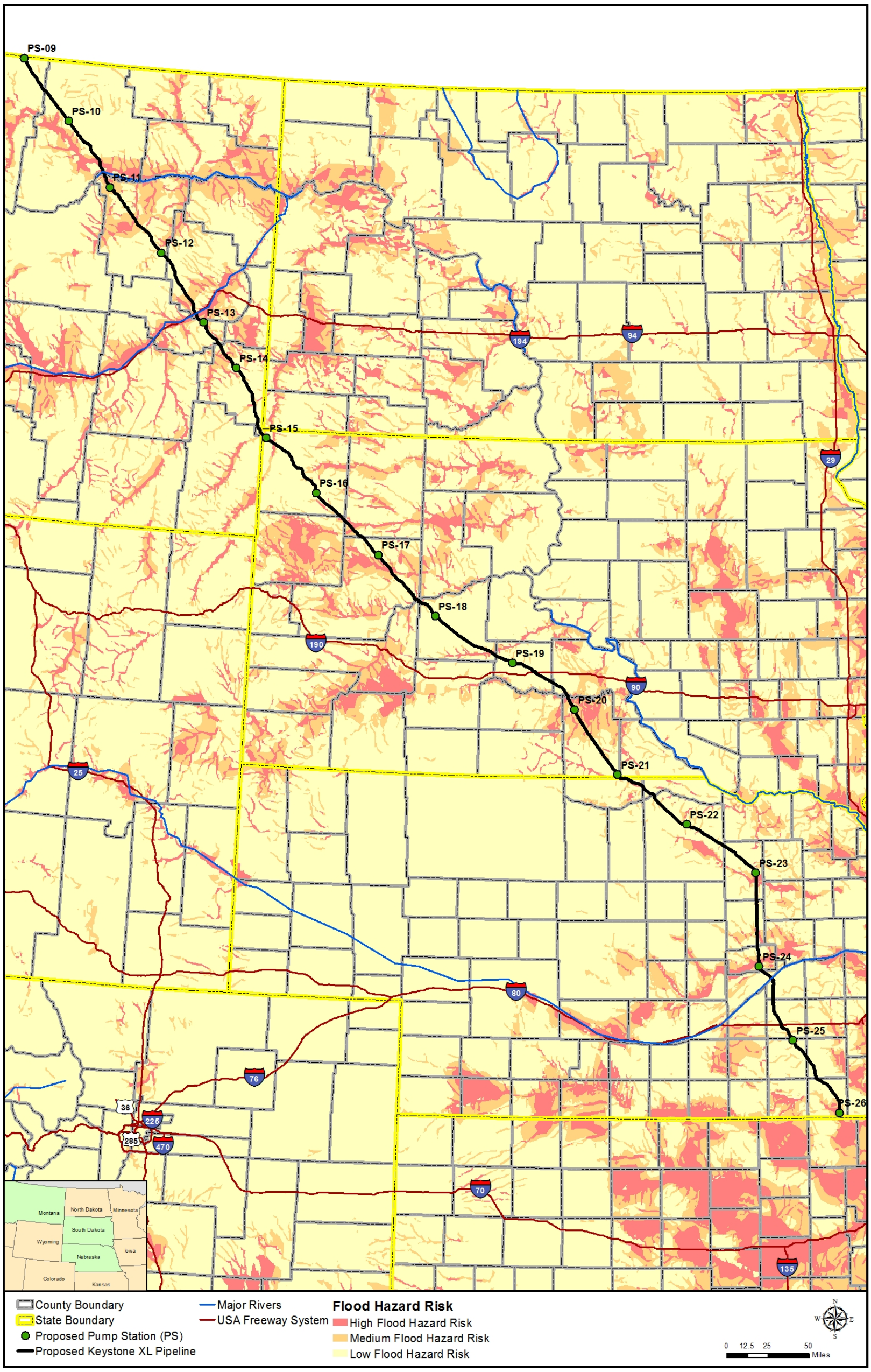

Source: FEMA.

Figure 3.1.2-4 Flood Hazard Areas

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Similar to the proposed pipeline route itself, the Bakken Marketlink Project would cross a major structural feature, the Williston Basin, which is a structural basin that contains approximately 15,000-foot-deep sedimentary rock. The majority of the connected Project would be located within the Fort Union Formation, which consists primarily of sandstone, siltstone, mudstone, carbonaceous shale, and lignite. The Fort Union Formation is known to contain PFYC Class 4 and 5 fossil-bearing members. The potential for geologic hazards in this vicinity is generally low, with the exception of an increased risk of landslides towards the outer reaches of the 5-mile-long Bakken Marketlink pipeline (see Figure 3.1.2-3).

3.1.3.2 Big Bend to Witten 230-kV Transmission Line

The Western Area Power Administration determined that a 230-kilovolt (kV) transmission line approximately 70 miles long would be required to ensure system reliability within the Western Area Power Administration power grid given the power requirements for Pump Stations 20 and 21 in the Witten, South Dakota area. Geological surface materials in the vicinity of the Big Bend to Witten line consist of eolian deposits and terrace deposits, as well as the Ogallala Formation and Pierre Shale. No PFYC Class 4 or PFYC Class 5 paleontological resources were identified via field surveys along the proposed route adjacent to the Big Bend to Witten line. This connected Project is not expected to disturb high fossil-bearing formations. Similarly, the connected Project is not expected to cross areas with fossil fuel or mineral resources, or any active mine operations. The potential for seismic activity and geologic hazards such as landslides, land subsidence, or flooding is similar in nature to that found along the proposed route in south-central South Dakota. The potential for geologic hazards is generally low in south-central South Dakota.

3.1.3.3 Electrical Distribution Lines and Substations

The proposed Project would require electrical service from local power providers for pump stations and other aboveground facilities in Montana, South Dakota, and Nebraska. In Montana, approximately 136 miles of new 115-kV electrical distribution lines would be required to be constructed along with approximately 159 miles in South Dakota. Although the precise locations of pump stations and transmission lines in Nebraska have not yet been determined, the total estimated length of distribution lines in Nebraska is 70 miles. In Kansas, approximately 14 miles of distribution lines would be constructed. In general, the transmission lines would be constructed in the vicinity of the proposed route. As such, the same geological resources and hazards discussed previously for the pipeline route are expected to be encountered along the transmission lines (see Sections 3.1.2.1, Geological Resources; 3.1.2.2, Paleontological Resources; 3.1.2.3, Potential Fossil-Bearing Geologic Formations; and 3.1.2.4, Fossil Fuel and Mineral Resources).

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