AFFECTED ENVIRONMENT

CHAPTER 3

3.0 AFFECTED ENVIRONMENT

3.1 Affected Environment

The Affected Environment section addresses the natural and human resources potentially affected by the Keystone Pipeline Project. The description of the Affected Environment is based on existing environmental information. Sources of these data include aerial photography, U.S. Geological Survey (USGS) topographic maps, National Wetland Inventory maps, publicly available databases, GIS files downloaded from the appropriate resource-based information system, and data requested from federal and state agencies for the project area. These data were compiled, quantified, and evaluated for this ER.

Field surveys for cultural resources, biological resources, waters of the U.S., and wetland delineations have been initiated and will continue into 2007. Protocols for field surveys and preliminary results for spring/summer 2006 field surveys have been submitted to the Department of State (filed on September 15 and November 15, 2006, respectively). Final 2006 field survey reports will be submitted in early 2007. Information gathered from these surveys will be used for compliance purposes, including compliance with Section 106, the ESA, and the Migratory Bird Treaty Act (MBTA), as well as federal and state permitting.

3.2 Climate and Air Quality

The climate and air quality section in this ER describes the regional climate and meteorological conditions that influence transport and dispersion of air pollutants and discusses the existing levels of criteria air pollutants in the region. Criteria pollutants are those pollutants for which ambient air quality standards have been set. This section also presents a summary of the regulatory requirements for air quality permits in each of the affected states (North Dakota, South Dakota, Nebraska, Kansas, Missouri, Illinois, and Oklahoma).

Operational air emissions generally are restricted to proposed pump stations. The proposed pump stations are electrically driven with electricity to be provided from existing local electric utilities. There is no backup power supply proposed for the pump stations. Air quality impacts from the construction and operation of Keystone's facilities are summarized in Section 4.2.1.

The data presented here are representative of the region where pipeline construction emissions could impact air quality. Climate data for Grand Forks, North Dakota; Lincoln, Nebraska; Tulsa, Oklahoma; and Salisbury, Missouri, are found in **Table 3.2-1**.

3.2.1 Regional Climate

The project area is located within the humid continental climate that is found over great expanses in the temperate regions of the mid-latitudes. The humid continental climate is noted for its variable weather patterns and its large temperature range due to its interior location in mid-latitude continents. This climate lies in the boundary zone between many different air masses, principally polar and tropical. Polar-type air masses collide with tropical type air masses causing uplift of the less dense and moister tropical air resulting in precipitation. These huge systems generally work their way across the surface in a west to east fashion, embedded in the dominant wind flow of the westerly wind belt.

Annual temperature ranges can exceed 82 degrees Fahrenheit (°F). For example, the minimum average low temperature in January in Grand Forks,North Dakota, is -5.5°F while the average maximum temperature in July in Grand Forks is 81°F (**Table 3.2-1**). Winter low temperatures of -40°F and summer high temperatures of 104°F have been recorded for this city. During the winter, the polar high expands in area to influence the northern portion of the continental humid climate. Record-setting cold temperatures occur during winter when continental arctic air masses sweep into the region. Otherwise, continental polar air masses dominate for much of the winter.

Precipitation in the humid continental climate is primarily due to invasions of maritime tropical air. A noticeable decrease and seasonality to the precipitation occurs as distance from the Gulf of Mexico and the Caribbean Ocean increases.

3.2.1.1 Cool Summer Subtype

The cool summer subtype of the humid continental climate in North America is found throughout much of the Great Lakes region and upper Midwest extending into south central Canada. Most of its precipitation falls in the summer half of the year. However, it receives less precipitation than the warm summer subtype due to the colder temperatures and their associated lower humidity. Average annual temperature at Grand Forks is 50°F. The cool summer subtype typically has very cold temperatures during the winter, with many months averaging below 32°F.

3.2.1.2 Warm Summer Subtype

The warm summer subtype is noted for its hot, humid summers and occasional winter cold waves.

Table 3.2-1 **Climate Data in the Vicinity of Pipeline Route**

GRAND FORKS, ND [1]	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average Max. Temperature (°F)	13.5	20.4	32.6	51.8	67.5	76.2	81.2	80.2	69.0	55.3	34.7	19.8	50.2
Average Min. Temperature (°F)	-5.5	1.1	14.6	30.7	42.1	52.2	56.6	54.3	44.5	33.3	18	2.5	28.7
Average Total Precipitation (in.)	0.69	0.5	0.8	1.18	2.31	3.17	3.09	2.69	1.97	1.37	0.87	0.62	19.27
Average Total Snow Fall (in.)	10	5.2	7.1	2.8	0.2	0	0	0	0	1	6.8	7.9	41.1
Average Snow Depth (in.)	7	7	4	0	0	0	0	0	0	0	1	4	2
LINCOLN, NE [1]	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average Max. Temperature (°F)	33.4	40.0	50.5	63.7	73.8	84.5	89.2	86.6	78.7	66.4	49.5	37.3	62.8
Average Min. Temperature (°F)	11.9	17.9	27.2	38.8	50.1	60.7	66.0	63.6	53.1	40.3	27.4	16.4	39.4
Average Total Precipitation (in.)	0.72	0.86	2.04	2.87	4.25	3.75	3.42	3.36	2.92	1.88	1.56	0.76	28.39
Average Total Snow Fall (in.)	6.5	5.4	4.9	1.5	0.0	0.0	0.0	0.0	0.0	0.6	2.7	5.3	26.8
Average Snow Depth (in.)	2	2	0	0	0	0	0	0	0	0	0	1	0
SALISBURY, MO [1]	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average Max. Temperature (°F)	36.4	42.6	53.2	65.9	75.7	84	88.6	87.3	80.1	69	53.5	41.1	64.8
Average Min. Temperature (°F)	17.4	22.5	31.2	42.9	53	62	66.3	63.8	55.5	44.4	33	22.8	42.9
SALISBURY, MO [1]	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average Total	1.63	1.68	2.75	3.57	4.92	4.84	4.29	3.84	4.22	3.31	2.5	1.95	39.51

Table 3.2-1 Climate Data in the Vicinity of Pipeline Route

Precipitation (in.)													
Average Total Snow Fall (in.)	6.4	4.5	3.2	0.4	0	0	0	0	0	0	1.1	4.6	20.2
Average Snow Depth (in.)	2	1	0	0	0	0	0	0	0	0	0	0	0
TULSA, OK [2]	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Average Max. Temperature (°F)	46.5	52.9	62.4	72.1	79.6	88	93.8	93.2	84.1	74	60	49.6	71.4
Average Min. Temperature (°F)	26.3	31.1	40.3	49.5	59	67.9	73.1	71.2	62.9	51.1	39.3	29.8	50.1
Average Total Precipitation (in.)	1.6	1.95	3.57	3.95	6.11	4.72	2.96	2.85	4.76	4.05	3.47	2.43	42.42
Average Total Snow Fall (in.)	3	2.1	1.4	0	0	0	0	0	0	0	0.6	2	9.1
Average Snow Depth (in.)	[3]	[3]	[3]	0	[3]	0	0	0	0	0	[3]	[3]	[3]

[1]Source: HPRCC 2006.

[2]Source: NCDC 2006.

[3]Annual statistics for mean snow depths are not appropriate.

Lincoln, Nebraska, and Salisbury, Missouri, lie in the warm summer subtype. Lincoln has an average annual temperature of 62.8°F, while Salisbury is a little warmer. Both locales have rather large annual average temperature ranges of over 76°F. Summer high temperatures average over 86°F, while winter low temperatures average 13 to 20°F. Typical of the humid continental climate most of its precipitation falls during the summer when air masses are warmer and wetter.

3.2.2 Ambient Air Quality

Potential sources of emissions along the proposed pipeline ROW can be classified as one of three types: stationary, mobile, and fugitive. Stationary sources could include pump stations; however, because they are all electric, pump stations are not considered to be potential sources of stationary emissions on the Keystone Pipeline Project. Mobile sources of emissions are the vehicles and equipment used during construction of the pipeline, pump stations, and other ancillary facilities. Fugitive sources include road dust, dust from the operation of earthmoving equipment, and leaks or programmed releases of volatile constituents in fuels and crude oil from valves, fittings, or sump tanks.

Six common air pollutants comprise the federal list of criteria pollutants: ozone (O_3); nitrogen dioxide (commonly called NO_2); carbon monoxide (CO); sulfur dioxide (SO_2); lead (Pb); and particulate matter based on a particle size of 10 microns or less (PM_{10}). The criteria pollutants are described in more detail below and the national standards for the control of criteria pollutants are discussed in Section 3.2.3.

The proposed underground pipeline will not have consequential air emissions under normal operating conditions. The pump stations are electric driven and will not contribute to local air emissions.

The Clean Air Act (CAA), 42 USC 7401 et seq. as amended in 1977 and 1990 is the basic federal statute governing air pollution. The provisions of the CAA that potentially are relevant to this project are listed below and discussed in the following sections:

- National Ambient Air Quality Standards (NAAQS);
- Prevention of Significant Deterioration (PSD);
- New Source Review (NSR);
- New Source Performance Standards (NSPS);
- Maximum Achievable Control Technology (MACT) Standards; and
- Title V Operating Permits.

The only air quality standards that apply to this project are the NAAQS. All pump stations are electric, and therefore there are no significant stationary services subject to the standards listed above (PSD, NSR, NSPS, MACT, and Title V Operating Permits).

3.2.3 National Ambient Air Quality Standards

The CAA empowered the USEPA to promulgate NAAQS air quality standards for six common air pollutants: O_3, CO, Pb, oxides of nitrogen (NO_x), PM_{10}, and SO_2. These standards were to include primary standards designed to protect health, and secondary standards to protect public welfare, predominately visibility. The NAAQS reflect the relationship between pollutant concentrations and health and welfare effects and therefore, are supported by sound scientific evidence. **Table 3.2-2** summarizes the primary and secondary standards for the six pollutants, and the averaging time for determining compliance with the standards.

The states are required to implement and enforce the NAAQS under a process called State Implementation Plans (SIPs), which are approved by the USEPA. Generally the SIPs are comprised of air quality rules that are applicable to stationary sources that may emit criteria or hazardous air pollutants. The CAA as amended in

1990 assigned new NAAQS attainment deadlines and categorized non-attainment as marginal, moderate, serious, severe, or extreme, depending upon the degree of violation of the NAAQS. The standards, other than ozone, particulate matter, and those based on averages, are not to be exceeded more than once a year. The eight-hour ozone standard is attained when the fourth highest eight-hour concentration in one year, averaged over three years, is equal to or less than the standard of 0.08 parts per million (ppm).

Table 3.2-2 National Ambient Air Quality Standards

Pollutant	Standard Value	Standard Type
CO		
8-hour Average	9 ppm (10 micrograms per cubic meter [$\mu g/m^3$])[1]	Primary
1-hour Average	35 ppm (40 $\mu g/m^3$)[1]	Primary
NO_2		
Annual Arithmetic Mean	0.053 ppm (100 $\mu g/m^3$)	Primary & Secondary
O_3		
1-hour Average[2]	0.12 ppm (235 $\mu g/m^3$)[1]	Primary & Secondary
8-hour Average	0.08 ppm (157 $\mu g/m^3$)[1]	Primary & Secondary
Pb		
Quarterly Average	1.5 $\mu g/m^3$	Primary & Secondary
PM_{10}		
Annual Arithmetic Mean	50 $\mu g/m^3$	Primary & Secondary
24-hour Average	150 $\mu g/m^3$	Primary & Secondary
$PM_{2.5}$		
Annual Arithmetic Mean	15 $\mu g/m^3$	Primary & Secondary
24-hour Average	65 $\mu g/m^3$	Primary & Secondary
SO_2		
Annual Arithmetic Mean	0.03 ppm (80 $\mu g/m^3$)[1]	Primary
24-hour Average	0.14 ppm (365 $\mu g/m^3$)[1]	Primary
3-hour Average	0.50 ppm (1300 $\mu g/m^3$)[1]	Secondary

[1]Parenthetical value is an approximately equivalent concentration. Regional air basins are designated as either in attainment of the NAAQS or as non-attainment for violating the NAAQS. States or air quality control regions (AQCRs) that are non-attainment must require control equipment on their stationary sources in order to reduce criteria pollutants.

[2]The ozone one-hour standard applies only to areas that were designated non-attainment when the ozone eight-hour standard was adopted in July 1997. This provision allows a smooth, legal, and practical transition to the eight-hour standard.

Source: USEPA 2006.

The Keystone Pipeline Project does not pass through any non-attainment areas.

3.3 Geology, Mineral Resources, and Paleontology

This section discusses the geology, mineral resources, and paleontology along the Keystone Mainline and Cushing Extension routes. Geologic hazards are discussed in Section 3.12.7.

KEYSTONE MAINLINE

3.3.1 North Dakota

3.3.1.1 Geology

The Keystone Pipeline Project is located in the Dakota-Minnesota Drift and Lake-bed Flats physiographic subdivision (Hammond 1965). Overall, this area is typified by low relief and is covered by glacial moraines and lakebeds (Radbruch-Hall et al. 1982). The majority of the proposed route follows areas of low relief, except for locations that cross the Pembina River and Sheyenne River Valleys, where the change in elevation from the valleys to the top the escarpments can range from 200 to 300 feet. Elevations along the proposed route range from 950 to 1,550 feet above mean sea level (amsl). The proposed route in northern North Dakota generally parallels the Pembina Hills, an escarpment that marks the western edge of the Red River Valley (Bluemle and Ashworth 2002).

The surficial unconsolidated geologic materials crossed by the proposed route are composed of alluvium, lake sediments, and glacial drift (Bluemle 1977). The lake sediments were derived from the ancient Lake Agassiz, a huge lake that occupied portions of Manitoba and Ontario, extreme eastern North Dakota, and northern Minnesota around 12,000 to 7,500 years ago (Bluemle 2002a). The glacial drift resulted from the action of continental glaciers on the landscape over several glacial episodes. The alluvial deposits have resulted from the action of streams in recent time.

The bedrock geology that underlies the surficial materials along the proposed route are Upper Cretaceous units consisting of the Pierre Formation, Niobrara Formation, the Carlisle Formation, and the Greenhorn Formation (Bluemle 1988). These formations are composed of marine shale, limestone, and sandstone and occur beneath the cover of the glacial and alluvial materials described above. The Cretaceous rocks outcrop along gullies, river valleys, and road cuts along the Pembina Escarpment (Bluemle and Ashworth 2002).

3.3.1.2 Mineral Resources

The major mineral resources along the proposed route in North Dakota are sand, gravel, crushed stone and clay (USGS 2004a). There are no oil, natural gas, coal, or metallic ore resources.

3.3.1.3 Paleontological Resources

In isolated places where the Upper Cretaceous rocks outcrop, there is the potential of finding various fossils of marine organisms that lived in shallow seas that covered the area in late Cretaceous time. These animals include turtles, fish, and invertebrates (clams, cephalopods, gastropods, corals, and crustaceans) (Walhalla, North Dakota, undated). The glacial deposits may contain fossils of large vertebrates including mastodon and mammoth (Paleontology Portal 2003).

3.3.2 South Dakota

3.3.2.1 Geology

The proposed route crosses the Dakota-Minnesota Drift physiographic subdivision (Hammond 1965). As described above, the Drift and Lake-bed Flats is an area of low relief. The route is in the James River Valley, a broad valley of low relief that trends north to south across the eastern portion of the state. The James River

Valley was formed when the dam forming a large glacial lake (Lake Dakota) was breached and the outflow carved the valley (South Dakota Department of Environment and Natural Resources [SDDENR] 2006). The elevations in the James River Valley area at about 1,200 feet amsl and it is situated between areas of higher elevation, the Coteau du Missouri to the west and the Coteau du Prairies to the east (South Dakota State Geological Survey [SDSGS] 1964). A major point of relief occurs in Yankton County along the Missouri River.

Elevations along the proposed route vary from around 1,300 feet amsl in the north to about 1,150 feet amsl in the south. There is very low relief along the route except where major drainages have cut into the glacial deposits. There is about 140 feet of relief where the route crosses the James River and about 100 feet of relief where the route drops into the Missouri River Valley.

The geologic surficial deposits along the proposed route are composed of glacial drift consisting of till deposits made up of material derived from the Cretaceous bedrock (SDSGS 1964). The glacial till deposits can be hundreds of feet thick especially in the eastern part of the state. The surficial deposits also may include loess (fine-grained glacial material re-deposited by wind) and alluvium (Tomhave and Schultz 2004).

The bedrock underneath most of the proposed route is Upper Cretaceous rocks similar to those described in North Dakota. The Cretaceous units include the Pierre Shale, Niobrara Formation, Carlisle Shale, Greenhorn Formation, and Graneros Shale (Tomhave and Schultz 2004). There may be minor areas of Dakota Formation which is Upper-lower Cretaceous. The Upper Cretaceous units are mainly composed of shale and minor amounts of limestone and sandstone. The Dakota Formation consists of medium- to coarse-grained sandstone with minor interbedded shale. In Hansen County, the bedrock is Precambrian in age and is composed largely of quartzite (SDSGS 1964). As in North Dakota, the bedrock occasionally outcrops along road cuts and stream valleys.

There are potential karst features along the proposed route in southern portions of Miner County, northern portions of Hanson County and in the southern part of Hutchinson County and all of Yankton County to the Nebraska State line (Davies et al. 1984). Karst occurs as a result of the dissolution of certain rocks by water. The dissolution can cause caves or can result in subsurface voids, which if manifested to the surface can cause hazards to life and property in the form of sinkholes. The area is underlain by carbonate rocks of the Cretaceous Niobrara Formation. Small fissures may develop in the Niobrara but are less than 1,000 feet long and 100 feet deep and are widely spaced with over 1,000 feet of competent rock between fissures (National Atlas of the United States [NAUS] 2006). However, the Niobrara Formation where fissures occur generally is covered by 50 feet or more of cover.

3.3.2.2 Mineral Resources

Sand and gravel and crushed stone are the major mineral resources extracted in the vicinity of the proposed route. Day and Clark counties are important producers of sand and gravel and Hanson County is a major producer of crushed stone (USGS 2004b). There are no oil, natural gas, coal, or metallic ore resources in the vicinity of the proposed route (SDSGS 1964).

3.3.2.3 Paleontological Resources

As in North Dakota, the Upper Cretaceous rocks fossils are marine organisms that lived in shallow seas in the late Cretaceous time and include turtles, fish, and invertebrates (clams, cephalopods, gastropods, corals, and crustaceans). The glacial deposits may contain fossils of large mammal vertebrates that were common during the ice ages: mastodon, bison, mammoth, and horse (Paleontology Portal 2003).

3.3.3 Nebraska

3.3.3.1 Geology

The northern portion of the proposed mainline route in Nebraska is located in the Middle Western Upland Plain physiographic subdivision which extends east-west from Nebraska to Ohio (Hammond 1965). The area is characterized by rolling and dissected topography and the glacial deposits are thin in upland areas (Radbruch-Hall et al. 1982). South of Wayne County to the Kansas State line, the proposed route travels across the West-Central Rolling Hills. This area also is underlain by glacial deposits and is of low to moderate relief. Moderate relief is found along the Missouri River where the proposed route crosses from South Dakota into Nebraska.

Elevations along the proposed route in Nebraska vary from around 1,150 feet amsl in the Missouri River Valley to more than 1,800 feet in the southern part of the state. The relief along the edge of the Missouri River is about 100 feet and from 100 to 130 feet where the route crosses the Elkhorn River. The topography is generally rougher north of the Platte River where the surficial deposits are more dissected.

The surficial deposits consist of glacial materials and alluvium. In many places glacial drift also is covered in loess (Bennison and Chenowith 1984). In the north, where the route crosses Cedar County, the surficial deposits are thin and loess lies directly over bedrock with no deposits of glacial drift. In the valley of the Platte River, the deposits are recent alluvium.

Most of the proposed mainline route in Nebraska crosses upper and Lower Cretaceous and Upper Tertiary rock units (King and Beikman 1974). From the South Dakota State line to Butler County, the route primarily crosses Upper Cretaceous rocks as described for North and South Dakota: Pierre Shale, Niobrara Formation, Carlisle Shale, Greenhorn Formation, and Graneros Shale (Bennison and Chenowith 1984). In portions of Cedar, Wayne, and Stanton counties the route crosses areas underlain by Miocene (Tertiary) deposits of the Ogallalla Group. The Ogallalla Group consists of sandstones and shale interbedded with layers of ashfall material. South of Butler County to the Kansas State line, the route crosses primarily Lower Cretaceous rocks of the Dakota Group and which consists of sandstone and shale.

As in southeastern South Dakota, areas prone to karst development along the proposed route in Nebraska are in Cedar and Wayne counties. The route in this area is underlain by upper Cretaceous bedrock that has limestone in the Niobrara Formation that may weather into shallow, widely spaced fissures (Davies et al. 1984).

3.3.3.2 Mineral Resources

The major minerals along the proposed route are sand, gravel, crushed stone, and clay (USGS 2004c). There are no oil, natural gas, coal, or metallic ore resources in the vicinity of the proposed route.

3.3.3.3 Paleontological Resources

Fossils that may potentially be found in the upper Cretaceous rocks include turtles, fish, and ammonites (Paleontology Portal 2003). The glacial deposits may have the remains of large vertebrates including elephants and horses.

3.3.4 Kansas

3.3.4.1 Geology

The Keystone Mainline route crosses the West-Central Rolling Hills physiographic subdivision in Kansas (Hammond 1965). The area is underlain by glacial deposits and is characterized by low to moderate relief and is referred to as the Glaciated Region of Kansas (Buchanan and McCauley 1987). Areas of sharp relief can be encountered along the bluffs above the Missouri River in Doniphan County where glacial loess deposits form bluffs over 300 feet above the Missouri River floodplain (Kansas Geological Survey [KGS] 1999a).

Elevations along the proposed route in Kansas range from around 790 feet amsl at the Missouri River to 1,500 in eastern Marshall County. The topography is generally rough, which is indicative of the erosion of the surficial deposits. At the Missouri River, there is about 220 feet of relief where the route comes down to the floodplain of the river. Steep relief also is found where the route crosses the Big Blue and Nemaha Rivers where the changes in elevation vary from 100 to 130 feet.

The surficial geologic materials are glacial deposits and alluvium. The mainline route crosses an area of glacial drift composed of till, lake deposits, and loess (SGSK 1964). Alluvium is found in river valley and drainages. The glacial deposits are commonly not continuous or thick and bedrock units are exposed in drainages but the loess deposits can be more than 100 feet thick in places (KGS 1999a).

The bedrock is composed of Pennsylvanian and Permian rocks. The Shawnee Group and the Wabaunsee Group are Pennsylvanian in age and are largely composed of limestone and shale and localized sandstone (State Geological Survey of Kansas [SGSK] 1964). The Permian rocks consist of the Admire, Council Grove, Chase, and Sumner Groups which are composed mainly of limestone and shale. The route is underlain by the Permian rocks in Marshall, Nemaha, and western Brown Counties. The Pennsylvanian rocks are crossed in eastern Brown and Doniphan Counties.

There are small isolated areas of potential karst development identified on the national karst map characterized as fissures, tubes and caves usually less than 1,000 feet long and less than 50 feet deep. (Davies et al. 1984). The karst appears to be similar to South Dakota and Nebraska; widely spaced, relatively small solution fissures in nearly flat-lying carbonate rocks covered with varying amounts of overburden.

3.3.4.2 Mineral Resources

The major mineral resources in northeast Kansas are sand, gravel, and crushed stone (USGS 2004d). The proposed route lies in the Forest City structural basin and there are several small oil fields in northeast Nemaha County and northwest Brown County (Brooks et al. 1975). Coal beds are present in Pennsylvanian rocks but are generally too deep to mine, although there is potential for coal bed methane production (Rice 1995).

3.3.4.3 Paleontological Resources

The Pennsylvanian-aged rocks have the potential to have invertebrate fossils including mussels, echinoids, bryozoans, crinoids, snails, corals, and trilobites (Paleontology Portal 2003). Permian time was not conducive to abundant life but fossils of fish including shark may be found. The surficial glacial deposits in the area have the potential to contain typical ice-age large vertebrates.

3.3.5 Missouri

3.3.5.1 Geology

The proposed mainline route crosses three physiographic subdivisions from west to east: West-Central Rolling Hills, Mid-continent Plains and Escarpments, and Middle Western Upland Plain (Hammond 1965). These areas are generally low to moderate relief with rolling hills and dissected drainages (Radbruch-Hall et al. 1982). Areas of steep relief are found adjacent to the major river valleys.

Elevations along the proposed route in Missouri vary from 790 feet amsl at the Missouri River to 1,165 amsl feet in northwest Missouri down to around 400 amsl feet in the Mississippi River flood plain. From the Missouri River to Montgomery County, Missouri, the topography is similar to that crossed in Kansas, but with steeper relief. Areas with slopes greater than 15 percent are present in northwest Missouri (less than two percent of the total distance of the proposed route). The greatest elevation change is along the Missouri River in northwest Missouri where the elevation change at the edge of the floodplain is about 250 feet.

The surficial geology is composed of alluvium and glacial drift composed of till and loess. The Missouri River generally marks the southern limit of glaciation and most of northern Missouri is covered with a mantle of glacial drift. The area is referred to by Raisz (1957) as the Loess-covered Till Prairies. While the glacial deposits are thick in places, deep erosion has exposed bedrock in the drainages. Alluvium is present in the river valleys and is especially thick in the flood plains of the Mississippi and Missouri Rivers.

The proposed route crosses Pennsylvanian-aged rocks from the northwest corner of the state to Montgomery County and then for a small distance west of the Mississippi River north of St. Louis. From Montgomery County to the Mississippi River, the route crosses Mississippian-aged rocks. The Pennsylvanian rocks that underlie the route consist of sandstone, limestone, shale, and coal (Oetking et al. 1966). The Mississippian rocks are composed mainly of cherty limestone and minor amounts of shale and sandstone.

In Caldwell, Lincoln, and St. Charles County, there are potential karst development areas identified on the national karst map characterized as fissures, tubes and caves usually less than 1,000 feet long and less than 50 feet deep (Davies et al. 1984). The karst description is the same as for South Dakota and Nebraska. Most of the classic karst geology in Missouri occurs in the Ozarks south of the proposed pipeline route and south of the Missouri River.

3.3.5.2 Mineral Resources

Important mineral resources in the vicinity of the proposed route are sand, gravel, crushed stone and fine clay (USGS 2004e). Oil, natural gas, and prospective coal bed methane resources are present where the proposed route traverses the Forest City Basin (Charpentier 1995). The proposed route crosses the basin from the Kansas State line to the western side of Chariton County. There are several oil fields in Clinton County but not near the proposed route. There also is an oil field located in St. Louis on the south side of the Missouri River (Association of Missouri Geologists 1982). Coal also is found in Pennsylvanian beds that the route crosses and mineable coal resources are present in Audrain, Buchanan, Caldwell, Carrol, Chariton, Montgomery, and Randolph counties (USGS 2004f).

3.3.5.3 Paleontological Resources

The surficial alluvial and glacial deposits may contain fossils of animals that lived during the ice ages and these deposits have yielded particularly good mastodon specimens (Paleontology Portal 2003). The Paleozoic rocks may contain fossil fish and a number of invertebrates including mollusks, corals, and echinoderms.

3.3.6 Illinois

3.3.6.1 Geology

The proposed mainline route is located in the Middle Western Upland Plain physiographic subdivision (Hammond 1965). The area has generally low to moderate relief. The only areas of substantive relief occur where the route crosses major drainages and at the edge of the Mississippi River alluvial valley.

The Mississippi River floodplain is relatively flat at an elevation of slightly over 400 feet amsl. As the proposed route climbs out of the floodplain, it crosses fairly level ground along Kahokia Creek and undulating incised terrain north and east of Edwardsville, Illinois. East of Edwardsville, the route climbs on to the till plains where there is slight rolling relief except for incised drainages where rapid elevation changes of up to 100 feet can occur in the larger drainages. The elevations on the till plains generally range from 500 to 600 feet amsl.

The surficial geology consists of glacial deposits and alluvium. As the route enters the state, it crosses the broad alluvial valley of the Mississippi River, which is composed of sand silt and clays (Lineback 1979). East of the Mississippi River, the route climbs onto loess deposits that are adjacent to the floodplain. Further east, the route crosses glacial tills that vary from 50 up to 200 feet thick.

The bedrock geology is comprised of Mississippian and Pennsylvanian-aged sedimentary rocks (Willman et al. 1967). The Mississippian subcrop is mainly underneath the alluvium of the Mississippi River. The Mississippian rocks are composed largely of limestone and sandstone with minor shale. A few miles east of the river, the route crosses Pennsylvanian rocks that consist of sandstone, shale, and coal.

Karst is present in Illinois in carbonate rocks that outcrop or are close to the surface along western edge of the state along the Mississippi River (Illinois State Geological Survey [ISGS] 2003). Numerous sinkholes and collapse structures have been identified. The area crossed by the proposed route from the Mississippi River to about three miles east of the river is underlain by bedrock that may be prone to the development of karst. However, no karst features have been identified in that particular area (Davies et al. 1984; USGS 2000).

3.3.6.2 Mineral Resources

The coals that are mined in the area are found in the Pennsylvanian rocks. These coal beds have been mined for many years and Illinois has a large coal reserve and numerous active coal mines (ISGS 2004). In addition to coal, the Illinois Basin has oil and gas resources (ISGS 2005c). Other mineral resources in the vicinity of the proposed route are crushed stone, sand, gravel, and clay (USGS 2004g).

3.3.6.3 Paleontological Resources

Fossils that potentially are found in the surficial deposits of Illinois can include beaver, mastodon, mammoth, and moose (Paleontology Portal 2003). The older Paleozoic rocks contain a diverse fauna while the Pennsylvanian rocks have many fossil plants as well.

CUSHING EXTENSION

3.3.7 Kansas

3.3.7.1 Geology

The proposed Cushing Extension route begins in the West-Central Rolling Hills physiographic subdivision and crosses into the Mid-continent Plains and Escarpments in the vicinity of southeastern Washington County (Hammond 1965). The Mid-continent Plains and Escarpments subdivision is an area of low to moderate relief. From the Nebraska state line to southern Washington County, the route crosses the Glaciated Region of northeast Kansas (Buchanan and McCauley 1987). South of the Glaciated Region, the entire length of the Cushing Extension in Kansas is in an area referred to as the Flint Hills. The Flint Hills is made up of a series of north-south trending escarpments formed by the erosion of the outcrops of gently west-dipping Permian sedimentary rocks. The upland areas of the Flint Hills are commonly covered with cherty gravels which are more resistant to erosion and thereby forming the prominent escarpment (KGS 1999b). Karst is not present along the Kansas portion of the Cushing Extension (Davies et al. 1984; USGS 2000).

The proposed extension crosses into Kansas at an elevation of about 1,330 feet amsl at the state line. For much of the route, it crosses gentle rolling hills where elevations generally range from 1,150 to over 1,400 feet amsl. Some relief is provided at major drainages where elevation changes are commonly around 100 feet, but are not steep. The lowest elevations are found in the Arkansas River valley where the elevation is around 1,070 feet amsl.

In the Glaciated Region, the surficial deposits are composed glacial till, loess, and alluvium. The proposed extension route crosses only a few miles of the Glaciated Region. Where the route leaves the glaciated area in southeastern Washington County, there are relatively thick (greater than 30 feet) deposits of loess until the route is in Dickinson County (Frye and Leonard 1952). South of the glaciated area, the dominant surficial materials are alluvium and colluvium and as mentioned above, cherty gravels are present in upland areas of the Flint Hills. Occasional loess deposits are present in Cowley County on the southern portion of the lateral.

The proposed route crosses Lower Cretaceous bedrock (Dakota Formation) in Washington County (SGSK 1964). The Dakota Formation is composed of sandstone and shale. From southern Washington County, Kansas to the Oklahoma State line the proposed extension crosses rocks of the Permian Council Grove, Chase, and Sumner Groups, which are composed primarily of limestone and shale (SGSK 1964).

3.3.7.2 Mineral Resources

Oil and natural gas are important mineral resources present along the Cushing Extension. From Marion County south to the Oklahoma state line, the route passes near or crosses a number of oil and gas fields (KGS 2005c). There are five small oil fields in Clay County, four of which are now abandoned. The proposed route passes near the active El Dorado oil field west of El Dorado, Kansas. The field was discovered in 1915 and has produced over 300 million barrels of oil (KGS 2006). In addition to oil and natural gas, sand, gravel, crushed stone, and dimension limestone are important mineral resources present along the Cushing Extension (USGS 2004d). Sulfur also is an important byproduct of oil production in Butler County.

3.3.7.3 Paleontological Resources

Permian time was not conducive to abundant life but fossils of fish such as shark may be found in addition to invertebrates including corals, brachiodpods, ammonoids, and gastropods (KGS 2005a). It also is possible that the surficial unconsolidated deposits in the area have the potential to contain typical ice-age large vertebrates such as mammoths, mastodons, camels, and saber-toothed tigers (Paleontology Portal 2003). The unconsolidated deposits also contain invertebrates such as mollusks which have been used to correlate different glacial episodes to various deposits (Frye and Leonard 1952).

3.3.8 Oklahoma

3.3.8.1 Geology

The Cushing Extension route in Oklahoma is in the Mid-continent Plains and Escarpments physiographic subdivision (Hammond 1965). The area is typified by low to moderate relief. Much of the relief is the result of escarpments formed from the erosion of gently west dipping bedrock formations similar to the Flint Hills of Kansas. The southern extension of the Flint Hills into Oklahoma is called the Osage Hills (KGS 1999b).

The proposed extension crosses relatively flat ground from the Kansas – Oklahoma state line to the Cimarron River. Elevations range from 900 to 1,150 amsl over broad rolling hills and relief changes along rivers and drainages are generally around 50 feet or less. The crossing of the Cimarron River has the greatest relief where elevation changes of 140 to 180 feet occur on each side of the river. South of the Cimarron River to the end of the line, the route crosses areas of sharply dissected drainages north and west of Cushing, Oklahoma, and elevations range from 860 to 1,070 feet amsl.

Surficial geologic deposits consist of alluvium and terrace deposits. The alluvium is associated with rivers and drainages and is thickest in the Cimarron River Valley (Bingham and Bergman 1980). The terrace deposits also are found along the margins of the major river valleys. The surficial deposits are composed primarily of sand, silt, and clay. The proposed route crosses mainly bedrock of Lower Permian age from the Kansas-Oklahoma state line to northeast Noble County. Where the route crosses the Salt Fork of the Arkansas River, there may be outcrops of Upper Pennsylvanian rocks along the edge of the floodplain. The Lower Permian rocks belong to the Wellington Formation and consist of sandstone, mudstone conglomerate, and chert. After the route crosses Highway 177 in northeast Noble County, it crosses the Upper Pennsylvanian of the Oscar and Vanoss Groups that are composed of sandstone, shale, and limestone (Bingham and Moore 1975; Bingham and Bergman 1980). Karst is not present along the Oklahoma portion of the Cushing Extension (Davies et al. 1984; USGS 2000).

3.3.8.2 Mineral Resources

Oil and natural gas are important mineral resources present in the area crossed by the Cushing Extension route. There are numerous oil and gas fields in the vicinity (Boyd 2002a). The oil fields primarily produce from Mississippian, middle and upper Pennsylvanian, and Permian reservoirs (Boyd 2002b). Discoveries of prolific oil fields near Cushing, Oklahoma in the early twentieth century resulted in Cushing becoming a major crude oil refining and pipeline transportation hub (Mid-Continent Oil and Gas Association of Oklahoma 2006). In 1916, Sinclair built a major crude oil pipeline from Cushing to Wood River, Illinois.

Other mineral resources in the counties along the route include sand, gravel, and crushed stone (Johnson 1998; USGS 2004h).

3.3.8.3 Paleontological Resources

The Wellington Formation (Lower Permian) in Noble County has yielded vertebrates fossils from fish, amphibians, and reptiles (May and Hall 2002). Fossil plants, insects, and invertebrates also can be found in the Permian formations in north central Oklahoma. The alluvium and terrace deposits associated with the rivers may contain fossilized wood, snails, clams, and large land invertebrates such as horses, camels, bison, and mammoths (Johnson 1996).

3.4 Soils

The Keystone Pipeline Project route will be located almost entirely within the northern part of the Central Lowlands physiographic province (Thornbury 1965). Within the project region, the geologic surface has been formed by repeated episodes of continental glaciation. As a result, glacial deposits and re-worked alluvium form the parent materials for the majority of soils along the route. As a general rule, bedrock-controlled terrain exists in the project area only within the Missouri and Mississippi River valleys in the vicinity of St. Louis, Missouri. Isolated bedrock exposures also may occur elsewhere along stream valleys and associated hillslopes.

Most soils in the northern part of the project area have formed in clays, silts, and sands from weathered glacial till and lacustrine deposits or from sands and gravels deposited as glacial outwash. Soil textures reflect the nature of the parent deposits, varying widely from clays to sands and gravels depending on location. Along major streams and river valleys, soils exhibit the stratified textures of alluvial deposits. The depth to bedrock is typically greater than 60 inches throughout the region.

KEYSTONE MAINLINE

North Dakota

In North Dakota, most of the soils have thick, dark topsoil layers and mixed mineralogy. Nearly level to undulating soils such as the Barnes, Svea, and Hecla series occur on upland till plains and glacial lake plains. These soils are well drained or moderately well drained. Sodic soils, such as the Aberdeen series, also occur on glacial lake plains. Very poorly drained, wet soils, such as the Parnell series occur in the numerous prairie potholes and along streams (U.S. Department of Agriculture-Soil Conservation Service [USDA-SCS] 1981). Soil fertility is inherently high and remains so where maintained by agricultural practices. Prime farmland soils are extensive, occupying approximately half of the proposed route in North Dakota. The average freeze-free period is 100 to 120 days at the northern border of the U.S., and lengthens to 120 to 140 days further south through the state (USDA-SCS 1981).

South Dakota

In the northern portions of South Dakota (to central Miner County), the soils are generally similar to those of North Dakota but have warmer mean annual temperatures. Houdek, Prosper, and Clarno soils series occur on nearly level to rolling glacial till plains. These are well drained to moderately well drained soils with thick, dark, fertile topsoil layers. Saline or sodic soils, such as the Dudley and Jerauld series, are interspersed on uplands with other soils more suited to cropland. Parnell and Tetonka soils occur in upland depressions with drainage restrictions. The average freeze-free period is about 130 to 155 days (USDA-SCS 1981).

From central Miner County to the Nebraska state line, uplands are formed from both loess (wind-deposited silts) and medium-textured glacial till. Most of the soils are deep, silty or loamy, and have thick, organically enriched topsoil layers that make them well-suited for agricultural uses. Overall, about 45 percent of the proposed route within South Dakota consists of prime farmland soils. Well drained, nearly level to moderately sloping soils, such as the Belfore and Moody series, formed from the loess parent materials. Other well drained, nearly level to moderately sloping soils, such as the Clarno, Egan, and Wentworth series, formed in glacial till. Upland depressions are typically poorly drained and contain wet, dark soils. In the Missouri River region, stream valley floors and bottomlands contain poorly drained soils with thick, dark-colored topsoils, such as the Lamo and Luton series. These are interspersed with well drained to poorly drained, highly stratified soils, such as the Albaton and Haynie series, which formed in more recent mixed sediments. The average freeze-free period is about 135 to 165 days (USDA-SCS 1981).

Nebraska

Along the proposed route into central Nebraska, soil characteristics are similar to those described for southern South Dakota. However, from Butler County, Nebraska, into northeastern Kansas, most of the soils are formed in loess deposits that are generally tens of feet thick over glacial deposits. These soils are deep, silty and loamy and have relatively thick, dark, fertile topsoil layers. Dissected topography is more extensive in southern Nebraska and these soils are highly erodible on slopes. Fertile, dark topsoils remain characteristic. Hastings and Holdrege soils formed on silty uplands and the Hall and Hord soils occur in silty sediments on stream terraces. Prime farmland soils are extensive in Nebraska, occupying approximately 63 percent of the proposed route. The average freeze-free period is about 160 to 180 days in this part of Nebraska.

Kansas

In southern Nebraska and northeastern Kansas, sedimentary bedrock may outcrop along valley sideslopes and ridge crests. These rocks consist mostly of shales, siltstones, and limestones in various stages of weathering. Shallow soils such as the Kipson series form in these locations. Elsewhere along the western part of the proposed route in Kansas, the Irwin, Ladysmith, and Geary soil series occur on the silty uplands. These are deep soils with fertile topsoils and loamy or clayey subsoils. The average freeze-free period is about 170 to 190 days.

Further along the proposed route in Kansas, from about central Marshall County eastward, the soil moisture regime becomes wetter. Loess-mantled ridgetops and upper sideslopes are occupied by deep, silty soils with fertile, dark topsoil layers. Marshall and Monona soil series are examples. Some soils in flatter landscape positions, such as the Sharpsburg, Wymore, and Grundy series, have more clayey subsoils. Loamy soils such as the Burchard and Shelby series formed in glacial till. All of these soils have thick topsoil layers. On bottom lands, soils with internal drainage limitations (such as the Kennebec, Colo, and Wabash series) occur. About 46 percent of the proposed route in Kansas consists of prime farmland soils. The average freeze-free period is about 160 to 190 days (USDA-SCS 1981).

Missouri

Silty loess deposits thicken near the Missouri River and deep, highly erodible soils parallel the river in both Kansas and Missouri. The erosion hazard remains high on rolling and moderately steep slopes for several miles inland on either side of the Missouri River floodplain. Poorly drained and very poorly drained soils such as the Colo, Vesser, and Wabash series occur in the Missouri River bottomlands and along tributary drainages. Loess deposits thin eastward into the state of Missouri, and the soils have formed in clayey glacial till on dissected hills. Deep, well drained and moderately well drained soils, such as the Armstrong, Keswick and Lindley series, occur on Missouri uplands. Soils along this portion of the proposed route typically have claypan layers, but some lack the highly fertile, dark topsoil found further north. Deep, poorly drained soils, such as the Adair and Clarinda series, also may occur on upland slopes. Wetness and poor soil drainage are common along much of the proposed route in central and eastern Missouri. In addition, the shrink-swell potential may be severe through the Missouri uplands. Shallow and moderately deep soils occur over cherty limestones near the surface in some places in central and eastern Missouri. About 54 percent of the proposed route through the state consists of prime farmland. The average freeze-free period ranges from about 180 to 190 days (USDA-SCS 1981).

Illinois

Through the Mississippi River valley and eastward to Patoka, Illinois, the proposed route crosses wide river bottomlands and bordering hillslopes. Shallow and moderately deep soils occur over cherty limestones bordering the river valley. Uplands are comprised of dissected glacial till and other parent materials. Soil characteristics vary widely. Depths range from shallow to deep and range from sandy to clayey. Most of the upland soils near the Mississippi River are medium-textured, well drained or moderately well drained, and lack highly fertile, dark topsoil layers. Extensive areas of alluvial soils are poorly drained, very deep, and more fertile due to organic material enrichment. Inland toward Patoka, upland topography becomes nearly level to gently rolling. Soils are generally deep and wetness is the major land use problem. Most of the soils are silty near the surface, with clay accumulations at greater depths. About 93 percent of the proposed route within Illinois to Patoka consists of prime farmland. The average freeze-free period ranges from about 180 to 200 days (USDA-SCS 1981).

CUSHING EXTENSION

Nebraska

Along the Cushing Extension in southern Nebraska, the soils are derived from loess, as described for the Mainline. Soils are deep and silty, with dark, organically enriched surface layers. Soils such as the Hastings and Holdrege series are highly erodible on slopes. As described for the Mainline, prime farmlands are extensive in the area and the average freeze-free period is about 160 to 180 days (USDA-SCS 1981).

Kansas

Further south along the Cushing Extension in Kansas, sandstones and limestones may outcrop along valley sideslopes and ridge crests. Shallow soils such as the Hedville series form in these locations. Elsewhere, the Irwin, Ladysmith, and Geary soil series occur where silty loess deposits mantle the bedrock on uplands. These are deep soils with fertile topsoils and loamy or clayey subsoils. Along smaller streams, Hobbs soils commonly occur. These are deep, stratified soils with fertile topsoils. Along major streams, wetter soils such as the Solomon, Sutphen, and Roxbury series occur. These are deep loamy, silty, or clayey soils that have fertile, organically enriched topsoils and may be wet near the surface during parts of the year. In some locations, the topsoil layer may have a thickness of 20 inches or more. Most of the land along the Cushing Extension is used for agricultural purposes. The average freeze-free period is about 170 to 190 days (USDA-SCS 1981).

Oklahoma

Near the Kansas – Oklahoma border, soils transition to a warmer temperature regime. On gently sloping uplands, soils are deep and have dark topsoil layers that overlie clay accumulations in the subsoil. Representative soils series include the Anocon, Grant, Tabler, and Bethany soils. Elsewhere, dark, fertile topsoil layers are common. Shallow to deep, well drained soils such as the Minco and Lucien series occur on steeper slopes. The hazard of soil erosion may be significant in these areas. Deep, clayey or loamy soils such as the Miller, Port, or Reinach series occur along drainages. Topsoil layers in these drainage soils extend to depths of 20 inches or more, and in some locations may be wet at depths of two feet or more below the surface during part of the year. The average freeze-free period is about 190 to 230 days (USDA-SCS 1981).

Summary Soil Characteristics

General soil characteristics for the Keystone Pipeline Project have been assessed by means of the STATSGO database (Soil Survey Staff, no date). This investigation focused on soil characteristics or limitations of particular interest to the proposed pipeline construction. The results of the STATSGO data assessment are shown in **Tables 3.4-1** and **3.4-2**.

Table 3.4-1 Summary of Sensitive Soils Along the Proposed Pipeline Route

State/County	Total Miles[1]	Highly Erodible[2]	Prime Farmland[3]	Hydric[4]	Compaction Prone[5]	Stony – Rocky[6]	Shallow Bedrock[7]	Droughty[8]
KEYSTONE MAINLINE								
North Dakota	216.9	18.7	115.1	28.4	14.4	3.1	29.5	0.0
South Dakota	218.9	11.6	99.8	26.8	27.7	1.5	0.0	0.0
Nebraska	213.7	43.8	134.8	8.9	10.9	0.5	4.0	0.0
Kansas	98.8	23.6	46.3	2.0	8.6	0.2	29.6	0.0
Missouri	273.1	48.9	145.9	51.8	140.3	16.5	80.2	0.0
Illinois	56.5	4.5	40.8	16.3	35.2	0.1	0.1	0.0
Keystone Mainline Subtotal[9]	**1,077.9**	**151.1**	**582.7**	**134.2**	**237.1**	**21.9**	**143.4**	**0.0**
CUSHING EXTENSION								
Nebraska	2.4	1.1	1.4	0.0	0.0	0.0	0.0	0.0
Kansas	209.7	13.0	156.7	1.4	10.9	9.8	140.1	0.0
Oklahoma	79.7	4.4	53.1	<0.1	0.3	7.8	47.3	0.0
Cushing Extension Subtotal[9]	**291.8**	**18.5**	**211.2**	**1.4**	**11.2**	**17.6**	**187.4**	**0.0**
Project Total	**1,369.7**	**169.6**	**793.9**	**135.6**	**248.3**	**39.5**	**330.8**	**0.0**

[1]Mileage does not account for areas or disturbance associated with metering or pump stations, transmission lines, laterals, or pipe storage/contractor yards. Individual soils may occur in more than one characteristic class.

[2]Includes all soils listed as highly erodible.

[3]Includes land listed by the NRCS (2005) as potential prime farmland if adequate protection from flooding and adequate drainage are provided.

[4]As designated by the NRCS (2005).

[5]Includes soils that have clay loam or finer textures in somewhat poor, poor, and very poor drainage classes.

[6]Includes soils that have either: 1) a cobbly, stony, bouldery, gravelly, or shaly modifier to the textural class, or 2) have >five percent (weight basis) of stones larger than three inches in the surface layer.

[7]Includes soils that have bedrock within 60 inches of the soil surface.

[8]Includes coarse-textured soils (sandy loams and coarser) that are moderately well to excessively drained.

[9]Discrepencies in mileage are due to rounding.

Table 3.4-2 Average Slope Class Along the Proposed Pipeline Route

State/County	Total Miles[1]	Slope Class[2] (percent) 0-5	>5-8	>8-15	>15-30	>30
		---Miles---				
KEYSTONE MAINLINE						
North Dakota	216.9	170.9	43.5	2.5	0.0	0.0
South Dakota	218.9	189.9	17.9	11.1	0.0	0.0
Nebraska	213.7	119.7	42.2	51.8	0.0	0.0
Kansas	98.8	31.7	58.2	8.9	0.0	0.0
Missouri	273.1	133.5	17.8	104.9	16.9	0.0
Illinois	56.5	34.0	2.9	19.6	0.0	0.0
Keystone Mainline Subtotal[3]	**1,077.9**	**679.7**	**182.5**	**198.8**	**16.9**	**0.0**
CUSHING EXTENSION						
Nebraska	2.4	0.2	2.2	0.0	0.0	0.0
Kansas	209.7	161.9	47.8	0.0	0.0	0.0
Oklahoma	79.7	74.2	5.5	0.0	0.0	0.0
Cushing Extension Subtotal[3]	**291.8**	**236.3**	**55.5**	**0.0**	**0.0**	**0.0**
Project Total	**1,369.7**	**916.0**	**238.0**	**198.8**	**16.9**	**0.0**

Note: Depth to bedrock listed in the STATSGO database is greater than 24 inches for the entire Keystone Project.

[1]Mileage does not account for disturbance associated with metering or pump stations, transmission lines, laterals, or pipe storage/contractor yards.

[2]Slopes are grouped by the averages of the high and low slope ranges provided in the STATSGO database for each map unit identification (MUID) component soil series. For example, Tresano series, 3 to 10 percent slopes, is 20 percent of MUID CO010. Its average slope is six and one-half percent. The representative acreage, calculated by multiplying percent composition by the total MUID acreage, is included in the >five to eight percent slope class.

[3]Discrepencies are due to rounding.

3.5 Water Resources

3.5.1 Surface Water

KEYSTONE MAINLINE

Surface water resources that occur along the Keystone Mainline route are located in three water resource regions, as identified by their major river systems (Seaber et al. 1994):

- The Souris – Red – Rainy rivers region (in eastern North Dakota)
- The Missouri River region (in North and South Dakota, Nebraska, Kansas, and Missouri)
- The Upper Mississippi region (in Missouri and Illinois)

North Dakota

Primary drainages along the proposed route are indicated at a greater level of detail in **Figure 3.5-1**. As indicated in Appendix F, Table F-1, the larger stream crossings proposed in North Dakota include the Pembina River, the Tongue River, the Park River branches, Forest River branches, the Goose River and tributaries, and the Sheyenne River and several of its tributaries. In addition, the proposed route is located alongside Lake Ashtabula on the Sheyenne River in southern Steele County and northern Barnes County. Along the route in Steele County, the surface drainage flows away from Lake Ashtabula. A railroad grade also lies between the proposed route and the lake. Near Sibley in northern Barnes County, numerous side drainages and aquifer outcrops drain toward Lake Ashtabula from the vicinity of the proposed pipeline route. Lone Tree Lake and Lake Taayer also occur near the route, downstream of proposed tributary stream crossings in western Barnes County. Prairie potholes and ponds are common in and along the project route through North Dakota.

South Dakota

In South Dakota, primary drainages include Foster Creek and associated tributaries in southwestern Clark County, Pearl Creek and its tributaries in northeastern Beadle County; the Wolf Creek drainage in Hanson and Hutchinson counties; and the James River, Beaver Creek, and the Missouri River in Yankton County. The Missouri River at the proposed crossing is approximately 2,000 feet wide and the crossing will be located at the head of a braided reach downstream of the Highway 81 bridge. Marne Creek and a river side channel border the proposed approach to the river. Gavins Point Dam, a major control structure on the river, is located about three miles upstream of the proposed crossing. A large number of prairie potholes, ponds, and small lakes are located along the proposed route in southern Day County and Clark County.

Nebraska

A large number of drainage crossings are proposed in Nebraska, as shown in Appendix F, Table F-1. In addition to the Missouri River tributaries, the primary watersheds along the pipeline route include the Elkhorn River drainage, the Platte River drainage, and the Big Blue River basin. The Elkhorn is a highly meandering river with numerous oxbows and sloughs along its floodplain in the project vicinity. The Platte River at the proposed pipeline crossing is a highly braided stream, approximately 1,200 feet wide. It is located within sandy floodplain deposits up to three miles wide.

Kansas

The Big Blue River and its tributaries will be crossed in Kansas. Additional stream crossings in Kansas are proposed within the North Elm Creek drainage, the Robidoux Creek drainage, Wildcat Creek drainage, the Delaware River watershed, the Harris Creek drainage, and others. At the second proposed crossing of the

Missouri River, the channel is approximately 600 feet wide. A system of channel controls (levee and jetties) is located along the west bank and levees and ditches are located along the east bank.

Missouri

As indicated in Appendix F, Table F-1, a large number of streams will be crossed along the proposed route through Missouri. Major drainages to be crossed will include the Platte River (of Missouri); Castile Creek in Buchanan and Clinton counties; the Little Platte River, Mud Creek in Caldwell County; the Grand River watershed; the Chariton River and a number of its tributaries; Coon Creek tributaries in Montgomery County; the West Fork drainage of the Cuivre River in Audrain County; and the Cuivre River in Lincoln and St. Charles counties.

The proposed route crosses the Grand River. The floodplain is approximately five and one-half miles wide at the proposed crossing and there is a levee inland from the east bank of the river. The Missouri River is about 18 river miles downstream of the Grand River crossing, along an extensive system of levees. The Chariton River crossing will be about 12 miles upstream of the Missouri River, along an excavated channel. Levee systems are extensive along the Mussel Fork and the Little Chariton tributaries in the vicinity of the proposed route. At Bear Creek and Camp Creek in Lincoln County, the proposed route crosses deeply inset valleys less than a mile upstream of the Cuivre River. Further east, the Cuivre River is crossed twice as the proposed route enters St. Charles County. North of O'Fallon, Missouri, the proposed route begins to cross the extensive levee and ditch system on the floodplain at the confluence of the Mississippi and Missouri rivers. Abandoned stream meanders, ponds, and poorly drained conditions are common in the locale.

Illinois

The proposed route leaves the confluence floodplain system about five miles after crossing the Mississippi River. The Mississippi River is about 0.4 mile wide at the proposed crossing location. Cahokia Creek will be crossed within about three miles further eastward into Illinois from the Mississippi River floodplain. Highland Silver Lake will be crossed on the East Fork of Silver Creek north of Highland, Illinois. East of the Fayette County line, the proposed route crosses about three miles of floodplain (typically a one-half to one-mile portion is submerged in the spring months) associated with the Kaskaskia River as it flows into Carlyle Lake. This portion of the route is within the Carlyle Lake State Fish and Wildlife Area and Carlyle Dam is approximately 14 miles down the lake to the southwest. Carlyle Lake is a 26,000-acre multi-purpose lake administered by the USACE. The proposed eastern pipeline terminus near Vernon, Illinois, is approximately five miles further east.

In addition to stream crossings, a number of lakes and ponds are located along the proposed pipeline route. These also are indicated in Appendix F, Table F-1. Further map inspections indicate that additional waterbodies (primarily reservoirs or larger lakes) are located within several miles downstream of proposed pipeline crossings. These features are listed in **Table 3.5-1**. Levees and other surface water control features along the proposed route are summarized in **Table 3.5-2**.

3.5.2 Water Quality

The CWA, Section 303(c), requires each state to review, establish, and revise water quality standards for all surface waters within the state. To comply with this requirement, each state crossed by the proposed Keystone Pipeline Project has developed its own beneficial use classification system to describe state-designated use(s). Regulatory programs for water quality standards include default narrative standards, nondegradation provisions, a Total Maximum Daily Load (TMDL) regulatory process for impaired waters, and associated minimum water quality requirements for the designated uses of listed surface waterbodies within the state.

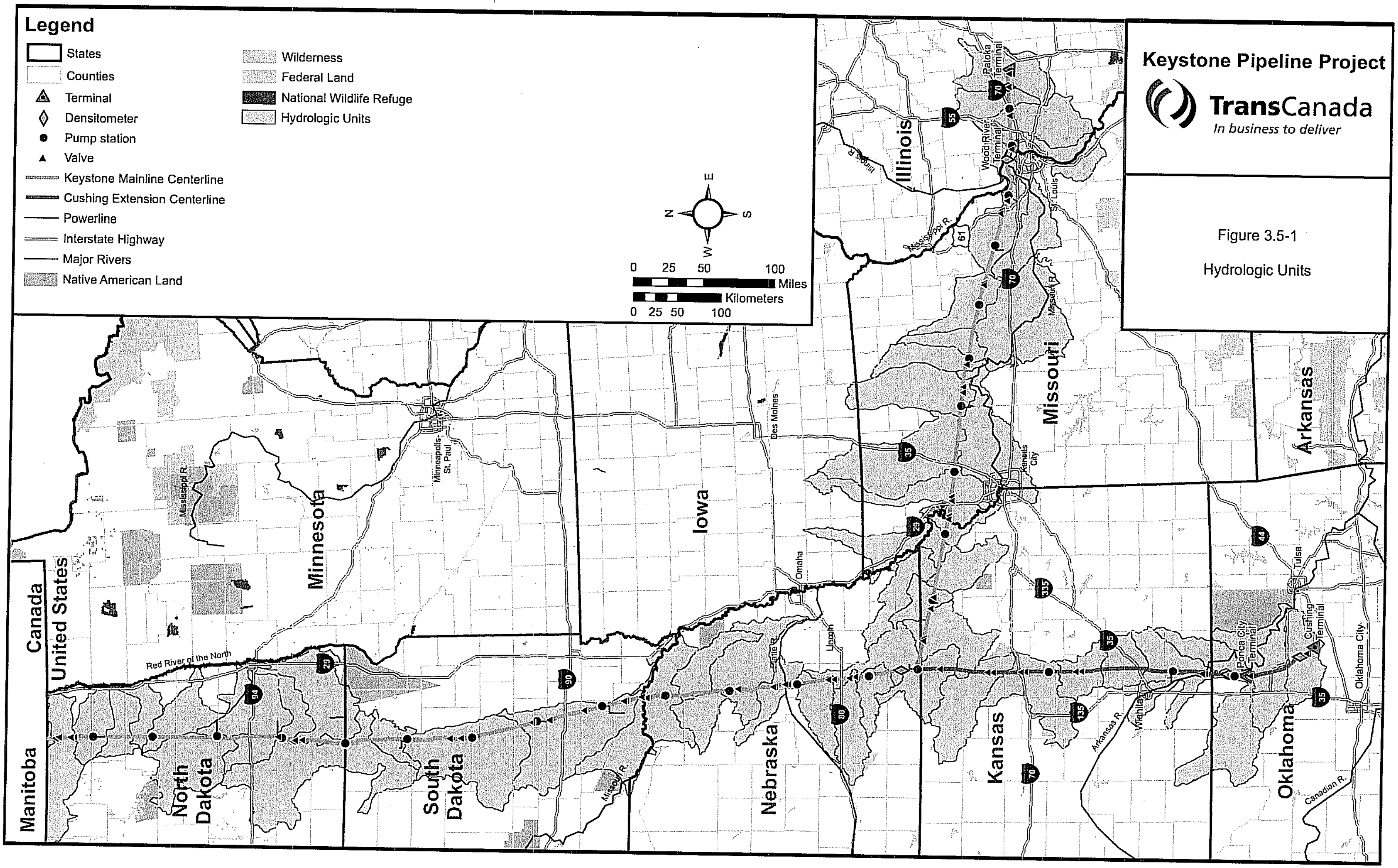


Figure 3.5-1

Hydrologic Units

Table 3.5-1 **Waterbodies Within 10 Miles Downstream of Proposed Crossings**

State	County	Stream Crossing Point	Approx. Milepost	Affected Downstream Reservoir/Fishery/Wildlife Area	Other Description
			KEYSTONE MAINLINE		
North Dakota	Pembina	Smith Coulee Tribs	10.5, 10.9	Weiler Dam/Reservoir	Immediately downstream of tributary crossings, also downstream Jay V Wessels Wildlife Management Area (WMA)
	Pembina	Busee Coulee	13.2	Unnamed reservoir	Downstream of crossing
	Pembina	Tribs to Tounge River	16.2, 17, 17.4	Herzog Dam/ two reservoirs	Two reservoirs just downstream of crossing of tributaries into reservoir
	Pembina	Crossing of Tongue River	18.4	Renwick Dam at Icelandic State Park	Two additional small dams and state wildlife areas immediately downstream of river crossing
	Pembina	Crossing of Willow Creek	20.62	Unnamed reservoir	at 134th Ave.
	Walsh	Crossing of unnamed trib	34.8, 35.3	Charles C Cook State Game Management Area and wetlands	
	Walsh	South Branch Park River	41.5	Homme Lake	Homme Lake and Homme Lake Project
	Nelson	South Branch Forest River Tribs	56.9, 57.4, 58.1	Reservoir/Dam	Large reservoir downstream; Forest River Biology Area below reservoir
	Nelson	Pickart Lake	74.0	Pickart Lake	Within 2,000 feet of the centerline, however, no stream crossings connected to reservoir
	Barnes	Tribs to Sheyenne River	168.0	Lake Ashtabula	Valley City National Fish Hatchery downstream of lake
	Ransom	Trib to Lone Tree Lake	180.3	Lone Tree Lake	Pipeline crosses trib that leads into Lone Tree Lake and Englevale Slough WMA
	Sargent	Trib to Lake Taayer	183.4	Lake Taayer	Lake Taayer, wetlands area

Table 3.5-1 Waterbodies Within 10 Miles Downstream of Proposed Crossings

State	County	Stream Crossing Point	Approx. Milepost	Affected Downstream Reservoir/Fishery/Wildlife Area	Other Description
South Dakota	Marshall	Renzienhausen Slough	228.7	Renzienhausen Slough	Renzienhausen Game Production Area (GPA), wetlands
	Day	Trib	257.5, 257.7	Amsden Lake	Unclear if trib is upstream or downstream
	Clark	Logan Dam/Reservoir	294.0	Logan Dam/Reservoir	Pipeline crosses directly upstream of reservoir
	Clark	Tribs to Fordham Reservoir	299.0	Fordham Reservoir	Area also includes Fordham GPA/Water Access (WA)
	Beadle	Crossing of Pearl Creek	326.0	Reservoir/Dam	Reservoir and LeClaire Waterfowl Production Area (WPA) dowstream of crossing
	Kingsbury	Lake Iroquois	329.0	Lake Iroquois	Crosses very close to or through Lake Iroquois
	Miner	Tribs to Twin lakes	354.3	Twin Lakes, National Wildlife Production Area (NWPA)	Downstream is Twin Lakes, NWPA, and associated GPA
	Hanson	Trib to Lake Eli	372.7	Lake Eli	NWPA, fishing, and hunting area
Nebraska	Colfax	Crossing of Tribs from Lake McCallister	539.8	Whitetail State Wildlife Management Area (SWMA), 3612 Fishing Spot	Feeds into the Platte River
	Colfax	Platte River	541.0	Whitetail SWMA, 3612 Fishing Spot	
	Butler	Crossing of Deer Creek	544.5, 547.5	Whitetail SWMA, 3612 Fishing Spot	Downstream of river crossing, also feeds into the Platte River
	Seward	Crossing of Lone Tree Creek	577.9	Three small reservoirs	Immediately downstream of crossing
	Jefferson	Crossing through Tribs of Big Indian Creek	626.9, 627.2	Unnamed Reservoir	
	Jefferson	Tribs to Big Indian Creek	633.1	Reservoir	Reservoir southwest of Diller
Kansas	No waterbodies located within 10 miles downstream of proposed crossing.				

Table 3.5-1 **Waterbodies Within 10 Miles Downstream of Proposed Crossings**

State	County	Stream Crossing Point	Approx. Milepost	Affected Downstream Reservoir/Fishery/Wildlife Area	Other Description
Kansas Missouri	Buchanan	Tribs to New Mud Lake/Old Mud Lake	749.9	New Mud Lake/Old Mud Lake	May not be connected to reservoirs but located close to centerline
	Buchanan	Crossing Platte River	762.2	3112, 3120 Fishing Spot	
	Clinton	Crossing of Horse Fork, Little Platte River	778.6, 780.9	Smithville Reservoir, 2668 Fishing area	Large reservoir just south of Plattesburg
	Caldwell	Crossing of Brush Creek	801.2	2696 Fishing Spot	
	Chariton	Crossing of Grand River	840.6	2472 Fishing Spot	
	Chariton	Crossing Tribs of Palmer Creek	851.0, 851.8	Cut-Off Lake	Palmer Creek feeds into Cut-Off Lake then connects to Missouri River
	Montogomery	Crossing of Trib. to Middletown Lake	943.4	Middletown Lake	
	St. Charles	Tribs to Horseshoe and Mud Lake	985.2, 986.0	Horseshoe Lake and Mud Lake	Pipeline crosses through streams between the two waterbodies
	St. Charles	Crossing of Trib to Graus Lake	1002.6	Graus Lake	Pipeline crosses through streams that lead between the two areas
Illinois	Bond	Crosses Highland Silver Lake	1034.8	Highland Silver Lake	Very large reservoir
	Bond	Unnamed Reservoir	1046.2	Unnamed Reservoir	Southeast of Pocahontas
	Bond	Crosses Spring Branch	1059.0	Carlyle Lake and Carlyle Lake SWMA	Very large reservoir

Table 3.5-1 Waterbodies Within 10 Miles Downstream of Proposed Crossings

State	County	Stream Crossing Point	Approx. Milepost	Affected Downstream Reservoir/Fishery/Wildlife Area	Other Description
	Bond/Fayette	Carlyle Lake State Wildlife Management Area	1061.5-1064.5		Pipeline crosses through northern section and various streams and reservoirs
	Fayette/Marion	Tribs to Maggot Creek, North Fork	1066.0-1069.0	Carlyle Lake and Carlyle Lake SWMA	
			CUSHING EXTENSION		
Kansas	Clay	W. Fancy Creek	36.5	Turtle Creek Wildlife Area, Turtle Creek Lake	More than 10 miles downstream, approximately 15 to 20, very large reservoir
	Clay	Lincoln Creek	44, 45.5, 46	Milford Wildlife Area, Milford Lake	Lincoln Creek feeds into the Republican River which leads directly downstream to the Milford Wildlife Area and Milford Lake
	Clay	Republican River	50	Milford Wildlife Area, Milford Lake	Pipeline crossed directly through the Milford Wildlife Area at this crossing. Feeds directly into Milford Wildlife Area and Milford Lake
	Clay	Cane Creek	54	Milford Wildlife Area, Milford Lake	Pipeline crossed directly through the Milford Wildlife Area at this crossing. Feeds directly into Milford Wildlife Area and Milford Lake
	Clay	Trib to Milford Lake	58	Milford Wildlife Area, Milford Lake	
	Clay	Quinnby Creek	61, 62	Milford Wildlife Area, Milford Lake, Milford Lake Project	
	Dickinson	Lyon Creek	98.5, 100, 101.5	Herington Reservoir	Immediately downstream
	Marion	Cottonwood River	117	Marion Lake Reservoir, Marion Lake State Wildlife Area	River crossing is downstream, but passes very closely to lake and WA
	Cowley	Arkansas River	206	Kaw WMA, Kaw Lake	
	Cowley	Spring Creek	210	Kaw WMA, Kaw Lake	Fishing area 3040 directly downstream
Oklahoma	Kay	Cholocco Creek	212, 213	Kaw WMA, Kaw Lake	
	Noble	Trib to Sooner Lake	254	Sooner Lake	

Table 3.5-2 Levees and Water Control Structures

State	County	Milepost	Type of Flood Protection Structure	Waterbody
		KEYSTONE MAINLINE		
North Dakota	N/A	N/A	None	N/A
South Dakota	Marshall	225.5	Spoil bank/ditch	Crow Creek Ditch/Crow Creek
Nebraska	Cedar	436.6	Ditch	Kaiser Ditch
	Cedar	438.2	Ditch/canal	Antelope Creek
	Colfax	537.9	Ditch	Barnholdt Ditch
	Colfax	544.0	Canal	Deer Creek Canal
Kansas	Doniphan	743.3	Embankment/levee	Missouri River
Missouri	Buchanan	743.7	Embankment/levee	Missouri River
	Buchanan	752.7	Embankment/levee	
	Buchanan	752.8	Embankment/levee	
	Chariton	840.5	Levee at or nearby	Grand River area
	Chariton	856.9, 857.1, 857.2	(3) levees	Mussel Fork
	Chariton	857.5	Levee	
	Chariton	867.0	Embankment/levee	Middle Fork Little Chariton River
	Lincoln	971.1	Levee	Cuivre River
	St. Charles	985.4	Ditch	Horseshoe/Mud Lake
	St. Charles	985.7, 985.8	(2) levees	Horseshoe/Mud Lake
	St. Charles	986.0	Ditch	Horseshoe/Mud Lake
	St. Charles	986.4	Levee	Horseshoe/Mud Lake
	St. Charles	987.0	Levee	Fish Slough
	St. Charles	987.4, 987.5	(2) levees	Fish Slough
	St. Charles	987.7	Levee	None
	St. Charles	988.3	(2) levees	None
	St. Charles	988.7	Levee	None
	St. Charles	989.8-990.2	(3) levees	Dardenne Lake Area
	St. Charles	991.8	Levee	None

Table 3.5-2 **Levees and Water Control Structures**

State	County	Milepost	Type of Flood Protection Structure	Waterbody
	St. Charles	1008.9	Levee	Mississippi River Area
	St. Charles	1018.9	Levee	Mississippi River Area
	St. Charles	1021.0	Levee	Mississippi River Area
Illinois	Fayette	1069.8-1070.2	Levee	Carlyle WMA
	Fayette	1070.4	Levee	Carlyle WMA
	Fayette	1071.4	Levee	Carlyle WMA
CUSHING EXTENSION				
Nebraska	None	None	None	None
Kansas	None	None	None	None
Oklahoma	None	None	None	None

Where stream segments have been designated by the states, the uses of surface waterbodies at proposed crossings are indicated in Appendix F, Table F-1. For waterbodies proposed to be crossed, the table also indicates that major uses are supported or impaired as listed by the USEPA. Stream segments listed as impaired by the USEPA, and the reasons for such listing, are identified in **Table 3.5-3**.

A number of National Sediment Quality Survey sampling points located within 10 stream- or river-miles of the proposed ROW are listed as being Tier 1 or Tier 2 sites (USEPA 2004). A Tier 1 site is one where sediment quality is such that associated adverse effects on aquatic life or human health are probable. A Tier 2 site is one where sediment quality is such that associated adverse effects on aquatic life or human health are possible (USEPA 2004). Given that sediment is transported as a natural result of surface flow dynamics, the possibility exists that sediment quality upstream or downstream of Tier 1 or Tier 2 sampling points may have adverse effects on aquatic life or human health. Such locations within proximity of the proposed ROW are identified in **Table 3.5-4**.

A watershed classified as an Area of Probable Concern (APC) is one in which 10 or more sediment sampling sites are categorized as Tier 1 and at least 75 percent of all sampling stations are categorized as either Tier 1 or Tier 2 (USEPA 2004). No APC-classified watersheds occur along the proposed route.

CUSHING EXTENSION

Nebraska

The Cushing Extension route runs approximately two and one-half miles in Nebraska from the Keystone Mainline, just east of Steele City, to the Nebraska border. Tributaries to the Little Blue River are the only proposed stream crossings along this section.

Kansas

Numerous stream crossings are proposed along the Cushing Extension route in Kansas. Some of the major stream crossings in Kansas, along with many of their associated tributaries, include the Little Blue River, West Fancy Creek, the Republican River, the Smokey Hill River, the Cottonwood River, the East Branch Whitewater and Whitewater rivers, and the Arkansas River. The Big Blue River will not be crossed along the Cushing Extension but several of its tributaries will be crossed.

Additionally, several large reservoirs are located within a few miles of some of the major waterbody crossings. Turtle Creek Lake and its associated wildlife area, located in Riley County, lie within 10 miles downstream of the proposed West Fancy Creek crossing. The crossing of the Republican River in Clay County passes through the Milford Wildlife Area, just upstream of Milford Lake. In Marion County, the proposed route crosses the Cottonwood River below Marion Dam. The Marion Reservoir and the Marion Wildlife Area are located within approximately one mile upstream of this crossing. Finally, the crossing of the Arkansas River in Cowley County occurs within approximately 10 miles upstream of Kaw Lake, located in north central Oklahoma. The Kaw Wildlife Management Area also is associated with the reservoir and begins just south of Arkansas City, Kansas. It extends down through Oklahoma along the Arkansas River and ends around Kaw Lake.

Table 3.5-3 Impaired Waterbodies

State	Waterbody Name	Designated Use	Use Support/ Attainment	Impairment	TMDL Priority
KEYSTONE MAINLINE					
NORTH DAKOTA[1]	Pembina River	Fish and Other Aquatic Biota	Fully Supporting but Threatened	Sedimentation / Siltation	2
		Recreation	Fully Supporting but Threatened	Total Fecal Coliform	2
	Tongue River	Fish and Other Aquatic Biota	Fully Supporting but Threatened	Sedimentation / Siltation	1B
	North Branch, Middle Branch, South Branch Park River	Fish and Other Aquatic Biota (Designation for Park River)	Fully Supporting but Threatened	Sedimentation / Siltation, Total Dissolved Solids (TDS) and Organic Enrichment	2
	North Branch, Middle Branch, South Branch, Forest River	Fish and Other Aquatic Biota (Designation for Forest River)	Not Supporting	Biological Indicators, Sedimentation / Siltation, TDS	2
	North Branch Turtle River	Fish and Other Aquatic Biota (Designation for Turtle River)	Not Supporting	Cadmium, Sedimentation / Siltation, Selenium, TDS	2
	Goose River	Fish and Other Aquatic Biota	Not Supporting	Sedimentation / Siltation	2
		Recreation	Fully Supporting but Threatened	Total Fecal Coliform	
	Sheyenne River	Fish and Other Aquatic Biota	Fully Supporting but Threatened	Sedimentation / Siltation	2
		Recreation	Fully Supporting but Threatened / Not Supporting	Total Fecal Coliform	
SOUTH DAKOTA[2]	No Data For Streams Crossed				
NEBRASKA[3]	Missouri River	Primary Contact Recreation	Inhibited	Fecal Coliform	5
		Aquatic Life Use	Inhibited	Dieldrin, polychlorinated biphenyls (PCBs)	
		Agriculture Water Supply	Supported		
		Industrial Water Supply	Supported		
	Antelope Creek	N/A	N/A	N/A	3
	West Bow Creek	N/A	N/A	N/A	3
	Norwegian Bow Creek	N/A	N/A	N/A	3
	Bow Creek	N/A	N/A	N/A	3
	Middle Logan Creek	N/A	N/A	N/A	3

Table 3.5-3 Impaired Waterbodies

State	Waterbody Name	Designated Use	Use Support/ Attainment	Impairment	TMDL Priority
	Elkhorn River	Primary Contact Recreation	Inhibited	Fecal Coliform	5
		Aquatic Life Use	Supported		
	Shell Creek	N/A	N/A	N/A	3
	Lost Creek	N/A	N/A	N/A	3
	Platte River	Primary Contact Recreation	Inhibited	Fecal Coliform	5
		Aquatic Life Use	Inhibited	PCBs	
		Agriculture Water Supply	Supported		
	Deer Creek	N/A	N/A	N/A	3
	Little Blue River	N/A	N/A	N/A	3
	Big Blue River	Aquatic Life Use	Inhibited	DO	5
		Agriculture Water Supply	Supported		
	Lincoln Creek	Aquatic Life Use	Inhibited	Selenium	5
		Agriculture Water Supply	Supported		
	Crooked Creek	N/A	N/A	N/A	3
	West Fork Big Blue River	Primary Contact Recreation	Inhibited	E. Coli, Fecal coliform	5
		Aquatic Life Use	Inhibited	Selenium, Dieldrin	
		Agriculture Water Supply	Supported		
	Turkey Creek	N/A	N/A	N/A	3
	Swan Creek	Aquatic Life Use	Supported		2
		Agriculture Water Supply	Supported		
	Cub Creek	N/A	N/A	N/A	3
KANSAS[4]	Meadow Creek	N/A			
	Indian Creek	N/A		Biological Impairment	1
	Deer Creek	GP, AL-E, CR-b		Atrazine, Berillium, Copper, pH	2 & 3
	Big Blue River	N/A		Atrazine, Berillium, Copper, pH	2 & 3

Table 3.5-3 Impaired Waterbodies

State	Waterbody Name	Designated Use	Use Support/ Attainment	Impairment	TMDL Priority
	North Elm Creek	GP, AL-E, CR-b		Atrazine, Berillium, Copper, pH	1
	Robidoux Creek	GP, AL-E, CR-B			
	Negro Creek	GP, AL-E, CR-b			
	North Fork Wildcat Creek	N/A			
	Wildcat Creek	GP, AL-S, CR-C, DS, FP, GR, IW, IR, LW or GP, E		Biological Impairment	1
	South Fork Big Nemaha River	GP, AL-S, CR-C, DS, FP, GR, IW, IR, LW		Biological Impairment	1
	Harris Creek	GP, AL-E		Biological Impairment	1
	Craig Creek	N/A			
	Delaware River	N/A		Beryllium, Biological Impairment	1
	Walnut Creek	GP, AL-E		Atrazine	1
	Middle Fork Wolf River	GP, AL-E, DS, FP, GR, IW, IR, LW		Atrazine, Biological Impariment	2
	Buttermilk Creek	GP, AL-E, CR-b		Atrazine, Copper	2
	South Fork Wolf River	GP, AL-E, DS, FP, GR, IW, IR, LW		Atrazine, Biological Impariment	2
	Squaw Creek	GP, AL-E, CR-b			
	Halling Creek	GP, AL-E		Atrazine, Biological Impairment	2
	Jordan Creek	GP, AL-E		Copper	3
	Rock Creek	GP, AL-E		Copper	3
	Brush Creek	GP, AL-E			
	Missouri River	GP, AL-S, CR-B, DS, FP, GR, IW, IR, LW			

Table 3.5-3 Impaired Waterbodies

State	Waterbody Name	Designated Use	Use Support/ Attainment	Impairment	TMDL Priority
MISSOURI[5]	Missouri River	IRR, LWW, AQL, WBC-B, SCR, DWS, IND	N/A	Chlorodane, PCBs	M
	Contrary Creek	LWW, AQL, WBC-B	N/A	N/A	N/A
	Platte River	IRR, LWW, AQL, WBC-B, SCR, DWS	N/A	N/A	N/A
	Malden Creek	N/A	N/A	N/A	N/A
	Wolfpen Creek	N/A	N/A	N/A	N/A
	Jenkins Branch	N/A	N/A	N/A	N/A
	Horse Fork Creek	LWW, AQL, WBC-B	N/A	N/A	N/A
	Little Platte River	LWW, AQL, WBC-B, SCR	N/A	N/A	N/A
	Shoal Creek	LWW, AQL, WBC-B, SCR		Fecal Coliform	M
	Little Shoal Creek	N/A	N/A	N/A	N/A
	Deer Creek	N/A	N/A	N/A	N/A
	Plum Creek	N/A	N/A	N/A	N/A
	Log Creek	LWW, AQL, WBC-B, SCR	N/A	N/A	N/A
	Brush Creek	N/A	N/A	BOD, VSS	H
	Crabapple Creek	LWW, AQL, WBC-B	N/A	N/A	N/A
	Mud Creek	LWW, AQL, WBC-B	N/A	N/A	N/A
	Willow Creek	LWW, AQL, WBC-B	N/A	N/A	N/A
	Big Creek	LWW, AQL, WBC-B	N/A	Metals, Sediment	H/M
	Grand River	IRR, LWW, AQL, WBC-A, SCR, DWS	N/A	N/A	N/A
	Potter Slough	N/A	N/A	N/A	N/A
	Salt Creek	LWW, AQL, WBC-B	N/A	N/A	N/A
	Brush Creek	LWW, AQL, WBC-B	N/A	BOD, VSS	H
	Lake Creek	LWW, AQL, WBC-B		Sediment	M

Table 3.5-3 **Impaired Waterbodies**

State	Waterbody Name	Designated Use	Use Support/ Attainment	Impairment	TMDL Priority
	Palmer Creek	LWW, AQL, WBC-B	N/A	N/A	N/A
	Mussel Fork Creek	LWW, AQL, WBC-B	N/A	Sediment	M
	Chariton River	IRR, LWW, AQL, WBC-A, SCR	N/A	N/A	N/A
	Puzzle Creek	LWW, AQL, WBC-B	N/A	N/A	N/A
	Middle Fork Little Chariton River	LWW, AQL, WBC-B (classifications for Little Chariton River)	N/A	N/A	N/A
	East Fork Little Chariton River	LWW, AQL, WBC-B (classifications for Little Chariton River)	N/A	N/A	N/A
	Big Creek	N/A	N/A	Metals, Sediment	H/M
	Saling Creek	N/A	N/A	N/A	N/A
	Long Branch Creek	LWW, AQL, WBC-B	N/A	Unknown	M
	Goodwater Creek	N/A	N/A	N/A	N/A
	Youngs Creek	LWW, AQL, WBC-B	N/A	N/A	N/A
	Skull Lick Creek	N/A	N/A	N/A	N/A
	South Fork Salt River	N/A	N/A	N/A	N/A
	Bean Creek	LWW, AQL, WBC-B	N/A	N/A	N/A
	Littleby Creek	LWW, AQL, WBC-B	N/A	N/A	N/A
	West Fork Cuivre River	LWW, AQL, WBC-B	N/A	N/A	N/A
	Coon Creek	LWW, AQL, WBC-B	N/A	N/A	N/A
	Long Branch Creek	N/A	N/A	N/A	N/A
	Elkhorn Creek	LWW, AQL, WBC-B	N/A	BOD, VSS	H
	Brush Creek	LWW, AQL, WBC-B	N/A	BOD, VSS	H
	Bear Creek	LWW, AQL, WBC-B	N/A	Unknown	M
	Camp East Creek	N/A	N/A	N/A	N/A

Table 3.5-3 Impaired Waterbodies

State	Waterbody Name	Designated Use	Use Support/ Attainment	Impairment	TMDL Priority
	Cuivre River	LWW, AQL, WBC-B/A, SCR	N/A	N/A	N/A
	Whites Branch Creek	N/A	N/A	N/A	N/A
	Peruque Creek	LWW, AQL, WBC-B/A, SCR		NVSS	M
	Belleau Creek	LWW, AQL, WBC-B	N/A	N/A	N/A
	Dardenne Creek	LWW, AQL, WBC-B/A, SCR		Unknown	M
	Trinity Channel	N/A	N/A	N/A	N/A
	Grand Lake	N/A	N/A	N/A	N/A
	Mississippi River	IRR, LWW, AQL, WBC-B, SCR, DWS, IND		Chlordane, PCBs	M
ILLINOIS[6]	Mississippi River				
	Indian Creek	Aquatic Life	Not Supporting	Habitat Assessment	(Category) 4C
		Fish Consumption	Fully Supporting		
		Primary Contact	Not Assessed		
		Secondary Contact			
		Aesthetic Quality			
	Cahokia Creek	Aquatic Life	Fully Supporting		2 & 5
		Fish Consumption			
		Primary Contact	Not Supporting	Fecal Coliform	
		Secondary Contact	Not Assessed		
		Aesthetic Quality			
	Burrough's Branch (N. loop)	Aquatic Life	Not Assessed	N/A	3
		Fish Consumption			
		Primary Contact			
		Secondary Contact			
		Aesthetic Quality			

Table 3.5-3 Impaired Waterbodies

State	Waterbody Name	Designated Use	Use Support/ Attainment	Impairment	TMDL Priority
	Mooney Creek (S. loop)	Aquatic Life	Not Assessed	N/A	3
		Fish Consumption			
		Primary Contact			
		Secondary Contact			
		Aesthetic Quality			
	Sugar Creek	Aquatic Life	Not Assessed	N/A	3
		Fish Consumption			
		Primary Contact			
		Secondary Contact			
		Aesthetic Quality			
	Silver Creek	Aquatic Life	Not Supporting/Fully Supporting	Dissolved Oxygen, Sedimentation/Siltation, TSS, pH, Total Nitrogen, TPH	2 & 5
		Fish Consumption	Fully Supporting		
		Secondary Contact	Not Assessed		
		Aesthetic Quality			
	Sugar Fork	Aquatic Life	Not Assessed	N/A	3
		Fish Consumption			
		Primary Contact			
		Secondary Contact			
		Aesthetic Quality			
	Sand Creek	Aquatic Life	Not Assessed	N/A	3
		Fish Consumption			
		Primary Contact			
		Secondary Contact			
		Aesthetic Quality			

Table 3.5-3 Impaired Waterbodies

State	Waterbody Name	Designated Use	Use Support/ Attainment	Impairment	TMDL Priority
	Highland Silver Lake	Aquatic Life	Not Supporting	Dissolved Oxygen, Sedimentation/Siltation, TSS, TPH, Aldrin	5
		Fish Consumption	Not Supporting	Chlordane	
		Public Food and Processing Water Supplies	Not Supporting	Manganese	
		Primary Contact	Not Assessed		
		Secondary Contact			
		Aesthetic Quality	Not Supporting	Aquatic Algae	
	Shoal Creek	Aquatic Life	Not Supporting/Fully Supporting	Dissolved Oxygen, Sedimentation/Siltation, TSS, TPH, Unknown Impairment	2 & 5
		Fish Consumption	Fully Supporting/Not Assessed		
		Public and Food Processing Water Supplies	Not Supporting	Manganese	
		Primary Contact	Not Supporting/Not Assessed	Fecal Coliform	
		Secondary Contact	Not Assessed		
		Aesthetic Quality			
	Little Beaver Creek	Aquatic Life	Not Assessed	N/A	3
		Fish Consumption			
		Primary Contact			
		Secondary Contact			
		Aesthetic Quality			
	Kaskaskia River	Aquatic Life	Not Supporting/Not Assessed	Dissolved Oxygen, Silver, pH, TSS, TPH, Unknown Impairment	2 & 5
		Fish Consumption	Fully Supporting		

Table 3.5-3 Impaired Waterbodies

State	Waterbody Name	Designated Use	Use Support/ Attainment	Impairment	TMDL Priority
		Public Food and Processing Water Supplies	Not Supporting	Manganese	
		Primary Contact	Not Supporting/Fully Supporting/Not Assessed	Fecal Coliform	
		Secondary Contact	Fully Supporting/ Not Assessed		
		Aesthetic Quality	Not Assessed		
	Bear Creek	Aquatic Life	Not Assessed	N/A	3
		Fish Consumption			
		Primary Contact			
		Secondary Contact			
		Aesthetic Quality			
CUSHING EXTENSION					
KANSAS	Little Blue River	GP, AL-E, CR-C, CR-b, DS, FP, GR, IW, IR, LW	Supporting	Copper, Biology	2
	Mill Creek	GP, AL-E, CR-b, FP	Supporting	Atrazine	3
	Coon Creek	GP, AL-E, CR-C, FP	Supporting	No Data	No Data
	Carter Creek	GP, AL-E, CR-b	Supporting	No Data	No Data
	West Fancy Creek	GP, AL-E, CR-b, FP	Supporting	No Data	No Data
	Lincoln Creek	GP, AL-E, CR-b	Supporting	Biology	2
	Republican River	GP, AL-S, CR-C, DS, FP, GR, IW, IR, LW	Supporting	Biology	2
	Chapman Creek	GP, AL-E, CR-C, DS, FP, GR, IW, IR, LW	Supporting	Fecal Coliform; Sulfate	1
	Smoky Hill River	GP, AL-E, CR-C, DS, FP, GR, IW, IR, LW	Supporting	Chloride; Fecal Coliform; Sulfate; Biology	1
	Carry Creek	GP, AL-S, FP	Supporting	Sulfates	1
	West Branch Lyon Creek	GP, AL-S, FP	Supporting	Fecal Coliform	1
	Mud Creek	GP, AL-S, DS, FP	Supporting	Chloride; Fecal Coliform; Sulfate	1

Table 3.5-3 Impaired Waterbodies

State	Waterbody Name	Designated Use	Use Support/ Attainment	Impairment	TMDL Priority
	Cottonwood River	GP, AL-E, CR-C, DS, FP, GR, IW, IR, LW	Supporting	Zinc	3
	Spring Branch	GP, AL-E	Supporting	No Data	No Data
	Catlin Creek	GP, AL-S, FP	Supporting	No Data	No Data
	Doyle Creek	GP, AL-E, DS, FP, GR, IW, IR, LW	Supporting	No Data	No Data
	East Branch Whitewater River	GP, AL-E, DS, FP, GR, IW, IR, LW	Supporting	Atrazine	2
	Diamond Creek	No Data	Supporting	No Data	No Data
	Brush Creek	No Data	Supporting	No Data	No Data
	Fourmile Creek	GP, AL-E, FP	Supporting	Atrazine	2
	Rock Creek	GP, AL-E	Supporting	Atrazine	2
	Spring Branch	GP, AL-E	Supporting	No Data	No Data
	Whitewater River	GP, AL-E, DS, FP, GR, IW, IR, LW	Supporting	Atrazine	2
	Badger Creek	GP, AL-E, DS	Supporting	Atrazine	2
	Dry Creek	GP, AL-E	Supporting	Atrazine	2
	Fourmile Creek	GP, AL-E, CR-C, DS, FP, GR, IW, IR, LW	Supporting	Atrazine	2
	Eightmile Creek	GP, AL-E, DS, FP, GR, IW, IR, LW	Supporting	No Data	No Data
	Polecat Creek	GP, AL-E, FP	Supporting	No Data	No Data
	Stewart Creek	GP, AL-E	Supporting	No Data	No Data
	Crooked Creek	GP, AL-E	Supporting	No Data	No Data
	Spring Creek	GP, AL-E	Supporting	Chloride; pH; Fecal Coliform; Sulfate	1; 2; 2; 4
	Arkansas River	GP, AL-S, CR-B, DS, FP, GR, IW, IR, LW	Supporting	pH; Chloride	2;1

Table 3.5-3 Impaired Waterbodies

State	Waterbody Name	Designated Use	Use Support/ Attainment	Impairment	TMDL Priority
OKLAHOMA	Chilocco Creek	No Data	No Data	No Data	No Data
	Bois d'Arc Creek	Agriculture; WW Aquatic Community; Hydropower; Primary Contact Recreation; Public and Private Water Supply; Fish Consumption; Aesthetics	Fully Supporting; Insufficient Information; Insufficient Information; Not Supporting; Fully Supporting; Not Assessed; Fully Supporting	Sulfates, Pathogens, Turbidity	High
	Cowskin Creek	No Data	No Data	No Data	No Data
	Salt Fork Arkansas River	Aesthetics; Agriculture; WW Aquatic Community; Industrial and Municipal Process and Cooling Water; Primary Contact Recreation; Public and Private water supply; Fish Consumption	Insufficient Data; Fully Supporting/Not Assessed; Not Supporting, Fully Supporting; Not Supporting; Not Assessed; Not Assessed	Pathogens, Turbidity	High
	Deadman Creek	Aesthetics; Agriculture; Warm Water Aquatic Community; Industrial and Municipal Process Cooling Water; Primary Contact Recreation; Fish Consumption	Insufficient Data; Insufficient Data; Insufficient Data; Insufficient Data; Not Assessed; Not Assessed	No Data	No Data
	Red Rock Creek	Aesthetics; Agriculture; Warm Water Aquatic Community; Industrial and Municipal Process Cooling Water; Primary Contact Recreation; Fish Consumption	Fully Supporting; Fully Supporting; Not Supporting; Fully Supporting; Not Supporting; Not Assessed	Turbidity	High
	Long Branch	Aesthetics; Agriculture; Warm Water Aquatic Community; Industrial and Municipal Process Cooling Water; Primary Contact Recreation; Fish Consumption	Not Assessed	No Data	No Data
	Greasy Creek	No Data	No Data	No Data	No Data
	Black Bear Creek	Aesthetics; Agriculture; Warm Water Aquatic Community; Industrial and Municipal Process Cooling Water; Primary Contact Recreation; Fish Consumption	Fully Supporting; Fully Supporting; Fully Supporting/Not Supporting; Fully Supporting; Not Supporting; Insufficient Data; Insufficient Data	Unknown Toxicity, Lead, Pathogens, Turbidity	High
	East Brush Creek	Aesthetics; Agriculture; Warm Water Aquatic Community; Industrial and Municipal Process Cooling Water; Primary Contact Recreation; Fish Consumption	Not Assessed	No Data	No Data

Table 3.5-3 Impaired Waterbodies

State	Waterbody Name	Designated Use	Use Support/ Attainment	Impairment	TMDL Priority
	Little Stillwater Creek	No Data	No Data	Nitrates	High
	Cimarron River	Aesthetics; Agriculture; Emergency Water Supply; Warm Water Aquatic Community; Industrial and Municipal Process Colling Water; Primary Contact Recreation; Fish Consumption	Fully Supporting; Fully Supporting; Fully Supporting; Insufficient Information; Fully Supporting; Not Assessed; Not Assessed	Sulfates, Pathogens, Turbidity	High
	Cabin Creek	Aesthetics; Agriculture; Warm Water Aquatic Community; Industrial and Municipal Process Colling Water; Primary Contact Recreation; Fish Consumption	Not Assessed	No Data	No Data

[1]Source: NDDH 2004.

1A = TMDLs are scheduled for completion in the next two years.

1B = TMDL activities (e.g., monitoring or modeling) are scheduled to begin in the next two years.

2 = scheduled for TMDL development in the next 10 years.

3 = impaired for fish consumption due to methyl mercury (low priority for state due to complexities related to fate and transport of methyl mercury and due to interstate and international nature of atmospheric mercury sources.

[2]Source: SDDENR 2004.

[3]Source: Nebraska Department of Environmental Quality (NEDEQ) 2004.

Category 2 = Some of the designated uses are met but there is insufficient information to determine if all uses are being met; Category 3 = Insufficient data to determine if any beneficial uses are being met; Category 5 = One or more beneficial uses are determined to be impaired by one or more pollutants and all of the TMDLs have not been developed. Category 5 waters constitute the Section 303(d) list subject to EPA approval/disapproval.

[4]Source: KDHE 2004.

AL-E = expected aquatic life use.
AL-S = special aquatic life use.
CR-B = primary contact recreation segment is by law or written permission of the landowner open to and accessible to the public.
CR-b = secondary contact recreational segment is not open to and accessible by the public under Kansas law.
CR-C = primary contact recreation segment is not open to and accessible by the public under Kansas law.
DS = domestic water supply use.
FP = food procurement use.
GP = general purpose waters.
GR = groundwater recharge.
IR = irrigation use.
IW = industrial water supply use.
LW = livestock watering use.

Priority Levels – unknown.

[5]Source: MODNR 2004.

AQL = protection of warmwater aquatic life and human health-fish consumption.
BOD = biological oxygen demand (mg/l).
DWS = drinking water supply.
IND = industrial water supply.
IRR = irrigation water supply.
LWW = livestock and wildlife watering.
SCR = secondary contact recreation.
THP = total petroleum hydrocarbons (mg/l).
VSS = volatile (organic) suspended solids (mg/l).
WBC-A = whole body contact recreation open to public with whole body contact recreational use(s).
WBC-B = whole body contact recreation waters not contained within Category A.

Priority M – Medium.

Priority H – High.

[6]Source: ILEPA 2006.

Table 3.5-4 Crossing Locations within 10 Stream-Miles of USEPA Tier 1 or Tier 2 Sediment Sampling Sites

Surface Waterbody Associated with Sampling Site[1]	County	State	Waterbody Crossing Closest to Sampling Site (MP)[2]	USEPA Sediment Quality Category
KEYSTONE MAINLINE				
Pembina River	Pembina	ND	7	Tier 3
Lewis and Clark Lake	Knox	SD	436	Tier 3
Lake Yankton	Cedar	NE	436	Tier 2
Chalkrock Lake	Cedar	NE	441	Tier 2
Maskenthine Reservoir	Stanton	NE	499	Tier 2
Elkhorn River	Madison	NE	502	Tier 2
Lake Babcock	Platte	NE	535	Tier 3
Loup River	Platte	NE	540	Tier 1
Shell Creek	Colfax	NE	532	Tier 2
Platte River	Butler	NE	542	Tier 1
Lincoln Creek	Seward	NE	574	Tier 2
Big Blue River	Seward	NE	575	Tier 2
Big Blue River	Seward	NE	578	Tier 2, Tier 3
Big Blue River	Seward	NE	582	Tier 1
West Fk., Big Blue River	Seward	NE	591	Tier 1, Tier 2
Turkey Creek	Saline	NE	597	Tier 2
Swan Creek	Saline	NE	613	Tier 2
Big Blue River	Marshall	KS	659	Tier 1, Tier 2 (3)
Missouri River	Buchanan	MO	750	Tier 1, Tier 2 (4)
Platte River	Buchanan	MO	762	Tier 1, Tier 2 (2)
Grand River	Chariton	MO	841	Tier 1, Tier 2 (2)
Chariton River	Chariton	MO	862	Tier 2
Middle Fork, Little Chariton River	Randolph	MO	868	Tier 2
East Fork, Little Chariton River	Randolph	MO	872	Tier 2
South Fork, Salt River	Audrain	MO	918	Tier 2
Cottonwood Branch	Lincoln	MO	964	Tier 1
North Fork, Cuivre River	Lincoln	MO	967	Tier 1
Cuivre River	Lincoln	MO	971	Tier 1
Mississippi River	Calhoun	MO	987	Tier 1
Mississippi River	Calhoun	MO	1002	Tier 1
Mississippi River	Jersey	IL	1007, 1009	Tier 1, Tier 2
Mississippi River	Madison	IL	1014	Tier 3
Cahokia Diversion Channel	Madison	IL	1015	Tier 1, Tier 2
Mississippi River	Madison	IL	1015-1021	Tier 1, Tier 2
East Fork, Wood River	Madison	IL	1024	Tier 2
Wood River	Madison	IL	1026	Tier 2

Table 3.5-4 Crossing Locations within 10 Stream-Miles of USEPA Tier 1 or Tier 2 Sediment Sampling Sites

Surface Waterbody Associated with Sampling Site[1]	County	State	Waterbody Crossing Closest to Sampling Site (MP)[2]	USEPA Sediment Quality Category
Indian Creek	Madison	IL	1026	Tier 2
Cahokia Creek	Madison	IL	1027	Tier 1, Tier 2
CUSHING EXTENSION				
Little Blue River	Jefferson	NE	0	Tier 1
Rose Creek	Jefferson	NE	0	Tier 2
Little Blue River	Washington	NE	3	Tier 2
Milford Lake	Geary	KS	67	Tier 2
Smoky Hill River	Dickinson	KS	79	Tier 1
Herington Reservoir	Dickinson	KS	95	Tier 3
Prairie Creek	Sedgwick	KS	152	Tier 3
West Branch Whitewater River	Butler	KS	154	Tier 1
Walnut River	Butler	KS	158	Tier 1
Walnut River	Butler	KS	170	Tier 1
Little Walnut River	Butler	KS	171	Tier 2
Arkansas River	Sumner	KS	192	Tier 3
Arkansas River	Cowley	KS	212	Tier 3
Kaw Lake	Kay	OK	218	Tier 1

[1]Indicates waterbody associated with the sediment sampling location. Waterbody may not be directly impacted by the proposed project.

[2]Indicates the approximate waterbody crossing point that might lead to the USEPA Tier 1 or Tier 2 sampling site. The waterbody, which is crossed by the project, may be a tributary to the waterbody associated with the sampling site. Refer to Appendix F for names and classifications of the crossed waterbodies.

Oklahoma

The major water drainages crossed by the proposed Cushing Extension route in Oklahoma include the Salt Fork Arkansas River in the southeastern corner of Kay County, several of its tributaries, the Cimarron River in southeastern Payne County near Cushing, Oklahoma, and many of its smaller tributaries. The Arkansas River is not crossed in Oklahoma but the river is crossed by the route just above the northern state border in Kansas. However, tributaries to the Arkansas River are crossed throughout Kay County. The proposed route also crosses or intersects the Bois d'Arc Creek nearly a dozen times in Kay County. Additionally, the crossing of Chiloco Creek near the northern Oklahoma boarder occurs several miles upstream of Kaw Lake and its associated Wildlife Management Area.

3.5.3 Groundwater

For this assessment, groundwater resources were investigated by collection and review of existing literature, with additional guidance and assistance provided by state agency personnel. The following descriptions and subsequent assessment of potential impacts are based on the level of detail presented in the existing data and information that was collected for the proposed route. Uncertainty always exists in water resource inventories, due to the locations and intensities of investigations, the number of variables involved, and the nature of the resources themselves. Unconsolidated aquifers generally do not begin or end clearly. Rather, zones thin out, become discontinuous, are not mapped across civil boundaries, do not provide enough water to wells for a desired purpose, or are simply not discovered. Aquifer boundaries are defined arbitrarily under these conditions.

Similarly, solution fissures and other underground features of limestone-dominated terrain are described here in a general fashion where this type of landscape occurs along the project route. As permitting efforts proceed, local expertise will provide additional information and guidance to further address site-specific groundwater issues.

KEYSTONE MAINLINE

The proposed Keystone Mainline route lies almost entirely within the glaciated Central Lowlands physiographic province (Thornbury 1965). Repeated continental glaciations left a complex dispersal of buried stream channels and sand and gravel deposits, frequently covered by subsequent layers of glacial till. Deposits of glacial drift, ancient buried stream courses, and recent stream alluvium generally form the shallowest sources of groundwater in the project region. These are extensively used for agricultural, domestic, and industrial purposes. In locations where such favorable zones are absent or unsaturated, deeper wells have been constructed into bedrock aquifers. However, these are much less common than wells supplied by glacial drift and alluvial sources and generally will be isolated from the proposed pipeline by greater than 100 feet of glacial till overlying sedimentary bedrock.

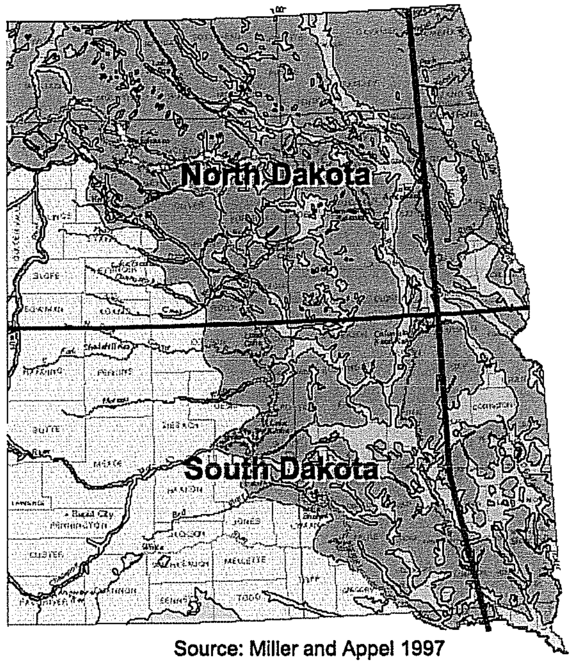
The general locations of coarse-grained deposits in the project region are shown in **Figure 3.5-2**. Not all of these areas contain saturated zones that provide suitable water to wells. It should be noted that the extent and productivity of aquifer zones in these depositional environments vary widely and this complicates the precision and accuracy with which they can be mapped. Small discontinuous lenses of water-bearing materials may occur away from the primary source zone, yet still be hydraulically connected.

North Dakota

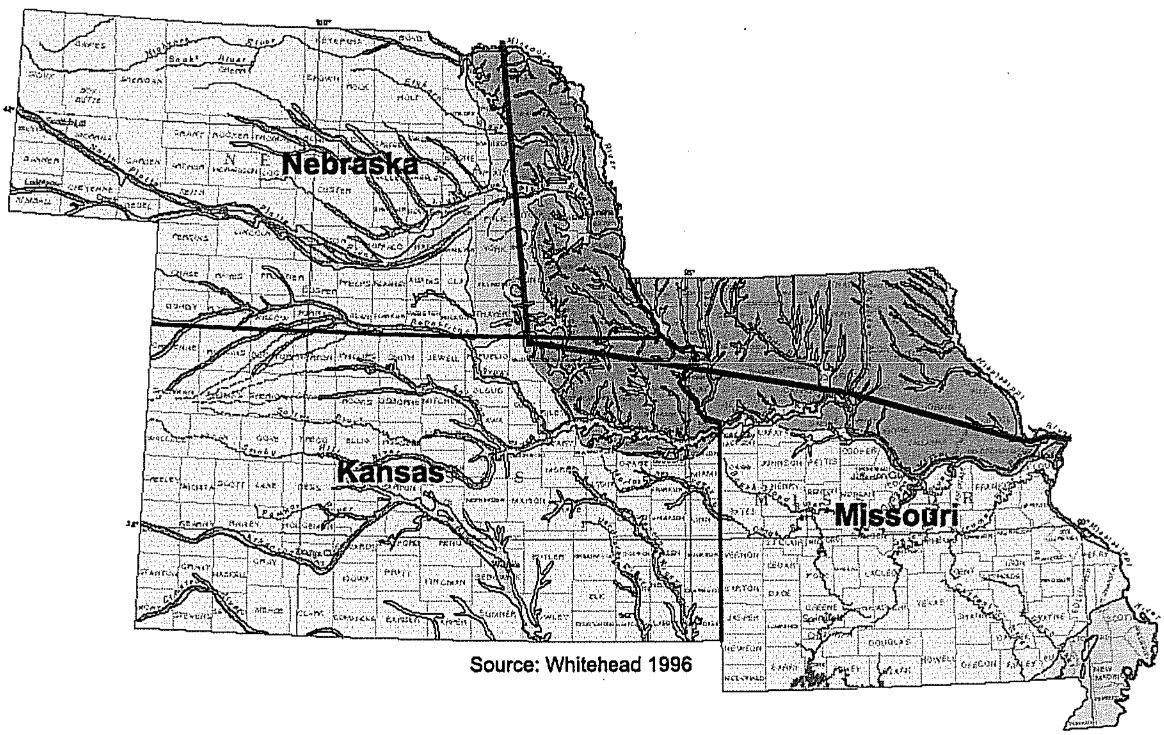
In North Dakota, the proposed route crosses the Pembina River Aquifer and the Pembina Delta Aquifer (Hutchinson 1977). The Pembina River Aquifer is potentially one of the most productive zones in eastern Cavalier and western Pembina counties. It occupies about 20 square miles in Pembina and Cavalier counties. Nearby surface water resources (the Pembina River) and the aquifer are closely interrelated through recharge and discharge. The groundwater/surface water interface is at the surface along most of the floodplain across the proposed route.

The proposed route will cross approximately 3 miles of the Pembina Delta Aquifer where well yields are on the order of 10 to 50 gallons per minute, and 4 miles where well yields are 0 to 10 gallons per minute (Hutchinson 1997). Depth to the saturated zone of this aquifer is approximately 50 feet. Groundwater from the Pembina River and the Pembina Delta aquifers near the proposed route tends to be of the calcium-magnesium bicarbonate type, with total dissolved solids (TDS) concentrations of about 625 milligrams per liter (mg/l) and 340 mg/l, respectively (Hutchinson 1977).

Southward into Walsh County, North Dakota, the proposed route will intersect the Edinburg Aquifer near the county line. The aquifer occupies about 13 square miles and depths to water range from about 20 to 40 feet near the project route (Downey 1973). TDS concentrations range from about 450 to 900 mg/l. The proposed route will pass about three to four miles west of the Fordville and Medford aquifers. The Fordville Aquifer is the largest and most extensively used glacial drift aquifer in Walsh County. Most recharge to the aquifer is from



Source: Miller and Appel 1997



Source: Whitehead 1996

Legend

- Coarse-grained glacial deposits, stream-valley alluvium, or basin fill (may be aquifers)
- Till, loess, and fine-grained glacial-lake deposits (not aquifers)
- Southern extent of continental glacial deposits
- State boundaries
- Proposed Keystone pipeline route (approximate)

TransCanada
In business to deliver

N W E S

0 25 50 100 Miles

Keystone Pipeline Project

Figure 3.5-2

Quaternary Deposits in Eastern North and South Dakota, Nebraska, Kansas, and Missouri

03/20/2006

precipitation and snowmelt. The land surface above the aquifer generally is lacking in drainage features. The Fordville aquifer partially recharges from losing reaches of the Forest River system and discharges back into gaining reaches of the drainage. TDS concentrations range from about 300 to 600 mg/l (Downey 1973).

No major aquifer zones will be intersected by the route through Nelson County (Downey 1973). Most of the proposed route through Steele County is located several miles east of the McVille Aquifer. This aquifer lies in a buried river valley and has significant potential for development. In the extreme southern part of the county, the route lies adjacent to the McVille aquifer for about 6 miles before crossing it one mile south of the Barnes County line. Depth to water in this location is generally 70 to 100 feet, although shallower depths have been recorded (Downey and Armstrong 1977).

The McVille Aquifer and associated waterbearing zones occur for several miles along the proposed route in northern Barnes County, near Lake Ashtabula, in the vicinity of Sibley, North Dakota. This aquifer is readily recharged by precipitation. During an aquifer pumping test in which about two inches of rain fell from isolated thunderstorms, many observation wells underwent rapid water level rises. TDS concentrations in this area are about 2,200 mg/l (Downey and Armstrong 1977). Through most of Barnes County, the route will be located at least four miles east of the McVille aquifer (Kelly 1966).

Just inside Ransom County, the route will pass over the McVille aquifer and trend alongside the Sand Prairie Aquifer. The proposed route will then cross the north-south trend of the Sand Prairie/Englevale aquifers in northwest Ransom County. Both aquifers formed in buried channel deposits. The Englevale Aquifer consists of two (locally three) sand deposits that follow the ancestral course of the Sheyenne River and are mantled by sand and gravel deposits (Armstrong 1982). The depth to water in the aquifer ranges from the land surface near river sloughs to as much as 81 feet where shallower channels do not occur. The aggregate thickness of sand and gravel averages 40 feet but ranges from about five to 140 feet.

The proposed route will cross a branch of the Englevale Aquifer in southern Ransom County and will cross the Spiritwood Aquifer system, the Brampton Aquifer, and the Oakes Aquifer along the western edge of Sargent County (Armstrong 1982). The route will be nearly continuously located over aquifer zones through Sargent County. The Engelvale and Spiritwood aquifers are considered to be hydraulically connected (Armstrong 1982) and the Brampton aquifer is an alluvial tributary of the Spiritwood aquifer. All three formed in coarse-grained alluvial channels formed at different times before subsequently being buried by glacial till. The total area occupied by these aquifer zones is estimated to be approximately 450 square miles and hydraulic connections with similar aquifer zones probably extend well into South Dakota (Armstrong 1982). Locally, however, connectivity may be limited by fine grained materials between aquifer lenses. In the project vicinity, depths to water range from about 10 to 30 feet, with aquifer thicknesses on the order of 100 to 200 feet.

Water in the Englevale Aquifer is dominantly a calcium bicarbonate type but, locally, sodium may be the dominant cation. Sampled TDS concentrations ranged from 255 to 4,670 mg/l, with a mean of 595 mg/l (Armstrong 1982). Water quality in the Brampton Aquifer is mixed, varying with location and depth. Either calcium or sodium is the dominant cation and either bicarbonate or sulfate is the dominant anion. Sampled TDS concentrations ranged from 532 to 1,290 mg/l, with a mean of 948 mg/l (Armstrong 1982). The Spiritwood Aquifer system is extensive, heavily used, and hydrologically connected with other aquifers in North Dakota and probably South Dakota. TDS concentrations in the proposed project area range from about 625 to 2,260 mg/l, with the better water quality (lower constituent concentrations) occurring along the proposed route west of the town of Nicholson (Armstrong 1982).

In southwestern Sargent County and southeastern Dickey County, the proposed ROW will pass through the Oakes Aquifer. This is a water-table aquifer, with its upper boundary at the land surface (Armstrong 1980; Koch and Bradford 1976). It is bounded on the west by the James River. The Oakes Aquifer consists of valley fill, deltaic and lacustrine deposits of sand and gravel interbedded with silt and clay. In general, over 40 feet of silt, clay or glacial till separated the Oakes Aquifer from the underlying Spiritwood aquifer system, but in some places the two are hydraulically connected by downward leakage from the Oakes Aquifer (Armstrong 1980).

The mean saturated thickness is about 30 feet, but ranges from 2 to 100 feet. Yields from wells built in the Oakes Aquifer range from a few gallons per minute to about 1,500 gallons per minute. Water in the Oakes Aquifer is generally a calcium-bicarbonate type. Dissolved solids concentrations generally range from about 300 to 800 mg/l, with an average concentration of about 470 mg/l. In some locations, nitrogen concentrations may be elevated, apparently as a result of contamination from agricultural fertilizers (Armstrong 1980).

South Dakota

Near-surface aquifers in South Dakota consist primarily of sands and gravels deposited by glaciers or within glacially associated features such as lakes and buried channels. Additional aquifers occur in narrow bands of alluvium along stream channels. The Oakes Aquifer underlies the proposed route in Brown County, South Dakota, where it ranges from about 20 to 100 feet thick in the pipeline locale (Koch and Bradford 1976). Along the proposed pipeline route its upper boundary is within 50 feet of the land surface (Koch and Bradford 1976; Jensen 2001a). In South Dakota, this water-bearing zone is typically confined beneath surficial silts and clays. However, permeable eolian sands overlie the aquifer materials along the proposed route in extreme northeastern Brown County, and this cover transitions to sands and gravels as the proposed route trends into Marshall County. The aquifer follows the trend of ancient Lake Dakota in the James River basin, and has been named the "Middle James" aquifer in some existing studies (Koch and Bradford 1976). In Brown County overall, water quality varies widely in this water-bearing zone. Salinity is likely in most locations, with specific conductance ranging from about 700 to 3,000 micromhos per centimeter and averaging about 2,150 micromhos per centimeter (Koch and Bradford 1976). The proposed route overlies both the Brampton and the Oakes aquifers throughout Marshall County. The Brampton or similar aquifer deposits are dominant, with depths to water generally less than 50 feet (Jensen 2001b).

In the rest of South Dakota, the proposed route will largely avoid major aquifer zones, generally crossing the state between the main bodies of the Tulare and Vermillion aquifers and their associated groundwater management units (Geological Survey Program 2001). Through Day County and into Clark County, near-surface aquifer materials are sparse in the glacial drift. A number of small stream deposits will be crossed by the proposed route in northwestern Day County. Near-surface groundwater may occur at these crossings and may be more extensive if suitable coarse-textured glacial drift occurs along or near the drainage. Southward into Clark County and near the Spink County line, the route will cross the Altamont Aquifer north of Raymond, and south of Raymond along Foster Creek. This is another buried channel system. Groundwater is held in two zones. The top of the upper zone is commonly within about two to 10 feet of the ground surface. Depth to the more extensive lower layer ranges from 35 to 80 feet (Hamilton and Howells 1996). The average thickness of the Altamont Aquifer is about 22 feet. Dissolved solids concentrations (by sum of constituents) in samples range from about 500 to 1,400 mg/l, with a mean of 1,000 mg/l (Hamilton and Howells 1996). South of Raymond in west-central Clark County, glacial aquifers are mostly absent except for a branch of the Altamont Aquifer along Foster Creek. The first (shallowest) notable waterbearing zone is in sandstones of the Dakota Formation (Jensen 2001c). This aquifer is typically at depths of 900 to 1,100 feet below the land surface, and is isolated from the surface by thick deposits of glacial till and/or shale beds (Hamilton 1986). In addition, a small buried channel extension of the Tulare Aquifer will be crossed in extreme southern Clark County and into Beadle County for about two miles. The depth to water is likely greater than 50 feet (Schulz 2003).

In extreme southwestern Clark County and further south through Beadle County, near-surface aquifers are absent except for isolated tongues of the Tulare and Floyd aquifers (Howells and Stephens 1968). Generally the uppermost aquifer along the proposed route through northeastern Beadle County is the Codell Sandstone Member of the Carlile Shale, at depths of 350 to 500 feet. This unit is isolated from the surface by overlying glacial till and Niobrara Formation marlstones (Howells and Stephens 1968; Schulz 2003). Aquifers in southwestern Kingsbury County generally are deep below the land surface and are bedrock formations under hundreds of feet of clayey Pierre Shale (Hamilton 1989; Emmons 1988). An isolated branch of the Floyd Aquifer does occur at a depth of about 100 feet near the Miner County line. In Miner County, the uppermost aquifer along the route is generally the Floyd Aquifer, which will be crossed for several miles southwest of Carthage and again south of Roswell through the rest of the county. Dominant chemical constituents in the

Floyd Aquifer are sodium, calcium, and sulfate. TDS concentrations range from about 1,500 to 3,200 mg/l (Koch and McGarvie 1988). Thickness of the Floyd Aquifer ranges from about 20 to 45 feet and depth to the top of the zone ranges from the land surface to about 50 feet in the Carthage vicinity (Koch and McGarvie 1988). In the southern part of Miner County, depth to the aquifer is on the order of 100 feet. Between these areas, the first aquifer materials occur in the Niobrara Formation, an upper Cretaceous marine bedrock consisting of thinly bedded chalk and limestone interbedded with shale. Depths to this zone are generally on the order of 100 feet or more (Jensen 2002). Narrow bands of stream alluvium and associated sand and gravel deposits will be crossed in northwestern Miner County and again in the extreme southern Miner/northern Hanson county area.

The Floyd Aquifer underlies much of the proposed route through Hanson County and nearby studies generally indicate that isolated branches of this or other aquifer zones may occur at depths generally greater than 100 feet in southern McCook County (Cripe and Barari 1977). The Dolton Aquifer generally lies east of the proposed route. The Lower James – Missouri Aquifer occurs beneath the proposed route in southern McCook County and for about two miles at both the extreme northern and southern ends of Hutchinson County (Lindgren and Hansen 1990). This aquifer is approximately 50 to 75 feet thick in northern Hutchinson County and its upper contact is isolated from the surface by about 150 feet of till. The aquifer thickness is highly variable in southern Hutchinson County (reaching a thickness of 130 feet) but the upper contact is still about 150 feet below the surface (Lindgren and Hansen 1990). Dominant chemical constituents are calcium and sulfate. Sampled TDS concentrations range from about 775 to 3,300 mg/l, with an average of 920 mg/l (Lindgren and Hansen 1990). The proposed route continues over the Lower James – Missouri aquifer system through Yankton County. Depths to the aquifer are generally 50 to more than 100 feet. Shallower depths, from less than 50 feet to the land surface, occur at the James River, Beaver Creek, and along the Missouri River at Yankton (McCormick 2003). Groundwater is at or near the surface in the alluvial aquifer along the Missouri River and surface water and groundwater interact extensively there. Along the river, alluvium typically overlies thick deposits of glacial outwash (Johnson and McCormick 2005).

Nebraska

In Nebraska, glacial drift and alluvium continue to form the uppermost groundwater-bearing zones along the proposed ROW. The hydrologic connectivity between surface and groundwater resources in Nebraska was formally recognized by the state legislature with the passage of LB108 in 1996. The subsequent passage of LB962 in 2004 further enacted integrated water resource management in the state. This legislation requires Nebraska's Natural Resource Districts (NRD) annually to evaluate their overall water appropriations relative to sustainable supplies. Several NRDs in western and central Nebraska have determined that they are fully appropriated. In effect, this finding places a hold on new permits for surface water use, groundwater wells, and new irrigated acres until an Integrated Management Plan is jointly developed between the NRD and the Nebraska Department of Natural Resources (NEDNR) and implemented. None of the basin areas (or their respective NRDs) along the proposed route have been determined to be fully appropriated at present (NEDNR 2005).

In Cedar and Wayne counties, undifferentiated Quaternary sands and gravels form part of the High Plains Aquifer. Along the route, these waterbearing zones lie east of thinning sections of the Tertiary-aged Ogallala Formation, a major aquifer in the Great Plains (Miller and Appel 1997). In Stanton County, groundwater seepage provides much of the flow in the Elkhorn River (Newport and Kreiger 1957). Aquifer withdrawals are used mainly for irrigation, municipal supplies, and domestic and livestock water supplies. Norfolk and Stanton are towns near the proposed route using groundwater supplies. In upland settings, depth to Quaternary sands and gravels is on the order of 30 to 60 feet. The water table may be at or near the land surface in stream valleys near waterbody crossings. TDS concentrations are generally between 200 and 600 mg/l.

Quaternary aquifers in Platte and western Colfax counties are similar to those further north. Depth to water is generally 50 to 100 feet in the northern two-thirds of Platte and Colfax counties. This decreases to depths of five to 15 feet as uplands transition into the Platte River valley about 10 miles north of the river itself

(Conservation and Survey Division [C&SD] 1958). Low river terraces and bottomlands continue along the route for about four miles into Butler County. Shallow alluvial groundwater may occur in depressional areas and the headwaters of the Big Blue River near Garrison and Ulysses, Nebraska.

Glacial drift and alluvial aquifers continue through Nebraska in Butler, Seward, Saline, Jefferson, and Gage counties. The glacial aquifers are generally isolated into upper and lower zones by bedrock or clayey and silty glacial till (Verstraeten et al. 1998). Southward through Butler County, watertable depths increase to between 50 and 100 feet as the land surface rises from the Platte River valley. Deep, buried channel systems are cut into the bedrock in parts of Butler, Seward, and Saline counties (Verstraeten et al. 1998). Thick deposits of sand and gravel are more extensive across Saline County (C&SD 1946). These thin considerably to the east of the proposed route and southward from Saline County. The older buried sand and gravel deposits cross the proposed route from west to east and wells are constructed in them to depths of 400 feet or more (C&SD 1955). Sedimentary bedrock formations of Cretaceous age underlie the Quaternary deposits. They consist of the Greenhorn Limestone, Graneros Shale, and the Dakota Group sandstones. The latter occasionally are used for water supply. Depths to water in the glacial drift generally reflect the surface topography, varying from less than 50 to about 100 feet. Groundwater occurs closer to the surface along the Little Blue and Big Blue river valleys. Regionally, underlying Cretaceous formations transition to Permian-aged bedrock in southern Nebraska and northeastern Kansas.

Waters from the unconsolidated Quaternary deposits and Cretaceous bedrock sources generally appear to be of similar quality (Verstraeten et al. 1998). **Table 3.5-5** indicates selected water quality characteristics for major aquifers along this portion of the proposed route. Irrigation is the probable source of the wider variation and higher upper ranges of characteristics in the shallower waterbearing zones.

Table 3.5-5 Selected Groundwater Quality Characteristics in Southeastern Nebraska

Aquifer Zone	pH Range, standard units	pH Mean, standard units	Specific Conductance, Range, µS/cm	Specific Conductance, Mean, µS/cm	Dissolved Nitrate and Nitrite as N, Mean, mg/l
Shallow High Plains	6.1 – 8.8	6.9	320 - 920	620	7.6
Deeper High Plains	6.5 – 8.3	7.0	400 - 960	620	4.2
Undifferentiated High Plains	6.6 – 6.8	6.7	550 - 730	620	6.4
Dakota	7.0 - 7.4	7.3	550 - 570	560	0.26

Source: (Verstraeten et al. 1998).

µS/cm = microSiemens per centimeter; a measure of conductivity.

Kansas

In northern Marshall County, Kansas, the principal saturated zones are alluvium, terrace deposits, glacial drift zones, and the Barneston Limestone (Walters 1954). Sampled water quality from the Barneston Limestone vary widely, with TDS concentrations ranging from about 410 to 2,500 mg/l, and sulfate concentrations ranging from about 30 to 1,540 mg/l. Water quality from terrace deposits also vary considerably. Glacial deposits ranged in TDS from about 190 to 1,070 mg/l, with sulfate ranging from about 20 to 320 mg/l and nitrate ranging from 0.40 to 97 mg/l (Walters 1954). Groundwater from alluvial deposits had more consistent quality, with TDS ranging from about 470 to 650 mg/l and sulfates ranging from about 40 to 60 mg/l. Overall water supplies in Marshall County depend on both surface water and groundwater resources. Marysville, which had depended on Blue River surface water, now obtains its water supply from a relatively new (1990) wellfield southeast of town along a tributary about 10 miles south of the proposed Blue River crossing. Oketo obtains municipal water from a well on the Big Blue River floodplain. Summerfield and Axtell also are supplied by wells (Walters 1954).

Unconsolidated Pleistocene deposits of glacial drift are the best potential sources of groundwater to the east in Nemaha County (Ward 1974). The most favorable waterbearing zones consist of buried channel deposits overlying bedrock. Several sizeable springs flow from the glacial deposits in the region along the proposed route in Kansas. These include Maxwell Spring (near Seneca, Nemaha County) and Sycamore Springs and Sun Springs in Brown County (Buchanan et al. 1998). More recent terrace and alluvial deposits are primarily silt and clay throughout the county and provide little water to wells. Geologic structural deformations lead to Permian sedimentary rocks such as the Barneston, Wreford, Beattie, Foraker, and Grenola limestones forming deep groundwater supplies in Kansas and eastward. In the Permian limestones, TDS values range from about 1,000 to 3,000 mg/l (Walters 1954). The Grenola Limestone generally has high sulfate concentrations (Ward 1974). These formations generally yield on the order of 50 gallons per minute (gpm) to wells where fracture zones occur. Glacial drift aquifers yielding up to 50 or 100 gpm remain the most significant source of water supply eastward through the Missouri River basin in Brown and Doniphan counties, Kansas.

Unconsolidated deposits of sand and gravel along major streams are locally used as water supply sources. Examples of where these aquifers occur include the Big Blue River and the Missouri River drainages. Depth to groundwater is typically less than 10 feet. TDS concentrations are typically between 250 and 600 mg/l (Ward 1974; Walters 1954). Water levels in the Missouri River floodplain depend on seasonal river fluctuations, large floods, and releases from Gavins Point Dam near Yankton, South Dakota, TDS concentrations in groundwater from Missouri River alluvium are on the order of 500 to 700 mg/l (USGS 2006jbb).

Missouri

Glacial waterbearing zones in Missouri also are extensive as a result of the sequence of continental glaciations that affected the state north of the Missouri River. The deposits generally are similar to those described above for Nebraska and Kansas. On the margins of glaciation, drift deposits and buried streamchannel aquifers may be thinner than deposits to the north and west. Waterbearing zones in the drift consist of isolated lenses of sand and gravel or similarly coarse-textured materials that fill pre-glacial valleys cut into the underlying bedrock surfaces. As a result, many of the glacial drift aquifers in this area are isolated by deep valleys and drain to nearby surface waterbodies and/or adjacent alluvium. The depth to groundwater is highly influenced by topography, generally being deeper along ridges and shallower (e.g., 15 to 20 feet) toward the valley floors. TDS concentrations from the drift aquifers range from about 350 to 800 mg/l (Fuller et al. 1957a,b,c).

Unconsolidated deposits of sand and gravel along stream channels are used locally as water supply sources. Examples of where these aquifers occur include the Platte River, the Grand River, and the Chariton River drainages. Depth to groundwater is typically less than 10 feet.

Bedrock aquifers along the proposed ROW in western and central Missouri consist of sandstones and limestones having a wide variety of geologic ages. Examples include the Mississipian-aged Burlington-Keokuk formation and the Ste. Genevieve formation, the Ordovician-aged Cotter and Kimmswick formations, and the Pennsylvanian Ardmore Formation (Fuller et al. 1957a,b,c). Water from the bedrock formations, particularly the Ordovician and older rocks, is typically poor in quality, with TDS concentrations over 10,000 mg/l. This limits the suitability of these aquifers as sources of drinking water and for other uses. As a result, stream alluvium and glacial zones are the focus of most water supply investigations in the area.

Carbonate rocks that may form karst features (sinkholes, dissolution cavities, caves, and fissures) generally are isolated under 10 to 200 feet of glacial till in southeastern South Dakota, northeastern Nebraska and Kansas, up to where the proposed route crosses central Missouri (Veni 2002). There are potential karst development areas characterized as fissures, tubes, and caves usually less than 1,000 feet long and less than 50 feet deep in Caldwell, Lincoln, and St. Charles counties in Missouri (Davies et al. 1984). Groundwater resources in these areas may be exposed to a wide variety of contaminant sources. The dominant bedrock sequence is Mississippian in age and the dominant water-bearing formations below the glacial drift in eastern Missouri are the Keokuk and Burlington limestones. These supply water to wells primarily from solution cavities (Miller and Appel 1997). A number of springs may occur along the proposed route through Missouri. In southern Carroll and Chariton counties, the Mississippian system contains poor quality water, with TDS concentrations greater than 10,000 mg/l. Eastward from central Randolph County to the St. Charles area along the Mississippi River, TDS concentrations are generally 1,000 mg/l or less and the aquifer is more suitable for use (Miller and Appel 1997).

Illinois

Shallow wells are constructed in the broad floodplain alluvium in the vicinity of the confluence of the Missouri and Mississippi rivers. In Illinois, wells withdraw large quantities of groundwater from terrace deposits of the Cahokia Formation, a Quaternary deposit of river sand, gravel and silt. In Madison County, this extends inland from the Mississippi River approximately 12 miles (Wehrman et al. 2003). Additional shallow sand and gravel aquifers occur in east-central Madison County, in central Bond County, and all along the Kaskaskia River alluvium in Fayette County (Wehrman et al. 2003). Karst features are not present along the project route in westernmost Illinois (Davies et al. 1984). Away from the river, most of the surficial geology along the proposed route in Illinois is composed of end moraine and till plain glacial deposits underlying loess deposits from five to 20 feet thick (Illinois State Geological Survey 2004). Underlying bedrock consists mainly of the Pennsylvanian-aged Shelburn Formation. This consists of interbedded shale, siltstone, limestone, sandstone and coal (Devera and Denny 2003). Aquifer zones less than 15 meters below the land surface are scattered all along the proposed route in Illinois (Berg, no date). Springs occur along or in the vicinity of the proposed route in eastern Madison County, in southwestern Bond County, and in Fayette County (Wetzel and Webb 2004).

CUSHING EXTENSION

Nebraska

Glacial deposits and alluvium form the uppermost groundwater-bearing zones along the Cushing Extension route in Jefferson County. The pipeline also will pass over a portion of the Great Plains aquifer system that lies under these glacial deposits and alluvium or is exposed at the surface (Miller and Appel 1997). Additionally, a series of important natural springs and wells occur near Fairbury, Nebraska. Fairbury's main water supply comes from Crystal Springs, located west of Fairbury, approximately 12 miles northwest of the start of the Cushing Extension ROW and approximately 10 miles west of the mainline ROW. These groundwater supplies make up the Little Blue Public Water Project, which serves several hundred domestic, livestock, and business water supply hookups in Thayer and Jefferson counties, including the villages of Gilead and Gladstone. The Little Blue River intersects the locale, further separating the proposed pipeline from this important water supply. In addition, six wells further west of Fairbury also provide much of the city's water supply. An additional water source for Fairbury comes from three wells located one-half mile east of the town. This latter location is still approximately 11 miles west of the proposed ROW.

Kansas

Several major surface waters in Kansas supply water for municipal, private, irrigational, and other uses. However, groundwater is a major supplier for many of the water demands in the state. Part of the Great Plains aquifer, composed of semi-consolidated or consolidated sedimentary rock, underlies the surficial aquifer system or is exposed at the surface, in Washington and Clay counties (Miller and Appel 1997). This aquifer system is present at the land surface in a band that extends northeastward from south-central Kansas. The pipeline will cross over this aquifer almost the entirety of its route in Washington County. The Great Plains aquifer system consists of two sandstone aquifers in Cretaceous rocks, separated by a shale confining unit (Miller and Appel 1997). The aquifer system extends into the subsurface throughout Kansas and Nebraska, however, the water is often saline in many locations northward and westward from the area where it is exposed. Water with dissolved solid ranges of 1,000 to 10,000 mg/l is fairly typical of the aquifer. Freshwater is withdrawn in Kansas mostly along the southern and eastern margins of this aquifer (Miller and Appel 1997). These are the sections of the aquifer system that are nearest to land surface and contain most of the freshwater. A thick confining unit composed of Cretaceous shale, chalk, and limestone formations overlies the Great Plains aquifer system and separates it from the High Plains aquifer in most places (Miller and Appel 1997).

Further south along the Cushing Extension, primary surficial aquifer zones consist of stream-valley aquifers. These unconsolidated sand and gravel deposits are thickest and most productive in the valleys of large rivers (Miller and Appel 1997). These larger stream-valley aquifers will be crossed in Clay, Dickinson, Marion, and Cowley counties with the crossing of the Republican, Smokey Hill, Cottonwood, and Arkansas rivers. The stream-valley aquifer along the Smoky Hill River can range in width from three to five miles. The upland areas adjacent to this river are underlain by sandstone shale and limestone of Cretaceous to Permian age and are much less permeable than the alluvium (Miller and Appel 1997). The aquifer contains mostly freshwater in its upper 30 to 50 feet. Wells along the Smokey Hill commonly yield 200 to 900 gpm in this region. From Salina eastward, the aquifer contains saline water. As the water moves eastward through the Wellington aquifer, it partially dissolves rock salt and evaporate minerals in the Wellington Formation, increasing chloride and dissolved solids concentrations (Miller and Appel 1997).

Typically, the water in the stream-valley aquifers is under unconfined or water-table conditions. These stream-valley aquifers are in direct hydraulic connectivity with the adjacent streams and water levels in the aquifers closely mimic water levels in their related streams. Productivity close to 3,000 gpm has been reported from stream valley aquifers in Kansas, although more typical yields range from 100 to 1,000 gpm (Miller and Appel 1997). These aquifers are fairly reliable sources of ground water due to their coarse grained composition and high permeability. Water quality in the stream-valley aquifers is generally suitable for most uses, with higher calcium bicarbonate levels producing a hard water. Dissolved solids typically measure less than 500 mg/l, but can vary from location to location by as much as 7,000 mg/l (Miller and Appel 1997).

The Flint Hills aquifer system, extending north to south across east-central Kansas, consists of Permian limestones in the Chase and Council Grove groups. The Flint Hills aquifer lies beneath most of the route from Clay County to Cowley County. It is the source of water for many small springs and public water supplies. The principal limestones in this region are the Nolands, Winifield, and Barneston Limestones (Aber 2004). Some wells yield up to 1,000 gpm from these limestones (Macfarlane 2000). The continued movement of groundwater through the limestones in the region has created a network of solution-widened fractures and conduits of varying size. These features vary widely in size from fractures that are several millimeters wide up to one meter in diameter (Macfarlane et al. 2005). Sinkholes also are common where these formations crop out in uplands and springs emerge from these units in valleys and stream channels (Aber 2004).

The proposed Cushing Extension route will cross close to or through regions, mainly in Dickinson, Marion, and Butler counties that contain sinkholes and springs, however, these features are scattered throughout the entire region crossed in Kansas. In Marion County, the proposed Cushing Extension follows a route through the middle of the county, running just west of the eastern third of the county that is heavily dotted with sinkholes and springs. In central Butler County, the Cushing Extension route may pass through a section of scattered sinkholes and several springs. In Clay County, the ROW runs through the western third of the county, avoiding most of the sinkholes and springs, which are more centrally located in the county. Groundwater of the Flint Hills region generally has high TDS and high hardness concentrations (Aber 2004).

Regional groundwater evaluations have not been performed in much of eastern and central Kansas, however, it is believed that the Flint Hills aquifer is most appropriate for domestic and stock wells and other isolated, low volume uses (Macfarlane et al. 2000). The freshwater portion of the Flint Hills aquifer is assumed to be unconfined throughout its extent, with marginal water quality existing in the deeper parts of this aquifer. The Flint Hills aquifer also may have a role in providing short term backup sources for small to medium sized suppliers in drought situations (Macfarlane et al. 2000).

The Wellington aquifer consists of extensively fractured shales of the Permian Wellington Formation, resulting from the dissolution of the underlying halite and gypsum and anhydrite near the updip edge of the Hutchinson Salt Member of the Wellington Formation (Macfarlane 2000). This aquifer extends southward from Saline County to the Kansas-Oklahoma border. The formation of sinkholes and subsidence features at the surface continues to develop naturally in this region (Macfarlane et al. 2005). The proposed Cushing Extension route parallels the Wellington aquifer several miles east of its approximate boundary through the majority of Kansas. A small branch of this aquifer may be crossed in the southwest corner of Cowley County.

Small segments of the pipeline in Dickinson, Marion, Butler, and Cowley counties also may traverse through a large confining unit that stretches across the whole eastern third of Kansas. Only small to moderate amounts of water can be obtained from wells completed in these confining units, which have no principal aquifer (Miller and Appel 1997).

Oklahoma

Throughout its route in Kay, Noble, Pawnee, and Payne counties, the pipeline will predominantly pass over a large region with no principal aquifer. The main aquifers to consider will be those small and large stream valley alluvial terraces crossed along the route. Two alluvial aquifers of significant importance will be intersected along the Cushing Extension route in Oklahoma. The first is the Salt Fork Arkansas River, which will be crossed in Kay County, and the second is the Cimarron River, which will be crossed in Payne County. The Arkansas River, another significant alluvial aquifer will be crossed just north of the Oklahoma state border in Nebraska. These alluvial aquifers consist mainly of Quaternary age deposits of unconfined sand and gravel, like those seen in Kansas. Some of these deposits may be more than 100 feet thick and several miles wide. Often their total thickness is saturated throughout the year, yielding large quantities of water. These alluvial aquifers are very important sources of water in Oklahoma (Ryder 1996).

The Salt Fork Arkansas River originates in the gypsum hill of southern Kansas. The river contains saline water and is unsuitable for most uses. Alluvium and alluvial terrace deposits up to ten miles wide and 150 feet thick are located along the entire length of the river. Water contained in the alluvium often resembles the chemical quality of the water in the river (Ryder 1996).

The Arkansas River also enters Oklahoma from Kansas. The alluvium and alluvial terraces along the Arkansas can be up to five miles wide and 45 feet thick. Wells constructed within the alluvial beds in the northern portion of the aquifer are used primarily for irrigational use and can yield up to 600 gpm (Ryder 1996).

The Cimarron River contains alluvial terraces on its northeastern side that compose one of the best aquifers in Oklahoma. These highly productive alluvial terraces stretch for 110 miles starting in southern Woods County and ending in Logan County (Ryder 1996). This region lies east of the pipeline route and will not be crossed. However, smaller alluvial terraces along the Cimarron River will be crossed by the pipeline near Cushing, Oklahoma. Water in the Cimarron River alluvial terraces is a calcium-magnesium bicarbonate type with dissolved-solids concentrations of about 400 mg/l or less. Hardness is generally less than 200 mg/l. The water is suitable for municipal purposes as well as for domestic and irrigational supplies (Ryder 1996).

3.5.4 Water Supplies and Wells

KEYSTONE MAINLINE

Along the proposed ROW from the U.S. border to about Jefferson County, Nebraska, municipal water supplies are largely withdrawn from groundwater sources. Along the proposed route from Jefferson County eastward, a mixture of surface water reservoirs and groundwater wells serve municipal supply requirements. St. Joseph, Missouri, is supplied by a groundwater wellfield several miles north of the City in Andrew County (Water-Technology-net 2006). This facility will not be crossed by the proposed pipeline, which will be routed south of the city. Other municipalities are served by Highland Silver Lake and Carlyle Lake in Illinois. Municipal wells in the vicinity of the proposed route are indicated in **Table 3.5-6**. Large numbers of private wells also are located along the proposed route.

CUSHING EXTENSION

Information on locations of water supplies and wells along the Cushing Extension has been requested from appropriate federal, state, and local agencies, and will be analyzed as the project progresses.

3.5.5 Floodplains

From a geomorphic perspective, floodplains are relatively low, flat areas of land that surround waterbodies and hold overflows during flood events. Floodplains are often associated with rivers and streams, where they consist of stream deposited sediments forming levels (or "terraces") deposited at different times along the watercourse.

From a policy perspective, Federal Emergency Management Agency (FEMA) defines a floodplain as being any land area susceptible to being inundated by waters from any source (FEMA 2005). Much of the basic inventory, regulation, and mitigation effort for floodplains and flood mitigation (including the National Flood Insurance Program [NFIP]) has been led by FEMA. EO11988, Floodplain Management, states that actions by federal agencies shall 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 shall 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 1) acquiring, managing, and disposing of federal lands, and facilities; 2) providing federally undertaken, financed, or assisted construction and improvements; and 3) conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities.

KEYSTONE MAINLINE

Within the project area, low terraces occur at nearly every stream crossing. For smaller intermittent and ephemeral drainages, these are typically narrow and infrequently flooded. At crossings of rivers and larger perennial streams, floodplains are wider and may be more frequently flooded to a particular elevation depending on the magnitude of a given flood. Zones of major interest from a regulatory floodplain perspective are indicated on **Table 3.5-7**.

CUSHING EXTENSION

Floodplain settings associated with the Cushing Extension are similar to that for the Keystone Mainline. Significant floodplain crossings are indicated in **Table 3.5-7**.

3.5.6 Wetlands and Riparian Areas

Wetlands and riparian areas were identified along the Keystone Mainline and Cushing Extension by completing field surveys and reviewing aerial photographs for areas where reroutes have been developed. Wetlands and waters of the U.S. along the proposed route were delineated in accordance with the direction provided by the USACE – Omaha, Kansas City, St. Louis, and Tulsa districts. Specific information regarding discussions with the USACE districts' personnel, level of effort, wetland and other waters of the U.S. delineation methodology, and permitting requirements was submitted to the Department of State on September 16, 2006. Keystone coordinated with USACE representatives regarding features that needed to be field-checked and delineated.

Table 3.5-6 Public Water Supplies (PWS) within 1 mile of the Proposed Keystone Centerline

State	County	Approximate Mile Post Marker (mi)	Distance From CL (mi)	Cardinal Direction from CL	PWS Name	Well ID
KEYSTONE MAINLINE						
North Dakota	Pembina	20.24	0.99	east	Cavalier	ND5000201
	Pembina	30.67	0.48	east	North Val	ND3401129
	Pembina	30.71	0.46	east	North Val	ND3401129
	Pembina	30.72	0.40	east	North Val	ND3401129
	Pembina	30.72	0.56	east	North Val	ND3401129
	Walsh	30.73	0.51	east	North Val	ND3401129
South Dakota	Marshall	235.8-236.2	< 0.04	west	Marshal County Source Water Area	unk
	Kingsbury	326.7	0	crosses CL	Zone B Aquifer Protection Area	none
Nebraska	Wayne	488.1	< 1.0	unk	Hoskins, Village of	NE3118101
	Colfax	518	< 1.0	unk	Leigh, Village of	NE3103705
	Seward	577.05	0	crosses CL	Seward Co. SID #2	NE3115904
	Seward	577.55	0	crosses CL	Seward, City of	NE3115905
	Seward	580.58	0	crosses CL	Glenhaven Village Subdivision	NE3110929
	Seward	584.20	0	crosses CL	Milford, City of	NE3115907
	Seward	585.86	0	crosses CL	Milford, City of	NE3115907
	Jefferson	618.88	0	crosses CL	Plymouth, Village of	NE3109503
	Jefferson	636.3	< 1.0	unk	Steele City, Village of	NE3109502
Kansas	Doniphan	736.7	< 1.0	north	Bendena	unk
Missouri	Chariton	859.01	0.96	south	Keytesville	14616
	Chariton	859.04	0.92	south	Keytesville	14615
	Chariton	862.55	0.06	south	Salisbury	14630
	Chariton	862.63	0.06	north	Salisbury	14629
	Chariton	862.86	0.38	north	Salisbury	14628
	Audrain	919.68	0.56	south	National Refractories & Mineral	12790
	Audrain	931.60	0.84	north	Community R-VI School	12791
	Lincoln	961.30	0.46	north	Lincoln Co. Egg Farm	13014
	Lincoln	961.34	0.50	north	Lincoln Co. Egg Farm	10124
	Lincoln	961.35	0.51	north	Lincoln Co. Egg Farm	10123

Table 3.5-6 Public Water Supplies (PWS) within 1 mile of the Proposed Keystone Centerline

State	County	Approximate Mile Post Marker (mi)	Distance From CL (mi)	Cardinal Direction from CL	PWS Name	Well ID
	Lincoln	970.57	0.73	north	Glenmeadows Subd.	16726
	Lincoln	972.79	0.89	north	Lincoln Co. PWSD #1	12706
	Lincoln	974.96	0.78	south	Moscow Mills	10131
	Lincoln	975.30	0.46	north	Lincoln Co. PWSD #1	16983
	Lincoln	976.75	0.91	south	Majestic Lakes	16955
	Lincoln	980.26	0.30	north	Autumn Hills MHP	12875
	Lincoln	980.26	0.29	north	Autumn Hills MHP	12874
	Lincoln	981.18	0.25	south	Joan's Chain of Events	11866
	St Charles	1001.40	0.55	south	Trinity Lutheran	13538
	St Charles	1014.42	0.62	south	West Alton Elem. School	10932
Illinois	Madison	1030	< 0.04	unk	County Highway 1 over Cahokia	26512
	Madison	1030	< 0.04	unk	County Highway 1 over Cahokia	26511
	Madison	1032	< 0.04	unk	IL 157 over Mooney Creek	27998
	Madison	1032	< 0.04	unk	IL 157 over Mooney Creek	27997
	Madison	1032	< 0.04	unk	IL 157 over Mooney Creek	27999
	Madison	1035	< 0.04	unk	N.Y.C. & St. L. RR. Overhead	27222
	Madison	1035	< 0.04	unk	N.Y.C. & St. L. RR. Overhead	27223
	Madison	1035	< 0.04	unk	N.Y.C. & St. L. RR. Overhead	27226
	Madison	1035	< 0.04	unk	N.Y.C. & St. L. RR. Overhead	27228
	Madison	1035	< 0.04	unk	N.Y.C. & St. L. RR. Overhead	27227
	Madison	1035	< 0.04	unk	N.Y.C. & St. L. RR. Overhead	27229
	Madison	1035	< 0.04	unk	N.Y.C. & St. L. RR. Overhead	27225
CUSHING EXTENSION						
Nebraska	Jefferson	N/A	N/A	N/A	NONE	NONE
Kansas	Washington	3.75	0.32	east	Hollenberg	unk
	Washington	20.80	0.20	west	Greenleaf Well #7	unk
	Washington	21.06	0.27	east	Greenleaf Well #8	unk
	Washington	21.67	0.70	east	Greenleaf	unk
	Washington	21.70	0.67	east	Standby Well #5	unk

Table 3.5-6 Public Water Supplies (PWS) within 1 mile of the Proposed Keystone Centerline

State	County	Approximate Mile Post Marker (mi)	Distance From CL (mi)	Cardinal Direction from CL	PWS Name	Well ID
	Washington	21.77	0.71	east	Greenleaf	unk
	Washington	21.78	0.71	east	Greenleaf	unk
	Washington	21.83	0.67	east	Standby Well #6	unk
	Dickinson	73.79	0.37	east	Chapman	unk
	Dickinson	73.80	0.40	east	Chapman	unk
	Dickinson	73.80	0.42	east	Chapman	unk
	Butler	146.13	0.37	west	Potwin	unk
	Butler	146.16	0.38	west	Potwin	unk
	Butler	146.16	0.38	west	Potwin	unk
	Butler	146.20	0.24	west	Potwin	unk
	Butler	146.38	0.02	east	Potwin	unk
	Butler	146.41	0.05	west	Potwin	unk
	Butler	155.27	0.27	west	Towanda	unk
	Butler	155.50	0.78	west	Towanda	unk
	Butler	155.63	0.65	west	Towanda	unk
	Butler	155.78	0.02	west	Towanda	unk
	Butler	155.78	0.02	west	Towanda	unk
	Butler	155.90	0.05	west	Towanda	unk
	Butler	155.90	0.05	west	Towanda	unk
	Cowley	194.81	0.04	west	Winifield	unk
	Cowley	207.25	1.00	east	Arkansas City, Well #4	unk
	Cowley	207.42	1.00	east	Arkansas City, Well #3	unk
	Cowley	207.51	1.00	east	Arkansas City, Well #2	unk
	Cowley	207.57	0.99	east	Arkansas City, Well #1	unk
	Cowley	207.58	0.98	east	Arkansas City, Well #9	unk
Oklahoma	Kay	240.04	0.25	east	Marland	OK2005204
	Kay	240.02	0.26	east	Marland	OK2005204
	Kay	240.00	0.28	east	Marland	OK2005204
	Payne	290.17	0.04	west	Linclon Co RW & Sewer Dist	OK2004105

Table 3.5-7 Significant Floodplains Along the Proposed Route

State	Approximate Milepost	Watercourse Associated with Floodplain
KEYSTONE MAINLINE		
North Dakota	7.1 - 7.2	Pembina River
	168.0 – 168.5	Sheyenne River
South Dakota	228.4 – 228.8	Crow Creek
	390.9 – 391.1	Wolf Creek
	420.9 – 421.9	James River
South Dakota/Nebraska	435.2 – 438.1	Missouri River
Nebraska	502.0 – 503.0	Elkhorn River
	503.5 – 503.6	Union Creek
	541.9 – 542.3	Platte River
	573.1 – 573.3	Big Blue River
	590.9 – 591.0	West Fork, Big Blue River
Kansas	658.6 – 659.0	Big Blue River
Kansas/Missouri	747.8 – 752.7	Missouri River
Missouri	762.2 – 762.3	Platte River
	812.1 – 812.3	Mud Creek
	840.5 – 840.9	Grand River
	862.3 – 862.5	Chariton River
	867.8 – 868.2	Middle Fork, Chariton River
	871.6 – 871.8	East Fork, Chariton River
	918.4 – 918.5	South Fork, Salt River
	928.4 – 928.7	West Fork, Cuivre River
	971.0 – 971.3	Cuivre River
Missouri/Illinois	985.0 – 1022.1	Mississippi/Missouri River
Illinois	1037.0 – 1037.2	Silver Creek
	1045.9 – 1046.1	East Fork, Silver Creek
	1055.0 – 1055.5	Shoal Creek
	1070.2 – 1073.5	Carlyle Lake (Kaskaskia River)
CUSHING EXTENSION		
Nebraska	None	None
Kansas	4.0 – 4.5	Little Blue River
Oklahoma	9.1 – 14.4	Mill Creek
	49.9 – 51.2	Republican River
	68.5 – 72.0	Chapman Creek
	74.1 – 77.0	Smoky Hill River
	116.4 – 119.0	Cottonwood River
	154.5 – 161.7	Whitewater River
	189.5 – 191.5	Walnut River
	205.0 – 206.2	Arkansas River
	237.0 – 241.0	Salt Fork Arkansas River
	284.0 – 285.0	Cimarron River

In addition to collecting sufficient data for "routine on-site delineations" as per the Corps of Engineers Wetlands Delineation Manual (USACE 1987) and channel characteristics data for drainage crossings, wetland survey teams collected sufficient data (e.g., defined bed and bank and connectivity to navigable waters) for the USACE to make jurisdictional determinations for all wetlands and drainage crossings surveyed in the field.

Wetland and riverine communities crossed by the proposed pipeline are summarized in **Table 3.5-8**. Wetlands and riverine habitats occupy less than five percent of the proposed pipeline route. Of this, the majority occurs in North Dakota, South Dakota, and Missouri. Approximately 86 percent of the wetlands crossed are characterized as palustrine, which includes classifications such as marshes, bogs, and prairie potholes. The remaining 14 percent are riverine or areas that are contained within a channel. A portion of the palustrine wetlands potentially crossed by the ROW is identified as farmed wetlands. A number of wetland areas are located in actively grazed rangeland. Detailed tables that identify all of the wetlands crossed by the proposed ROW by state are provided in Appendix F.

The most common types of wetlands found along the proposed ROW are palustrine emergent and palustrine forested wetlands. Palustrine emergent wetlands are dominated by perennial rooted herbaceous vegetation, while palustrine forested wetlands are dominated by woody species greater than 20 feet in height. Common wetland species identified along the pipeline route are included in Section 3.6, **Table 3.6-1**.

Table 3.5-8 Miles of Wetlands Crossed by the Keystone Pipeline Project

State	Wetland Types Crossed (miles)				
	Palustrine Emergent	Palustrine Forested	Riverine/ Open Water/	Palustrine Scrub Shrub	TOTALS
NWI Codes	PEM	PFO	ROW	PSS	
KEYSTONE MAINLINE					
ND	16.7	0.4	0.6	1.0	18.7
SD	18.6	0.0	0.7	0.3	19.6
NE	2.0	0.4	1.3	0.1	3.8
KS	0.5	0.4	1.3	0.0	2.2
MO	1.9	3.3	4.1	0.3	9.6
IL	0.9	0.8	1.1	0.6	3.4
Keystone Mainline Total	**40.6**	**5.3**	**9.1**	**2.3**	**57.3**
CUSHING EXTENSION					
NE	0.0	0.0	0.0	0.0	0.0
KS	2.6	2.8	0.6	0.0	6.0
OK	3.1	1.1	0.2	0.0	4.4
Cushing Extension Subtotal	**5.6**	**3.8**	**0.8**	**0.0**	**10.4**
PROJECT TOTAL	**46.2**	**9.1**	**9.9**	**2.3**	**67.7**

Table 3.5-8 Miles of Wetlands Crossed by the Keystone Pipeline Project

State	Wetland Types Crossed (miles)				
	Palustrine Emergent	Palustrine Forested	Riverine/ Open Water/	Palustrine Scrub Shrub	TOTALS
NWI Codes	PEM	PFO	ROW	PSS	

[1]Delineations were completed for key wetlands and waters of the U.S.; key wetlands and waters of U.S. along a reroute in southeastern North Dakota were identified based on the review of aerial photographs.

[2]Delineations were completed for key wetlands and waters of the U.S.; key wetlands and waters of U.S. along a reroute in northeastern South Dakota were identified based on the review of aerial photographs.

[3]Delineations were completed for key wetlands and waters of the U.S.; key wetlands and waters of U.S. along a reroute in the state were identified based on the review of aerial photographs.

[4]Delineations were completed for wetlands and waters of the U.S. crossed by the Keystone Pipeline Project, excluding land tracts where access had been denied by private landowners.

[5]Delineations were completed for wetlands and waters of the U.S. crossed by the Project, excluding land tracts where access had been denied by private landowners.

[6]Illinois: Delineations were completed for all wetlands and waters of the U.S. from the Mississippi River to the Patoka Terminal.

[7]Preliminary identification of wetlands and waters of the U.S. was based on the review of aerial photographs.

3.6 Terrestrial Vegetation

3.6.1 Vegetative Types

Vegetation types crossed by the Keystone Pipeline Project were delineated based on the review of aerial photographs, general observations made during field reconnaissance activities, and detailed information collected during wetland and waters of the U.S. delineation activities and grassland assessment surveys. Thirteen vegetation types or general land use categories are crossed by the proposed route including cropland, pivot-irrigated cropland, grassland/rangeland, upland forest, palustrine emergent wetland, palustrine shrub/scrub wetland, palustrine forested wetland, streams, open water, ROW, residential, commercial/industrial, and special designation areas (**Table 3.6-1**). Subclasses associated with these vegetation types or general land use categories also have been provided in **Table 3.6-1**. Grassland/rangeland, upland forest, palustrine emergent wetland, palustrine shrub/scrub wetland, palustrine forested wetland, streams, and open water areas support naturally occurring terrestrial and aquatic vegetation whereas residential, commercial/industrial, and special designation areas (e.g., schools, parks, recreational facilities) primarily include artificially created landscapes with minimal naturally occurring vegetation. Cropland and pivot-irrigated cropland areas primarily include introduced crop species, which provide forage and grain for livestock and human consumption. ROW areas consist of previously disturbed areas associated with pipelines and other utilities that have been reclaimed primarily with native herbaceous species and may include some introduced species. Dominant species commonly associated with these vegetation types and general land use categories have been included in **Table 3.6-1**. **Table 3.6-2** provides the approximate mileages of the various vegetation types crossed by the proposed route.

Grasslands that occur along the Keystone Mainline and Cushing Extension were identified via the review of aerial photographs and completion of a grassland assessment survey. Grasslands that occur along the proposed route in southeastern North Dakota and eastern South Dakota were identified during a grassland assessment survey conducted in August 2006. Grasslands in these areas primarily support native grass and forb species typically associated with the mixed grass prairie and are considered important habitat areas for special status plant and wildlife species. Existing grassland mapping completed for the REX West Pipeline Project was used for portions of northeastern Kansas and northwestern and central Missouri where the two pipeline ROWs would be co-located. Grasslands that occur along the remainder of the Keystone Mainline and the Cushing Extension were identified via the review of aerial photographs. **Table 3.6-3** provides a list of the primary grasslands crossed by the Keystone Mainline and Cushing Extension, including the state and county in which they occurred; types, quality, number of grasslands; and approximate MPs.

3.6.2 Sensitive Plant Species

The information presented in this section reflects responses received from appropriate state and federal agencies at the time this document was prepared. This information will continue to be updated throughout the pre-construction process based on continued consultations.

Information on sensitive plant species potentially found along the proposed ROW was obtained from the USFWS, the various state Natural Heritage Programs (NHPs), state wildlife agencies, and field surveys. Federal agencies provided information on special status species. Data on species of special concern or species of concern were provided by the various state wildlife departments. The NHPs provided information on the global status of various plant populations. Surveys were conducted in 2006 in North Dakota and South Dakota along the proposed Keystone Pipeline Project construction ROW for native grassland habitat and for native grassland species. Based upon these information sources, a total of 63 sensitive plants (nine special status species and 54 species of special concern) were identified as potentially occurring within the project area. These species, their associated habitats, and their potential for occurrence along the pipeline ROW are listed and summarized in Appendix G. Occurrence potential along the ROW was evaluated for each plant species based on its habitat requirements and/or known distribution. Based on these evaluations, six sensitive plant species (one special status species and five species of special concern) were eliminated from detailed analysis. The remaining 57 sensitive plant species are analyzed in further detail. Eight are special status species and 49 are species of special concern. The potential occurrences of these species along each segment of the pipeline ROW are presented **Table 3.7-6** and **Table 3.7-7**.

3.6.3 Noxious and Invasive Weeds

After disturbances of the soil, vegetation communities may be susceptible to infestations of noxious species. These species are most prevalent in areas of prior surface disturbance, such as agricultural areas, roadsides, existing utility ROWs, and wildlife concentration areas. The prevention of the introduction or spread of noxious and invasive weeds is a high priority for nearby communities. Under EO 13112 of February 3, 1999 – Invasive Species, federal agencies shall not authorize, fund, or carry out actions likely to cause or promote the introduction or spread of invasive species in the U.S. or elsewhere unless it has been determined that the benefits of such actions outweigh the potential harm caused by invasive species and that all feasible and prudent measures to minimize the risk of harm will be taken in conjunction with the actions.

The terms "noxious weed," and "invasive weed" are often used interchangeably to describe any plant that is unwanted and grows or spreads aggressively. The term "noxious weed" is legally defined under both federal and state laws. Under the Federal Plant Protection Act of 2000 (formerly the Noxious Weed Act of 1974 [7 USC SS 2801-2814]), a noxious weed is defined as "any plant or plant product that can directly or indirectly injure or cause damage to crops, livestock, poultry, or other interests of agriculture, irrigation, navigation, the natural resources of the United States, the public health, or the environment" (USDA Agriculture, Animal, and Plant Health Inspection Service [APHIS] 2000; Institute of Public Law [IPL] 1994). Under EO 13112 of February 3, 1999, an "invasive species" is defined as "an alien species whose introduction does or is likely to cause economic or environmental harm or harm to human health" (APHIS 1999). The Federal Plant Protection Act contains a list of 137 federally restricted and regulated federal noxious weeds, including 19 aquatic and wetland weeds, 62 parasitic weeds, and 56 terrestrial weeds (7 CFR Chapter III, Part 360). Each state is required to comply with the rules and regulations set forth by this Act and to manage its lands accordingly.

In addition to federally listed noxious weeds, each state crossed by the proposed route maintains a list of regulated and prohibited noxious and invasive weed species. County weed control boards or districts are present in most counties crossed by the pipeline route. These county weed control boards monitor local weed infestations and provide guidance on weed control. **Table 3.6-4** provides a summary of noxious and invasive weeds by state that are known to occur or have the potential to occur along the proposed pipeline route. Noxious weeds that occur widely in areas crossed by the proposed route include: Canada thistle (*Cirsium canadensis*), nodding plumeless thistle (*Cirsium nutans*), leafy spurge (*Euphorbia esula*), purple loosestrife (*Lythrum salicaria*), field bindweed (*Convolvulus arvensis*), and Johnson grass (*Sorghum halepense*) (**Table 3.6-4**).

Table 3.6-1 Vegetation Types Crossed by the Keystone Pipeline

General Designation	Subclass Designations	General Description	Common Species	Occurrence Along ROW by State								
				Keystone Mainline						Cushing Extension		
				ND	SD	NE	KS	MO	IL	NE	KS	OK
Cropland	N/A	• Agricultural fields	Wheat, barley, oats, sorghum, corn, beans, hay	X	X	X	X	X	X			X
		• Horticulturally cultivated species										
		• Planted perennials										
		• Hay meadows										
Urban/Built Up Areas	Commercial/ Residential	• Suburban residential areas	Ornamental trees, shrubs	X	X	X	X	X	X			X
	Urban	• Commercial development areas										
	Impervious/No Vegetation	• Paved areas (roadways, parking lots)										
	Barren/Sand/ Outcrop	• Gravel quarries • Rock outcrops	None	X	X	X	X	X	X			X
Herbaceous Rangeland	Tall Grass Prairie	• Grassland community dominated by tall grasses 3 to 6 feet tall	Big Bluestem (*Andropogon gerardii*), Little Bluestem (*Schizachyrium scoparium*), Indian Grass (*Sorghastrum nutans*)	X	X	X	X	X	X	X	X	X
	Mid-Grass Prairie	• Grassland community dominated by grasses approximately 1 to 2 feet tall	Blue Grama (*Bouteloua gracilis*), Needle and Thread (*Hesperostipa comata*), Green Needlegrass (*Nassella viridula*), Western Wheatgrass (*Pascopyrum smithii*)	X								
	Short Grass Prairie	• Grassland community generally dominated by grasses less than 1 foot tall	Blue Grama (*Bouteloua gracilis*), Buffalograss (*Buchloe dactyloides*)			X						

Table 3.6-1 Vegetation Types Crossed by the Keystone Pipeline

General Designation	Subclass Designations	General Description	Common Species	Occurrence Along ROW by State								
				Keystone Mainline						Cushing Extension		
				ND	SD	NE	KS	MO	IL	NE	KS	OK
	Sand Prairie	• Grassland community on sand or gravel soils, dominated by mid to tall grasses	Sand Bluestem (*Andropogon hallii*), Blue Grama (*Bouteloua gracilis*), Prairie Sandreed (*Calamovilfa longifolia*), Needle and Thread (*Hesperostipa comata*)	X	X	X						
	Non-native Grassland	• Pasturelands planted with non-native cool-season grasses	Fescue (*Festuca* spp.), Smooth Brome (*Bromus inermis*), and other seed pasture grasses				X	X				
	Deciduous Shrubland	• Upland or lowland communities dominated by shrubs	Chokecherry (*Prunus virginia*), Sandbar Willow (*Salix interior*), Silver Buffaloberry (*Shepherdia argentea*), Western Snowberry (*Symphoricarpos occidentalis*)	X	X							
	Conservation Reserve Program	• Mixed native and non-native grasses and forbs. May include shrubs. Land is fallow	A variety of native and introduced grass species	X	X	X	X					
	Mixed Prairie	• Prairie grasses of mixed heights	Grama (*Bouteloua* spp.), Little Bluestem (*Schizachyrium scoparium*)	X	X	X	X					
Upland Forest	Deciduous Woodland	• Woodlands dominated by a wide variety of mixed native and non-native deciduous species	Green Ash (*Fraxinus pennsylvanica*), Quaking Aspen (*Populus tremuloides*), Bur Oak (*Quercus macrocarpa*), American Elm (*Ulmus americana*)	X		X		X				
	Maple-Basswood Forest	• Community dominated by sugar maple and basswood, found in valley slopes and bottoms	Sugar Maple (*Acer saccharum*), Red Oak (*Quercus rubra*), American Basswood (*Tilia americana*)				X					

Table 3.6-1 Vegetation Types Crossed by the Keystone Pipeline

General Designation	Subclass Designations	General Description	Common Species	Occurrence Along ROW by State								
				Keystone Mainline						Cushing Extension		
				ND	SD	NE	KS	MO	IL	NE	KS	OK
	Oak-Hickory Forest	• Upland community dominated by multiple oak and hickory species	Bitternut Hickory (*Carya cordiformis*), Shagbark Hickory (*C. ovata*), White Oak (*Quercus alba*), Black Oak (*Q. velutina*)				X	X	X		X	
	Green Ash Woodland	• Community dominated by green ash, occurs in floodplains and mesic slopes	Boxelder (*Acer negundo*), Green Ash (*Fraxinus pennsylvanica*), American Elm (*Ulmus americana*)	X								
	Aspen Woodland	• Woodlands dominated by aspen species	Green Ash (*Fraxinus pennsylvanica*), Quaking Aspen (*Populus tremuloides*), Bur Oak *Quercus macrocarpa*)	X								
	Bur Oak Woodland	• Woodlands dominated by bur oak, generally in ravines and well-drained uplands	Green Ash (*Fraxinus pennsylvanica*), Quaking Aspen (*Populus tremuloides*), Bur Oak (*Quercus macrocarpa*)	X								
	Evergreen Forest	• Forest with greater than 60% evergreen trees	Shortleaf Pine (*Pinus echinata*)					X				
	Mixed Oak Ravine	• Oak forest with multiple species on moderate to steep slopes of ravines and river valleys	Big Bluestem (*Andropogon gerardii*), Bur Oak (*Quercus macrocarpa*), *Chinquapin* Oak (*Q. muhlenbergii*)			X	X	X		X	X	
	Deciduous	• Native deciduous forest communities	Bur Oak (*Quercus macrocarpa*), Post Oak (*Q. stellata*)					X				
Riverine/ Open Water	Open Water	• Open water, sometimes associated with wetland habitat	N/A			X						
	Riverine Wetlands	• Wetlands contained within a channel		X								

Table 3.6-1 Vegetation Types Crossed by the Keystone Pipeline

General Designation	Subclass Designations	General Description	Common Species	Occurrence Along ROW by State								
				Keystone Mainline						Cushing Extension		
				ND	SD	NE	KS	MO	IL	NE	KS	OK
Palustrine Forested Wetlands	Floodplain Woodland	• Wooded communities in floodplains	Green Ash (*Fraxinus pennsylvanica*), Eastern Cottonwood (*Populus deltoides*), Bur Oak (*Quercus macrocarpa*), American Elm (*Ulmus americana*)	X								
	Riparian or Floodplain Woodland	• Temporarily flooded woodlands				X						
	Mixed Oak Floodplain Forest	• Oak-dominated forests with temporary flooding in floodplains	Bitternut Hickory (*Carya cordiformis*), Indian Woodoats (*Chasmanthium latifolium*), Bur Oak (*Quercus macrocarpa*), Shumard Oak (*Q. shumardii*)				X					
	Ash-Elm-Hackberry Floodplain Forest	• Forest in floodplains and upland ravine bottoms; dominated by ash, elm, and hackberry	Common Hackberry (*Celtis occidentalis*), Green Ash (*Fraxinus pennsylvanica*), Elm (*Ulmus* spp.)				X					
	Woody-dominated Wetland	• Semi-permanently or permanently flooded forest community	Maple (*Acer* spp.), Hickory (*Carya* spp.), Oak (*Quercus* spp.)					X				
	Cottonwood Floodplain Woodland	• Floodplain forest dominated by cottonwood species	Green Ash (*Fraxinus pennsylvanicus*), Eastern Cottonwood (*Populus deltoides*), Willow (*Salix* spp.)				X					
Palustrine Emergent/ Scrub-Shrub Wetlands	Palustrine or Emergent Wetlands	• Temporary, seasonal, or semipermanent wetlands dominated by persistent emergent vegetation	Common Spikerush (*Eleocharis palustrisi*), Rush (*Juncus* spp.), Rice Cutgrass (*Leersia oryzoides*), Bulrush (*Schoenoplectus* spp.), Bur-reed (*Sparganium* spp.), Cattail (*Typha* spp.)	X	X	X	X	X	X	X	X	X

Table 3.6-1 Vegetation Types Crossed by the Keystone Pipeline

General Designation	Subclass Designations	General Description	Common Species	Occurrence Along ROW by State: Keystone Mainline ND	SD	NE	KS	MO	IL	Cushing Extension NE	KS	OK
	Riparian Shrubland	• Temporarily flood shrub community	Sedge (*Carex* spp.), Willow (*Salix* spp.), Bulrush (*Schoenoplectus* spp.), Western Snowberry (*Symphoricarpos occidentalis*)	X	X	X						
	Aquatic Bed Wetland	• Intermittently, temporarily, or permanently flooded wetlands	Inland Saltgrass (*Distichlis spicata*), Western Wheatgrass (*Pascopyrum smithii*), Smartweed and Knotweed (*Polygonum* spp.), Pondweed (*Potamogeton* spp.)			X						
	Cattail or Freshwater Marsh	• Shallow to deep emergent marshes	Rush (*Juncus* spp.), Bulrush (*Schoenoplectus* spp.), Bur-reed (*Sparganium* spp.), Cattail (*Typha* spp.)	X	X	X	X					
	Herbaceous-dominated Wetland	• Semi-permanently or permanently flooded wetland	Rush (*Juncus* spp.), Bulrush (*Schoenoplectus* spp.), Cattail (*Typha* spp.), Sedge (*Carex* spp.)					X				
Right-of-Way	N/A	• Pipeline and other utilities	Mixture of grasses and forbs				X	X				

Table 3.6-2 Miles of Vegetative Communities Crossed by the Keystone Pipeline ROW

State	Vegetative Communities Crossed (miles)								TOTAL
	Urban or Built-up land	Cropland	Grassland/ Rangeland	Upland Forest Land	Riverine/ Open Water	Palustrine Forested Wetlands	Palustrine Emergent/ Scrub-Shrub	ROW	
KEYSTONE MAINLINE									
ND	0.2	167.6	26.3	3.0	0.6	0.4	17.7	1.1	216.9
SD	1.2	158.6	37.7	0.2	0.7	0.0	18.9	1.6	218.9
NE	0.3	181.0	24.8	2.1	1.3	0.4	2.1	1.7	213.7
KS	0.1	70.5	18.5	7.5	1.3	0.4	0.5	0.0	98.8
MO	2.9	148.3	72.5	35.9	4.1	3.3	2.2	3.9	273.1
IL	0.8	44.4	1.7	4.7	1.1	0.8	1.5	1.6	56.5
Subtotal	**5.5**	**70.4**	**181.5**	**53.4**	**9.1**	**5.3**	**42.9**	**9.8**	**1,077.9**
CUSHING EXTENSION									
NE	0.0	0.8	1.2	0.4	0.0	0.0	0.0	0.0	2.4
KS	0.1	136.6	58.9	5.9	0.6	2.8	2.6	2.2	209.7
OK	0.6	27.7	41.6	2.3	0.2	1.1	3.1	3.2	79.7
Subtotal	**0.7**	**165.1**	**101.7**	**8.6**	**0.8**	**3.9**	**5.7**	**5.4**	**291.8**
PROJECT TOTAL	**6.3**	**935.5**	**283.1**	**61.9**	**9.9**	**9.2**	**48.5**	**15.3**	**1,369.7**

Table 3.6-3 Grasslands Crossed by the Keystone Pipeline ROW

State	County	Grassland Types	Quality of Grasslands	Number of Grasslands	Approximate MPs
KEYSTONE MAINLINE					
North Dakota	Pembina[1]	Native prairie	High	7	6 to 32
	Walsh[1]	Prairie	Medium to high	13	32 to 46
	Nelson[1]	Prairie	High	3	58 to 59
	Barnes[1]	Prairie	Medium	1	124 to 125
	Ransom[1]	Prairie	High	2	167 to 169
	Sargent[2]	Wet lowland, native prairie, pasture and wetland mosaic	Low to high	4	200 to 205
	Dickey[2]	Wet meadows	Medium to high	2	207 to 213
Subtotal				***32***	
South Dakota	Day[2]	Native prairie, grazed pasture, and riparian area	Low to high	7	258 to 272
	Clark[2]	Pasture/wetland mosaic, grassland/wetland, riparian meadow, wetland	Low to medium	8	272 to 298
	Kingsbury[2]	Grassland	Medium/high	1	325 to 326
	Miner[2]	Pasture with isolated wetlands	Low	2	342 to 360
	McCook[2]	Native grassland with wetlands	Medium/high	1	384 to 385
	Hutchinson[2]	Native prairie and pasture	Low and high	2	390 to 392
	Yankton[2]	Native grassland and pasture	Low to high	6	419 to 429
Subtotal				***27***	
Nebraska	Cedar[1]	Grassland	High	1	436 to 437
	Stanton[1]	Grassland	High	1	503 to 504
	Colfax[1]	Grassland	High	1	540 to 541
	Butler[1]	Grassland	High	2	548 to 565
	Saline[1]	Grassland	High	1	606 to 607
	Jefferson[1]	Grassland	High	3	622 to 638
Subtotal				***9***	
Kansas	Nemaha[2]	Mixed grass prairie	Unknown	2	693 to 695
	Brown[2]	Mixed grass prairie	Unknown	2	714 to 715

Table 3.6-3 Grasslands Crossed by the Keystone Pipeline ROW

State	County	Grassland Types	Quality of Grasslands	Number of Grasslands	Approximate MPs
	Doniphan[2]	Mixed grass prairie	Unknown	2	740 to 742
Subtotal				***6***	
Missouri	Clinton[2]	Mixed grass prairie	Unknown	6	770 to 790
	Chariton[2]	Mixed grass prairie	Unknown	3	849 to 866
	Randolph[2]	Mixed grass prairie	Unknown	22	881 to 894
	Audrain[2]	Mixed grass prairie	Unknown	14	904 to 920
Subtotal				***45***	
Illinois	No grasslands observed within the state.	NA	NA	0	NA
MAINLINE TOTAL				**119**	
			CUSHING EXTENSION		
Nebraska	Jefferson[1]	Grassland	Unknown	7	0 to 2.5
Subtotal				***7***	
Kansas	Washington[1]	Grassland	Unknown	22	3 to 31
	Clay[1]	Grassland	Unknown	26	33 to 59
	Dickinson[1]	Grassland	Unknown	49	63 to 98
	Marion[1]	Grassland	Unknown	50	100 to 132
	Butler[1]	Grassland	Unknown	59	136 to 177
	Cowley[1]	Grassland	Unknown	23	181 to 209
Subtotal				***229***	
Oklahoma	Kay[1]	Grassland	Unknown	49	212 to 238
	Noble[1]	Grassland	Unknown	53	240 to 264
	Payne[1]	Grassland	Unknown	76	266 to 291
Subtotal				***178***	
CUSHING EXTENSION TOTAL				**414**	
PROJECT TOTAL				**533**	

[1]Grasslands identified via the review of aerial photography only.

[2]Grasslands identified via the review of aerial photography and field verification.

Table 3.6-4 Noxious and Invasive Weeds Potentially Occurring Along the Proposed Pipeline Route

Common Name[1]	Scientific Name[1]	Habitat	Keystone Mainline						Cushing Extension		
			ND	SD	NE	KS	MO	IL	NE	KS	OK
Russian knapweed	*Acroptilon repens*	Upland	X[2]	X[3,4]	--	X[5]	--		--	X[5]	--
Crested wheatgrass	*Agropyron cristatum*	Upland	X[6]	--	--	--	--	--	--	--	--
Garlic mustard	*Alliaria petiolata*	Upland	X[7]	--	--	--	--	--	--	--	--
Annual ragweed	*Ambrosia artemisiifolia*	Upland	--	--	--	--	--	X[8]	--	--	--
Woolyleaf burr ragweed	*Ambrosia grayi*	Upland	--	--	--	X[5]	--	--	--	X[5]	--
Great ragweed	*Ambrosia trifida*	Upland	--	--	--	--	--	X[8]	--	--	--
Corn chamomile	*Anthemis arvensis*	Upland	X[7]	--	--	--	--	--	--	--	--
Lesser burdock	*Arctium minus*	Upland	--	X[9]	--	--	--	--	--	--	--
Absinthium	*Artemisia absinthium*	Upland	X[2]	X[9]	--	--	--	--	--	--	--
Smooth brome	*Bromus inermis*	Upland	X[6]	--	--	--	--	--	--	--	--
Japanese brome	*Bromus japonicus*	Upland	X[7]	--	--	--	--	--	--	--	--
Cheatgrass Downy brome	*Bromus tectorum*	Upland	X[7]	--	--	--	--	--	--	--	--
Marijuana	*Cannabis sativa*	Upland	--	--	--	--	X[10]	X[8]	--	--	--
Siberian peashrub	*Caragana arborescens*	Upland	X[6]	--	--	--	--	--	--	--	--
Whitetop	*Cardaria draba*	Upland	X[7]	X[3,4]	--	X[5]	--	--	--	X[5]	--
Spiny plumeless thistle	*Carduus acanthoides*	Upland	X[7]	X[9,4]	X[11]	--	--	--	X[11]	--	--
Nodding plumeless thistle	*Carduus nutans*	Upland	X[2]	X[9,4]	X[11]	X[5]	X[10]	X[8]	X[11]	X[5]	X[12]
Meadow knapweed	*Centaurea debeauxii*	Upland	X[7]	--	--	--	--	--	--	--	--

Table 3.6-4 Noxious and Invasive Weeds Potentially Occurring Along the Proposed Pipeline Route

Common Name[1]	Scientific Name[1]	Habitat	Keystone Mainline						Cushing Extension		
			ND	SD	NE	KS	MO	IL	NE	KS	OK
White knapweed	*Centaurea diffusa*	Upland	X[2]	X[9,4]	X[11]	--	--	--	X[11]	--	--
Big-head knapweed	*Centaurea macrocephala*	Upland	X[7]	--	--	--	--	--	--	--	--
Spotted knapweed	*Centaurea maculosa*	Upland	X[2]	X[9,4]	X[11]	--	--	--	X[11]	--	--
Yellow star-thistle	*Centaurea solstitialis*	Upland	X[2]	X[4]	--	--	--	--	--	--	--
Rush skeleton weed	*Chondrilla juncea*	Upland	--	X[4]	--	--	--	--	--	--	--
Chickory	*Cichorium intybus*	Upland	--	X[9]	--	--	--	--	--	--	--
Canada thistle	*Cirsium arvense*	Upland, Wetland	X[2]	X[3,4]	X[11]	X[5]	X[10]	X[8]	X[11]	X[5]	X[12]
Bull thistle	*Cirsium vulgare*	Upland	X[7]	X[9]	--	X[5]	--	--	--	X[5]	--
Poison Hemlock	*Conium maculatum*	Upland	--	X[9]	--	--	--	--	--	--	--
Field bindweed	*Convolvulus arvensis*	Upland	X[2]	X[9,4]	--	X[5]	X[10]	--	--	X[5]	--
Common crupina	*Crupina vulgaris*	Upland	--	X[4]	--	--	--	--	--	--	--
Dodder	*Cuscuta* spp.	Upland	--	X[4]	--	--	--	--	--	--	--
Gypsyflower	*Cynoglossum officinale*	Upland, Woodland	X[7]	X[9]	--	--	--	--	--	--	--
Fuller's teasel	*Dipsacus fullonum*	Upland	--	--	--	--	X[10]	--	--	--	--
Cutleaf teasel	*Dipsacus laciniatus*	Upland	--	--	--	--	X[10]	--	--	--	--
Brazilian waterweed	*Egeria densa*	Aquatic	X[7]	--	--	--	--	--	--	--	--
Russian olive	*Elaeagnus angustifolia*	Upland, Wetland, Woodland	X[6]	--	--	--	--	--	--	--	--
Quackgrass	*Elymus repens*	Upland	X[7]	--	--	X[5]	--	--	--	X[5]	--

Table 3.6-4 **Noxious and Invasive Weeds Potentially Occurring Along the Proposed Pipeline Route**

Common Name[1]	Scientific Name[1]	Habitat	Keystone Mainline						Cushing Extension		
			ND	SD	NE	KS	MO	IL	NE	KS	OK
Leafy spurge	*Euphorbia esula*	Upland	X[2]	X[3,4]	X[11]	X[5]	--	--	X[11]	X[5]	--
Orange hawkweed	*Hieracium aurantiacum*	Upland	X[7]	--	--	--	--	--	--	--	--
Meadow hawkweed	*Hieracium pratense*	Upland	X[7]	--	--	--	--	--	--	--	--
Indian rushpea	*Hoffmannseggia densiflora*	Upland	--	--	--	X[5]	--	--	--	X[5]	--
Black henbane	*Hyoscyamus niger*	Upland	X[7]	--	--	--	--	--	--	--	--
Common St. Johnswort	*Hypericum perforatum*	Upland	--	X[9,4]	--	--	--	--	--	--	--
Broadleaffed pepperweed	*Lepidium latifolium*	Upland	--	X[4]	--	--	--	--	--	--	--
Chinese lespedeza	*Lespedeza cuneata*	Upland	--	--	--	X[5]	--	--	--	X[5]	--
Dalmatian toadflax	*Linaria dalmatica*	Upland	X[2]	X[9,4]	--	--	--	--	--	--	--
Butter-and-eggs	*Linaria vulgaris*	Upland	X[7]	X[9,4]	--	--	--	--	--	--	--
Purple loosestrife	*Lythrum salicaria*	Wetland	X[2]	X[3,4]	X[11]	--	X[10]	--	X[11]	--	--
Black medick	*Medicago lupulina*	Upland	X[6]	--	--	--	--	--	--	--	--
Yellow sweetclover	*Melilotus officinalis*	Upland	X[6]	--	--	--	--	--	--	--	--
Twoleaf watermilfoil	*Myriophyllum heterophyllum*	Aquatic	X[7]	--	--	--	--	--	--	--	--
Spike watermilfoil	*Myriophyllum spicatum*	Aquatic	X[7]	X[4]	--	--	--	--	--	--	--
Scotch cottonthistle	*Onopordum acanthium*	Upland	X[7]	X[9]	--	--	X[10]	--	--	--	X[12]
Reed canarygrass	*Phalaris arundinacea*	Wetland	X[6]	--	--	--	--	--	--	--	--
Kentucky bluegrass	*Poa pratensis*	Upland	X[6]	--	--	--	--	--	--	--	--
Japanese knotweed	*Polygonum*	Upland	X[6]	--	--	--	--	--	--	--	--

Table 3.6-4 Noxious and Invasive Weeds Potentially Occurring Along the Proposed Pipeline Route

Common Name[1]	Scientific Name[1]	Habitat	Keystone Mainline						Cushing Extension		
			ND	SD	NE	KS	MO	IL	NE	KS	OK
	cuspidatum										
Giant knotweed	*Polygonum sachalinense*	Upland	X[7]	X[9]	--	--	--	--	--	--	--
Curly pondweed	*Potamogeton crispus*	Aquatic	X[7]	--	--	--	--	--	--	--	--
Kudzu	*Pueraria lobata*	Upland	--	--	--	X[5]	X[10]	X[8]	--	X[5]	--
Common buckthorn	*Rhamnus cathartica*	Upland, Woodland	X[7]	--	--	--	--	--	--	--	--
Mulitflora rose	*Rosa multiflora*	Upland	--	X[4]	--	X[5]	X[10]	--	--	X[5]	--
Field sowthistle	*Sonchus arvensis*	Upland, Wetland	X[7]	X[3,4]	--	--	--	X[8]	--	--	--
Columbus grass	*Sorghum almum*	Upland	--	--	--	--	--	X[8]	--	--	--
Johnsongrass	*Sorghum halepense*	Upland	--	X[4]	--	X[5]	X[10]	X[8]	--	X[5]	--
Tamarisk	*Tamarix aphylla, T. chinensis, T. gallica, T. parviflora, T. ramosissima*	Upland, Wetland, Woodland	X[2]	X[3]	--	--	--	--	--	--	--
Common tansy	*Tanacetum vulgare*	Upland	--	X[9]	--	--	--	--	--	--	--
Puncturevine	*Tribulus terrestris*	Upland	X[7]	X[9]	--	--	--	--	--	--	--
Narrowleaf cattail	*Typha angustifolia*	Wetland	X[7]	--	--	--	--	--	--	--	--
Hybrid cattail	*Typha x. glauca*	Wetland	X[7]	--	--	--	--	--	--	--	--
Siberian elm	*Ulmus pumila*	Upland	X[6]	--	--	--	--	--	--	--	--
Common mullein	*Verbascum thapsus*	Upland	--	X[9]	--	--	--	--	--	--	--

Table 3.6-4 Noxious and Invasive Weeds Potentially Occurring Along the Proposed Pipeline Route

Common Name[1]	Scientific Name[1]	Habitat	Keystone Mainline						Cushing Extension		
			ND	SD	NE	KS	MO	IL	NE	KS	OK

[1]Updated common and scientific names of noxious and invasive plants was obtained from the PLANTS database as available at http://plants.usda.gov/ (USDA NRCS 2006).

[2]Noxious weeds as defined by the NDDA. These weeds are required to be controlled in any setting by county, state, or federal law. Distribution of these weeds by any means is not allowed (NDDA 2003).

[3]State noxious weeds as defined by the SDDA. These weeds are non-native plant species that are a concern to South Dakota land owners and managers. They can seriously impact the native plant community by altering or affecting agriculture, recreation, and wildlife (SDDA 2006a).

[4]Nonnative plant species, including all plants, plant parts, and seeds capable of propagation, as defined by the SDDA, which are regulated under the South Dakota Common Law (SDCL) 38-24A-6 (SDDA 2006a,b).

[5]Noxious species declared by KSDA legislative action as being 'noxious' (KSDA 2005).

[6]Invasive Plants to Ecological Locations as defined by the North Dakota Department of Agriculture (NDDA). These are plants which are commonly utilized by society for a variety of accepted uses. They become a concern as invasive plants when they invade native, natural areas which are desired to remain entirely native (NDDA 2003).

[7]Invasive Plants to Agricultural & Ecological Locations as defined by the NDDA. These are plants which will invade any area, regardless of use, and cause damage. Injury degree is partly determined by the intended use of invaded area (NDDA 2003).

[8]Noxious weeds are classified as any plant which is determined by the Director, the Dean of the College of Agriculture of the University of Illinois and the Director of the Agricultural Experiment Station at the University of Illinois, to be injurious to public health, crops, livestock, land or other property.

[9]Local noxious weeds as defined by the South Dakota Department of Agriculture (SDDA) Weed and Pest Commission. Statute requirements for control are the same as for statewide noxious weeds (SDDA 2006a).

[10]Noxious weeds, as defined by the Missouri Department of Agriculture (MDA), are extremely aggressive plants that tend to have a very high reproductive potential. Many have no useful value to humans and can be harmful to livestock, wildlife and wildlife habitat. Plants identified by the state as noxious weeds are required by law to be controlled on all properties.

[11]Noxious weeds as defined by the Nebraska Department of Agriculture (NDA). These are species which are destructive or harmful and pose a serious threat to the economic, social, or aesthetic well-being of the residents of the state (NDA 2006).

[12]Noxious species declared by Oklahoma Agriculture Food and Forestry (OAFF) legislative action as being 'noxious' (OAFF 2006).

3.7 Wildlife and Fisheries

3.7.1 Terrestrial Wildlife

Wildlife habitats along the proposed route consist of cropland, native prairie, range or pasture land, deciduous forest lands, riparian woodland, wetlands, and aquatic and riverine habitats. Descriptions of vegetative communities that will be crossed by the proposed route are discussed in Section 3.6. A majority (over 80 percent) of the route corridor will cross cropland or other agricultural areas. Although cropland is undeveloped land that represents open space, it has limited value as wildlife habitat since vegetative cover and food sources are present primarily on a short-term basis due to seasonal harvesting and cultivation. The primary value of agricultural land as wildlife habitat is that it contributes seasonal food sources for small mammals and avian species during the growing season. Crop residue remaining after harvest provides a food source for small mammals, songbirds, and waterfowl.

In view of the predominance of agricultural areas along the proposed route, remaining undeveloped natural areas such as riparian river bottoms, prairie pothole wetlands and aquatic habitat, grasslands and native prairie play an important role in sustaining native wildlife populations. Prairie pothole wetlands are considered a significant habitat for waterfowl and waterbird production, as well as resting, and foraging habitat for other wildlife species. Both upland and riparian woodlands provide important cover and habitat for game species, nesting areas for songbirds, and migratory stopover areas for forest-associated neotropical migrants. Mixed and tall grass native prairie habitat also provide important habitat for wildlife species. Important undeveloped wildlife habitats that will be crossed by the proposed route, as discussed below, include forests, wetlands, grasslands, and surface water features. Refer to **Tables 3.6-2**, **3.8-4**, and **3.8-5** for more detailed information on the following habitats.

North Dakota

Undeveloped wildlife habitat that will be crossed in North Dakota includes approximately 24 miles of USFWS wetland easement areas, 0.3 mile of USFWS Conservation easement, 3.5 miles of deciduous forest, 17.8 miles of non-forested wetlands, 1.2 miles of moderate to high quality, native grassland and 0.6 mile of open water (e.g., rivers, lakes, and ponds). In addition, the project route will cross approximately 0.8 mile of the Tetrault Woods State Forest and four rivers (Pembina, Sheyenne, Tongue, and Branch Forest rivers) that provide important wildlife habitat. Small remnant areas of tall grass prairie and areas of open water (e.g., rivers, lakes, and ponds) also provide important habitat for upland wildlife species and breeding and migrating waterfowl, respectively.

South Dakota

Undeveloped wildlife habitat that will be crossed in South Dakota includes approximately 11.8 miles of USFWS wetland easement areas, 0.5 mile of USFWS Conservation easement, and 1.0 mile of USFWS grassland easement, approximately 18.9 miles of non-forested wetlands, 9.5 miles of moderate to high quality native grassland, and 0.7 mile of open water (e.g., rivers, lakes, and ponds). Important wildlife habitats that will be crossed by the project route approximately 0.5 mile of the project route include a South Dakota Game, Fish, and Parks Department (SDGFD) designated Game Production Area (GPA) and the Missouri River. Small remnant areas of tall grass prairie and areas of open water (e.g., rivers, lakes, and ponds) also provide important habitat for upland wildlife species and breeding and migrating waterfowl, respectively.

Nebraska

Undeveloped wildlife habitat that will be crossed in Nebraska includes approximately 2.5 miles of forest, 0.5 mile of forested wetlands, 2.1 miles of non-forested wetlands, and 1.3 miles of open water (Missouri and Platte rivers). Small remnant areas of tall grass prairie and areas of open water (e.g., rivers, lakes, and ponds) also provide important habitat for upland wildlife species and breeding and migrating waterfowl, respectively.

Kansas

Undeveloped wildlife habitat that will be crossed in Kansas includes approximately 13.4 miles of forest and 1.9 miles of open water. Important wildlife habitats that will be crossed by the project route include approximately 3.6 miles consisting of four crossings of the Milford State WMA and the South Fork Nemaha River and Missouri River. Small remnant areas of tall grass prairie and areas of open water (e.g., rivers, lakes, and ponds) also provide important habitat for upland wildlife species and breeding and migrating waterfowl, respectively.

Missouri

Undeveloped wildlife habitat that will be crossed in Missouri includes approximately 35.9 miles of forest, 3.3 miles of forested wetlands, 2.2 miles of non-forested wetlands, and 4.1 miles of open water. Important wildlife habitats that will be crossed by the project route include two crossings of the Pigeon Hill Conservation Area, approximately 1.1 miles of Nature Conservancy Land, approximately 1.2 miles of Edward "Ted" & Pat Jones-Confluence point State Park, and seven rivers (Missouri, Platte, Grand, Chariton, Cuivre, Salt, and Mississippi rivers). Small remnant areas of tall grass prairie and areas of open water (e.g., rivers, lakes, and ponds) also provide important habitat for upland wildlife species and breeding and migrating waterfowl, respectively.

Illinois

Undeveloped wildlife habitat that will be crossed in Illinois includes approximately 4.7 miles of forest, 0.8 mile of forested wetlands, 1.5 miles of non-forested wetlands, and 1.1 miles of open water. Important wildlife habitats that will be crossed by the project route will include approximately 3.1 miles of the Carlyle WMA. As discussed above, areas of open water also provide important habitat for breeding and migrating waterfowl.

Oklahoma

Undeveloped wildlife habitat that will be crossed in Oklahoma includes approximately 2.3 miles of forest and 0.2 mile of open water. No important wildlife habitats have been identified along the project route in Oklahoma. However, small remnant areas of tall grass prairie and areas of open water (e.g., rivers, lakes, and ponds) also provide important habitat for upland wildlife species and breeding and migrating waterfowl, respectively.

3.7.1.1 Big Game

Habitat preferences and distribution of big game species occurring along or in the region of the proposed route are summarized in **Table 3.7-1**. White-tailed deer is the principal big game species occurring along the proposed route. White-tailed deer are highly adaptable and inhabit a variety of habitats including cropland, grasslands, shrublands, orchards, and woodlands. They can be found in close association with human development. In the northern portions of their range, white-tailed deer "yard up" during severe weather, concentrating along stream bottoms, lakes, or bogs where there is sufficient cover to intercept snow or on south-facing slopes with or without cover where snow accumulations are reduced. White-tailed deer are likely to occur along the entire proposed route corridor. The majority of the proposed route crosses private land that will require landowner permission for hunting privileges; however, two state WMAs crossed by the proposed route provide public hunting opportunities for white-tailed deer as well other small game species. These WMAs include the Pigeon Hill State WMA in Buchanon County, Missouri; and the Carlyle WMA in Fayette County, Illinois.

Table 3.7-1 Game and Furbearer Wildlife Species Potentially Occurring Within the Project Area[1]

Species	Sporting Status	Habitat Association	ND	SD	NE	KS	MO	IL	OK
Mammals									
White-tailed deer *Odocoileus virginianus*	game	This species is found in various habitats from forests to fields with adjacent cover. In northern regions, usually requires stands of conifers for winter shelter. In the north and in montane regions, limited ecologically by the depth/duration/quality of snow cover; summer ranges are traditional but winter range may vary with snow conditions.	X	X	X	X	X	X	X
Mule deer *Odocoileus hemionus*	game	This species is found in coniferous forests, desert shrub, chaparral, grasslands with shrubs, and badlands. Often associated with successional vegetation, especially near agricultural lands. Restricted primarily to the western portions of ND, SD, NE, KS, and OK.	X	X	X	X			X
Pronghorn *Antilocapra americana*	game	This species is generally found in grasslands, sagebrush plains, deserts, and foothills. Need for free water varies with succulence of vegetation in the diet. Restricted primarily to the western portions of ND, SD, NE, and KS.	X	X	X	X			
Elk *Cervus canadensis*	game	This species is found over a range of habitats. Uses open areas such as alpine pastures, marshy meadows, river flats, and aspen parkland, as well as coniferous forests, brushy clear cuts or forest edges, and semi-desert areas. Within project area, located only in northeast ND.	X						
Moose *Alces alces*	game	This species prefers mosaic of second-growth forest, openings, swamps, lakes, wetlands. Requires water bodies for foraging and hardwood-conifer forests for winter cover. Avoids hot summer conditions by utilizing dense shade or bodies of water. In project area, restricted to eastern edge of ND.	X						
Black bear *Ursus americanus*	game	This species prefers mixed deciduous-coniferous forests with a thick understory, but may occur in various situations. In project area, restricted to southern and southeast MO.					X		

Table 3.7-1 Game and Furbearer Wildlife Species Potentially Occurring Within the Project Area[1]

Species	Sporting Status	Habitat Association	ND	SD	NE	KS	MO	IL	OK
Eastern gray squirrel *Sciurus carolinensis*	game	This species prefers mature deciduous and mixed forests with abundant supplies of mast (e.g., acorns, hickory nuts). A diversity of nut trees is needed to support high densities. Also uses city parks and floodplains. Seldom far from permanent open water. Nests in tree cavities or in leaf nests, usually 25 feet or more aboveground.	X	X	X	X	X	X	X
Eastern fox squirrel *Sciurus niger*	game	Often found in open mixed hardwood forest or mixed pine-hardwood associations, this species has also adapted well to disturbed areas, hedgerows, and city parks. Prefer savannas or open woodlands to dense forests. Western range extensions are associated with riparian corridors of cottonwoods and fencerows of osage orange. Dens are in tree hollows (preferred) or leaf nests (especially in mild weather).	X	X	X	X	X	X	X
Eastern cottontail *Sylvilagus floridanus*	game	This species is generally found in early mid-successional habitats over much of continental U.S. May be found in brushy areas, open woodlands, swampy areas, stream valleys, grasslands, and suburbs. Very adaptable species. Nests usually are in shallow depressions in thick vegetation or in underground burrows.	X	X	X	X	X	X	X
Coyote *Canis latrans*	furbearer	Wide ranging and found in virtually all habitats. Often considered a pest species, especially by the livestock industry. Control programs have been largely ineffective.	X	X	X	X	X	X	X
Red fox *Vulpes vulpes*	furbearer	Found in various open and semi-open habitats. Usually avoids dense forest, although open woodlands frequently are used. Sometimes occurs in suburban areas or even cities. Maternity dens are in burrows dug by fox or abandoned by other mammals, often in open fields or wooded areas, sometimes under rural buildings, in hollow logs, under stumps, etc.	X	X	X	X	X	X	X
Gray fox *Urocyon cinereoargenteus*	furbearer	Found in a variety of habitats including chaparral, rimrock, riparian, old fields, early successional stage woodlands. Usually prefers a diversity of open and wooded areas rather than large tracts of homogeneous habitat.	X	X	X	X	X	X	X

Table 3.7-1 **Game and Furbearer Wildlife Species Potentially Occurring Within the Project Area**[1]

Species	Sporting Status	Habitat Association	ND	SD	NE	KS	MO	IL	OK
Swift fox *Vulpes velox*	furbearer	The swift fox resides in shortgrass and midgrass prairies over most of the Great Plains. The swift fox will also use agricultural lands and irrigated meadows. Its range includes most of ND, SD, and NE but not eastern KS and OK or MO and IL.	X	X	X				
Raccoon *Procyon lotor*	furbearer	Found in a variety of habitats but prefers riparian and edges of wetlands, ponds, and lakes.	X	X	X	X	X	X	X
Ermine *Mustela erminea*	furbearer	Inhabits agricultural lowlands, woodlands, and meadows. Range within project area includes only eastern ND.	X						
Long-tailed weasel *Mustela frenata*	furbearer	This is the most widespread weasel. It is found in all habitats within the project area but prefers brushland, open woodlands, and habitats near water.	X	X	X	X	X	X	X
Least weasel *Mustela nivalis*	furbearer	Inhabits cultivated fields, brushy areas, open woods, wetland edges, and meadows.	X	X	X				
Mink *Mustela vison*	furbearer	Wetlands; riparian woodlands; edges of lakes, rivers, and ponds.	X	X	X	X	X	X	X
Striped skunk *Mephitis mephitis*	furbearer	This species prefers semi-open country with woodland and meadows interspersed, brushy areas, bottomland woods. Frequently found in suburban areas. Dens often under rocks, log, or building. May excavate burrow or use burrow abandoned by other mammal.	X	X	X	X	X	X	X
Eastern spotted skunk *Spilogale putorius*	furbearer	Found in forested areas or habitats with significant cover. Also open and brushy areas, rocky canyons and outcrops in woodlands and prairies. When inactive or bearing young, occupies den in burrow abandoned by other mammal, under brushpile, in hollow log or tree, in rock crevice, under building, or in similar protected site.	X	X	X	X	X		X
American badger *Taxidea taxus*	furbearer	This species prefers open grasslands and fields and may also frequent brushlands with little groundcover. When inactive, occupies underground burrow.	X	X	X	X	X	X	X

Table 3.7-1 Game and Furbearer Wildlife Species Potentially Occurring Within the Project Area[1]

Species	Sporting Status	Habitat Association	ND	SD	NE	KS	MO	IL	OK
Bobcat *Felis rufus*	furbearer	Found in woodlands, brushlands, and wooded swampy areas. Range includes ND, NE, KS, and OK but not project area portions of SD, MO, or IL.	X		X	X			X
American beaver *Castor canadensis*	furbearer	Beavers inhabit permanent sources of water of almost any type in their range, which extends from arctic North America to the Gulf of Mexico and arid Southwest, and from sea level to over 6,800 feet in the mountains. They prefer low gradient streams (which they modify), ponds, and small mud-bottomed lakes with dammable outlets. Beavers are associated with deciduous tree and shrub communities.	X	X	X	X	X	X	X
Birds									
Dark Geese: **Canada goose** *Branta canadensis* **White-fronted goose** *Anser albifrons* **Brant** *Branta bernicla*	game	Found in various habitats near water, from temperate regions to tundra. Breed and feed in areas usually near lakes, ponds, large streams, inland and coastal marshes. Forage in pastures, cultivated lands, grasslands, and flooded fields. All but Canada goose present in project area only during migration.	X	X	X	X	X	X	X
Light Geese: **Snow goose** *Chen caerulescens* **Ross' goose** *Chen rossii*	game	Found in various habitats near water, from temperate regions to tundra. Winters in both freshwater and coastal wetlands, wet prairies and extensive sandbars, foraging also in pastures, cultivated lands and flooded fields. Present in project area only during migration.	X	X	X	X	X	X	X
Tundra swan *Cygnus columbianus*	game	Generally found in lakes, sloughs, rivers, sometimes fields, in migration. Open marshy lakes and ponds and sluggish streams in summer. Present in project area only during migration. Considered a game animal only in ND and SD.	X	X	X	X	X	X	X

Table 3.7-1 **Game and Furbearer Wildlife Species Potentially Occurring Within the Project Area**[1]

Species	Sporting Status	Habitat Association	ND	SD	NE	KS	MO	IL	OK
Sandhill crane *Grus canadensis*	game	In n-breeding habitats this species roosts at night along river channels, on alluvial islands of braided rivers, or natural basin wetlands. A communal roost site consisting of an open expanse of shallow water is a key feature of wintering habitat. Considered a game species only in ND, SD, and OK.	X	X	X	X			X
Dabbling ducks: includes a number of species such as mallard and teal	game	Primarily found in shallow waters such as ponds, lakes, marshes, and flooded fields; in migration and in winter mostly in fresh water and cultivated fields, less commonly in brackish situations.	X	X	X	X	X	X	X
Diving ducks: includes a number of species such as canvasback and redhead	game	Commonly found on marshes, ponds, lakes, rivers and bays.	X	X	X	X	X	X	X
Mergansers and Coot	game	Commonly found on marshes, ponds, lakes, rivers and bays.	X	X	X	X	X	X	X
Woodcock *Scolopax mir* **Snipe** *Gallinago gallinago*	game	Wetlands, marshes, moist woodlands and thickets.	X	X	X	X	X	X	X
Mourning dove *Zenaida macrora*	game	Inhabits open woodland, forest edge, cultivated lands with scattered trees and bushes, arid, and desert country.	X	X	X	X	X	X	X
Ring-necked pheasant *Phasianus colchicus*	game	Non-native game bird. Inhabits open country (especially cultivated areas, scrubby wastes, open woodland and edges of woods), grassy steppe, desert oases, riverside thickets, swamps and open mountain forest. Winter shelter includes bushes and trees along streams, shelterbelts, and fencerows. Usually nests in fields, brushy edges, or pastures, also along road ROWs. Nest is shallow depression scratched out by female.	X	X	X	X	X	X	X

Table 3.7-1 Game and Furbearer Wildlife Species Potentially Occurring Within the Project Area[1]

Species	Sporting Status	Habitat Association	ND	SD	NE	KS	MO	IL	OK
Wild turkey *Meleagris gallopavo*	game	Found in forest and open woodland, scrub oak, deciduous or mixed deciduous-coniferous areas. Also agricultural areas in some regions, which may provide important food resources in winter. Roosts in trees at night. Nests normally on the ground, usually in open areas at the edge of woods.	X	X	X	X	X	X	X
Greater prairie chicken *Tympanus cupido*	game	Inhabits tall grassland prairies and occasionally croplands. Nests in grasslands, prairies, pastures, and hayfields. Within the project area present only in ND, KS, OK, and possibly in MO.	X			X			X
Sharp-tailed grouse *Tympanuchus phasianellus*	game	Inhabits short to tall grasslands intermixed with cropland and shrublands.	X	X	X				
Northern bobwhite *Colinus virginianus*	game	Inhabits a wide variety of vegetation types, particularly early successional stages. Occurs in croplands, grasslands, pastures, fallow fields, grass-brush rangelands, open pinelands, open mixed pine-hardwood forests, and habitat mosaics. In the Midwest and Northeast, associated principally with heterogeneous, patchy landscapes comprised of moderate amounts of row crops and grasslands and abundant woody edge. Nests on the ground, in a scrape lined with grasses and/or other dead vegetation.		X	X	X	X	X	X
Gray partridge (Hun) *Perdix perdix*	game	Non-native game bird. Inhabits cultivated land, hedgerows, brushy pastures, and meadows.	X	X	X				
Ruffed grouse *Bonasa umbellus*	game	Inhabits mixed and deciduous woodlands. Not common in project area but occurs in isolated areas of ND and SD.	X	X					

[1]Listing and habitat descriptions based on Chapman and Feldhamer 1982; Burt and Grossenheider 1980; Terres 1980; National Geographic Society 1987; and Ehrilch et al. 1988.

Mule deer and pronghorn inhabit primarily the western portions of North Dakota, South Dakota, and Nebraska, although small isolated populations of pronghorn extend into eastern South Dakota. Neither species is likely to occur along the proposed route. Elk have been extirpated from the Great Plains but small populations have been reintroduced into small, isolated wildlife areas. The northeast corner of North Dakota is the only area along the proposed route where elk may be present. Moose could occur along the proposed route only in the northeast portion of North Dakota, while black bear only will be found along the proposed route near the eastern Missouri border (Wild Mammals of North America 1982).

3.7.1.2 Small Game Species

Small game species that could occur along the proposed route and possible alternatives include upland gamebirds, waterfowl, furbearers, and small mammals. Specific species could include mourning dove, northern bobwhite, ring-necked pheasant, greater prairie chicken, sharp-tailed grouse, ruffed grouse, gray partridge, wild turkey, eastern fox squirrel, eastern gray squirrel, red squirrel, eastern cottontail, sandhill crane, and a number of migratory waterfowl. Furbearers include beaver, bobcat, red fox, gray fox, swift fox, raccoon, badger, ermine, least weasel, long-tailed weasel, and mink. Habitat preferences and distribution of small game and furbearer species occurring along or in the region of the proposed route are summarized in **Table 3.7-1.**

Greater prairie chicken is a native small game species with the greatest population viability concern in the vicinity of the proposed route. Populations of other small game species are relatively stable within the proposed route region. Greater prairie chicken is listed as endangered by the State of Missouri and hunting of this species is not permitted in the state. It remains a legally hunted bird in all of the other states crossed by the proposed route; however, it is a species of management concern in those areas. Greater prairie chickens occur in association with tall grass prairie habitats and their populations in the Northern Great Plains have been severely reduced by conversion of tall grass prairie to croplands. Populations in the region of the proposed route are now restricted to small remnant areas of tall grass prairie primarily in eastern North Dakota, central South Dakota and Nebraska, eastern Kansas, and northern Missouri and Oklahoma. The proposed route crosses known occupied ranges of this species in North Dakota, South Dakota, Kansas, Oklahoma, and possibly Missouri.

3.7.1.3 Nongame Species

The proposed route traverses various regions which are inhabited by a diversity of nongame species (e.g., small mammals, raptors, songbirds, amphibian, and reptiles). Nongame mammals include shrews, bats, squirrels, prairie dogs, pocket gophers, pocket mice, voles, and, mice. These small mammals provide an important prey base for the region's predators including, coyote, badger, skunk, raptors (eagles, buteos, accipiters, owls), and snakes.

Nongame birds include a variety of songbirds and raptor species, most being species associated with open, grassland habitat, although woodland species also are represented along woodland riparian corridors as well as in upland, deciduous woodlands which become more prevalent near the southeastern end of the proposed route in Missouri. Raptors likely to be present in open habitats include turkey vulture, burrowing owl, golden eagle, red-tailed hawk, Swainson's hawk, northern harrier, American kestrel, short-eared owl, and great horned owl. Woodland associated raptor species likely to be present include sharp-shinned hawk, Cooper's hawk, broad-winged hawk, long-eared owl, and eastern screech owl. Most of these species, including the open-country raptors, require some type of tree or tree cavity for a nest site. Northern harrier and short-eared owl are the only ground nesters.

The majority of the songbirds inhabiting the region, particularly in woodland areas, are neotropical migrants. These are birds that breed in North America but winter in the neotropical region of Central and South America. Examples of neotropical migrants that potentially could occur in the area of the proposed route include lark bunting, kingbird, and various vireos and warbler species. Eastern kingbird, American crow, western and eastern meadowlark, horned lark, and sparrows are common open-country inhabitants, while woodpeckers, blue jay, chickadees, wrens, vireos, warblers, and cardinal are typical summer or year-long residents of shrublands and woodlands.

Aerial raptor surveys were conducted between April 26 and May 2, 2006, to identify active and inactive nest sites along the project ROW. Raptor surveys were not surveyed from MP 0 to MP 34 due to poor weather conditions. In addition, raptor surveys were not conducted from MP 580, east to the project terminus in eastern Illinois, or along the Cushing Extension in Kansas and Oklahoma.

A total of 165 nests or breeding territories were documented within 0.25 mile of the project ROW. Of these 165 nest sites, 116 were determined to be active by raptor species including 85 red-tailed hawk nests, 16 great-horned owl nests, seven Swainson hawk nests, two American kestrel nests, two bald eagle nests, and four occupied nests of unknown species.

3.7.2 Aquatic Resources

Aquatic biology resources are defined in this study as fish and invertebrate communities that inhabit perennial streams and pond/lake environments. The description of aquatic communities focuses on important fisheries, which are defined as species with recreational or commercial value or threatened, endangered, or sensitive status (i.e., special status). This section of the document describes recreationally or commercially important fisheries that occur at or immediately downstream of the proposed crossings. Special status aquatic species are discussed in Section 3.7.3. The study area for aquatic resources includes the perennial streams, rivers, and ponds/lakes that will be crossed by the proposed pipeline route. Other waterbodies are included if they are located within approximately 0.5 mile of the proposed crossing and support recreationally or commercially important game fish or special status aquatic species.

KEYSTONE MAINLINE

Invertebrate communities that occur in waterbodies along the proposed route include a mixture of worms, immature and adult insect groups, clams and mussels, and numerous other groups. The composition can vary depending on flowing or standing water and other physical characteristics of the waterbody. Invertebrates serve important roles in the aquatic environment through their food web dynamics. They represent important food sources for fish and also are used as indicators of water quality conditions. For the purpose of describing aquatic resources, it is assumed that invertebrates are present in all project area waterbodies.

Over 20 recreationally important fish species or groups occur in waterbodies crossed by the proposed Keystone Mainline route (**Table 3.7-2**). These include shovelnose sturgeon, paddlefish, bass, sunfish, walleye, Northern pike, catfish, and perch. The following information describes game and commercial fish species occurrence, fishery classifications, and characteristics of fishery management in each of the states traversed by the proposed Keystone Mainline route. Sources of fish occurrence information are identified at the end of **Table 3.7-2**. Fishery classification definitions are provided in **Table 3.7-3**. General spawning periods for the primary game and commercial fish species are identified in **Table 3.7-4**. Waterbodies crossed by the Cushing Extension are discussed separately at the end of this section.

North Dakota

The North Dakota portion of the proposed route will cross four perennial streams and numerous unnamed ponds. Two of these streams (Pembina and Sheyenne Rivers) are considered Class I or IA waters that support suitable habitat for warmwater fisheries. The Tongue and Middle Branch Forest rivers (Class II) provide limited fish habitat due to an abundance of intermittent flows within the drainages. The Sheyenne River supports the most diverse composition of game fish species with nine species or groups. The other waterbodies contain two to four game fish species. Northern pike, yellow perch, and bass species represent the primary species in terms of management or game fish harvests. The only known recent stocking effort in

Table 3.7-2 Game Fisheries in Waterbodies Crossed or Downstream of the Proposed Keystone Pipeline Project

State/Waterbody	County	Fishery Class[1]	Number of Crossings
KEYSTONE MAINLINE			
NORTH DAKOTA			
Pembina River	Pembina	Class I	1
Tongue River	Pembina	Class II	1
Middle Branch Forest River	Walsh	Class II	1
Sheyenne River	Ransom	Class IA	1
SOUTH DAKOTA			
Amsden Lake and unnamed tributary	Day	None	1
Mud Creek	Day	None	1
Foster Creek	Day	None	1
Wolf Creek	Hutchinson/ Hanson	WW Marginal	1
James River	Yankton	WW Semipermanent	1
Beaver Creek	Yankton	WW Marginal	1
Missouri River	Yankton	WW Permanent	1
NEBRASKA			
Missouri River	Cedar	WW Class A	1
Antelope Creek	Cedar	WW Class B	1
West Bow Creek	Cedar	WW Class B	1
Norwegian Bow Creek	Cedar	WW Class B	1
Bow Creek	Cedar	WW Class B	1
Middle Logan Creek	Cedar	WW Class B	1
Elkhorn River	Stanton	WW Class A	1
Union Creek	Stanton	WW Class B	
Shell Creek	Colfax	WW Class A	1
Lost Creek	Colfax	WW Class B	1
Platte River	Colfax	WW Class A	1
Unnamed tributary to Platte River	Colfax	WW Class B	2
Deer Creek	Butler	WW Class B	1
Unnamed Pond	Butler	None	1
Unnamed Pond	Seward	None	1
Big Blue River	Seward	WW Class B	1
Lincoln Creek	Seward	WW Class B	1
Crooked Creek	Seward	WW Class B	1
West Fork Big Blue River	Saline	WW Class A	1
Turkey Creek	Saline	WW Class A	1
Swan Creek	Saline	WW Class A	1
Cub Creek	Jefferson	WW Class A	1
Cole Creek	Jefferson	WW Class B	1
Unnamed tributary to Cole Creek	Jefferson	None	1
KANSAS			
Indian Creek	Marshall	Expected Use	1
Deer Creek	Marshall	Expected Use	1
Big Blue River	Marshall	Expected Use	1

Table 3.7-2 Game Fisheries in Waterbodies Crossed or Downstream of the Proposed Keystone Pipeline Project

State/Waterbody	County	Fishery Class[1]	Number of Crossings
North Elm Creek	Marshall	Expected Use	2
Unnamed tributary to North Elm Creek	Marshall	None	2
Unnamed tributary to North Elm Creek	Marshall	None	4
Robidoux Creek	Marshall	Expected Use	1
Negro Creek	Nemaha	Expected Use	1
North Fork Wildcat Creek	Nemaha	Unknown	1
Wildcat Creek	Nemaha	Expected Use	1
South Fork Nemaha River	Nemaha	Special Use	1
Unnamed tributary to Hams Creek	Nemaha	Unknown	1
Harris River	Nemaha	Expected Use	2
Unnamed tributary to Harris Creek	Nemaha	Unknown	1
Craig Creek	Nemaha	Unknown	1
Delaware River	Brown	Expected Use	1
Unnamed tributary to Delaware River	Brown		2
Walnut Creek	Brown	Expected Use	1
Wolf River	Brown	Expected Use	1
Middle Fork Wolf River	Brown	Expected Use	1
Buttermilk Creek	Brown	Expected Use	1
South Fork Wolf River	Brown	Expected Use	1
Squaw Creek	Brown	Expected Use	1
Halling Creek	Doniphan	Expected Use	1
Three unnamed tributaries to N. Branch Independence Creek	Doniphan	Unknown	1 each
Two unnamed tributaries to Jordan Creek	Doniphan	Expected Use	1 and 2
Jordan Creek	Doniphan	Expected Use	1
Rock Creek	Doniphan	Expected Use	1
Unnamed tributary to Missouri River	Doniphan	Expected Use	1
Missouri River	Buchanan	Special Use	1
MISSOURI			
Missouri River	Buchanan	WW	1
Contrary Creek	Buchanan	WW	1
Unnamed tributary to Little Platte River	Buchanan	WW	3
Pigeon Creek	Buchanan	WW	3
Platte River	Buchanan	WW	1
Three unnamed tributaries to Platte River	Buchanan	WW	1 each
Malden Creek	Buchanan	WW	1
Wolfpen Creek	Clinton	WW	1
Jenkins Branch	Clinton	WW	1
Castile Creek	Clinton	WW	1
Horse Fork Creek	Clinton	WW	1
Little Platte River	Clinton	WW	1
Unnamed tributary to Little Platte River	Clinton	WW	2
Shoal Creek	Clinton	WW	1
Little Shoal Creek	Clinton	WW	1