4.15 CUMULATIVE EFFECTS ASSESSMENT

A cumulative effects assessment (CEA) considers the residual impacts of the proposed Project in combination with the residual impacts from the connected actions and actions from other "past, present, and reasonably foreseeable future" projects, as outlined in the Council on Environmental Quality (CEQ) guidance on Considering Cumulative Effects under the National Environmental Policy Act (NEPA). Cumulative effects, by definition, are residual in nature because they occur, or continue to occur, long after the construction of a project is completed. In the Final Environmental Impact Statement (Final EIS) the CEA focused on existing, under construction, and planned linear energy transportation systems, including natural gas pipelines, crude oil pipelines, and electric transmission lines, water delivery projects, and a number of energy development projects.

The CEA presented in this Supplemental Environmental Impact Statement (Supplemental EIS) seeks to focus the list of projects from the Final EIS as they pertain to the proposed Project, and broaden the scope of past, present, and reasonably foreseeable future projects under consideration to include non-linear projects and other development activities with the potential to contribute to overall cumulative effects within the Project area. In addition, the Final EIS focused on projects that geographically intersected with the proposed Project; the Supplemental EIS CEA broadens the geographic boundary of the projects and activities considered to have the potential to contribute to cumulative effects. This broader perspective is provided to supplement the analysis provided in the Final EIS to support decision-making. Within this context, although geographically widely separated, this CEA also considers the potential for impacts associated with the proposed Project in combination with the TransCanada Gulf Coast Pipeline, which began construction in August 2012. This was done in response to public comment received on the scope of work for this Supplemental EIS, which indicated a concern that impacts from both projects (proposed Project plus the Gulf Coast Pipeline) would be additive, because when completed, they would be part of one larger system of crude oil transportation pipelines. Keystone has indicated that it considers the Gulf Coast Pipeline to have independent utility, and construction is underway. Therefore, impacts associated with the Gulf Coast Pipeline were not evaluated beyond this CEA.

As a matter of Department policy, extraterritorial considerations related to the Canadian portion of the TransCanada Keystone Pipeline, LP (Keystone) proposed Project are evaluated in Section 4.15.4, Extraterritorial Concerns, to the extent that the proposed Project would contribute to cumulative environmental impacts within Canada.

Accidental or emergency events may arise due to an unforeseen chain of events during the proposed Project's operational life. For an assessment of the potential short- and long-term effects of oil releases to the environment, see Section 4.13, Potential Releases, for a discussion of potential cumulative effects of oil releases to the environment, see Section 4.15.3.13, Potential Releases.

Potential long term or permanent beneficial impacts of proposed pipeline construction could occur in the form of increased tax revenues, the focus of this CEA is on potential adverse effects that may result from the proposed project on resources, ecosystems, and human communities. In addition, ancillary facilities in North Dakota and Kansas are not included in this CEA since the activities in these states would occur on previously developed/disturbed lands and/or are

geographically small areas. Therefore, these facilities would have negligible contributions to overall cumulative effects.

4.15.1 Methods and Scope of the Cumulative Impacts Analysis

In general, the analysis of cumulative impacts in this CEA follows the processes recommended by CEQ (1997 and 2005) and the regulations at Title 40 of the CFR Part 1508.7. The scope of the CEA is governed by the geographic and temporal boundaries that correlate to the resources impacted by the proposed Project, and how the proposed Project intersects with connected actions and other projects across these resources. In general, the geographic limits of the area evaluated in the CEA can be organized into three categories:

- Project Area—Defined as the area of physical disturbance associated with the proposed Project limits; that is, in and along the pipeline right-of-way (ROW) construction corridor and its ancillary facilities, e.g., access roads, pump stations, and construction camps.
- Local Area[1]—Defined as a 2-mile distance on either side of the proposed pipeline ROW corridor, and its ancillary facilities.
- Regional—Defined by the potentially impacted resource, e.g., home range of a wildlife species, bird migration corridor, or a regional airshed.

Activities within what is termed the Project Cumulative Impact Corridor (PCIC) indicate geographic proximity to the proposed Project (e.g., project area or local area as noted above). The temporal boundaries for this analysis reflect the nature and timing of the proposed Project activities as they relate to knowledge of past and present projects, and the availability of information on future projects that have a high probability of proceeding. For any given project, the duration of potential impacts is typically categorized as temporary, short-term, long-term, or permanent. Temporary impacts would likely occur during construction, with the resources returning to pre-construction conditions almost immediately afterward. Short-term impacts are defined as those that would continue for approximately 3 years following construction. Long-term impacts are those where the resource would require longer than 3 years to recover. Permanent impacts occur as a result of activities that modify resources to the extent that they would not return to pre-construction conditions during the design life of the proposed Project (50 years), such as with construction of aboveground structures.

When considering the broad scope of evaluating the combined effects of past, present, and reasonably foreseeable future projects, it is the long-term and permanent impacts of individual projects that would have the greatest potential to combine with one another to create significant cumulative impacts. Therefore, the primary focus of this CEA is to gain an understanding of the potential combined long-term or permanent impacts to resources, ecosystems, and human communities from the proposed Project, connected actions, and other past, present, and reasonably foreseeable future projects (federal, non-federal, and private actions). Temporary and/or short-term impacts, which could occur concurrently (geographically and temporally) between the proposed Project, connected actions, and other projects to produce short term cumulative impacts, are considered qualitatively.

[1] Correlates to the socioeconomic analysis area as defined in Section 3.10, Socioeconomics.

Key factors in controlling the temporal scale of cumulative effects are several measures designed to mitigate, offset, and/or restore impacted resources to pre-construction conditions. Keystone's Construction, Mitigation, and Reclamation Plan (CMRP) (see Appendix G), additional mitigations, individual federal and state agency permitting conditions, and/or existing laws and regulations all function to control potential impacts and reduce long-term and permanent effects. Therefore, this CEA incorporates the implementation of these measures in the evaluation of anticipated resource impacts, specifically as they affect the duration of impacts and their potential to contribute significantly to cumulative effects. The attribution of significance requires the assessment and integration of a number of lines of evidence:

- The effectiveness of mitigation measures or other embedded controls;
- The geographic context of where the activities are taking place (e.g., pristine land versus previously disturbed areas); and
- The degree to which residual impacts on a local scale are additive with similar impacts from other projects and activities, and their magnitude (i.e., relative contribution).

This analysis is enhanced through the use of geographic information system mapping, which is presented where applicable.

The remaining sections of this CEA are organized as follows:

- Section 4.15.2, Past, Present, and Reasonably Foreseeable Projects: This section evaluates reasonably identifiable federal, state, local, and private projects and/or development activities based on publically available information with possible effects that could be temporally and/or geographically coincident with those of the proposed Project on resources, ecosystems, and human communities. The discussion in this section is organized by the project/activity timeframe: past, present or future, with an accompanying table listing the identified project/activity. Connected actions to the proposed Project are presented separately following the other future project/activity descriptions.
- Section 4.15.3, Cumulative Impacts by Resource: This section discusses the potential cumulative impacts of the proposed Project and other actions by resource area, along with any pertinent mitigation actions, and how these anticipated cumulative impacts interact with the other past, present, and reasonably foreseeable future projects/activities described in Section 4.15.2.
- Section 4.15.4, Extraterritorial Concerns: This section discusses the potential extent to which the proposed Project would contribute to cumulative environmental impacts within Canada.

4.15.2 Past, Present, and Reasonably Foreseeable Projects

The proposed Project would occur in locations that include numerous existing, under construction, and planned major capital public and private projects, including oil and gas well fields, major product pipelines, water distribution lines, energy development projects (including wind farms) and associated electric transmission lines, and mining projects. The identification of the projects and/or activities to be included in the cumulative impact analysis was accomplished through independent research, beginning with review of the Pipeline and Hazardous Materials Safety Administration (PHMSA) National Pipeline Mapping System (U.S. Department of Transportation 2012). This was followed by queries of the Montana, South Dakota, and Nebraska state government websites, and private company websites providing publically

available data and details on projects and activities within the geographic boundaries of interest. Please see Appendix V, Past, Present, and Reasonably Foreseeable Future Project Descriptions, for a more detailed description of the projects identified, as well as a complete list of the data sources accessed for this CEA.

As previously mentioned, the discussion in this section is organized by the project/activity timeframe: past, present, or future, with an accompanying table listing the identified project/activity. Connected actions to the proposed Project are presented separately following the other future project/activity descriptions.

4.15.2.1 Cumulative Impacts from Past Projects

Past projects and activities considered in the CEA are those that have been completed and their physical features are part of the current/existing landscape. Residual (i.e., permanent) effects from these projects/activities are considered to be potentially cumulative with the effects of the proposed Project. These projects are further described in Table 4.15-1 below. Unless otherwise noted, it is assumed the impacts of these projects are reflected in existing environmental conditions as described in Chapter 3, Affected Environment.

Table 4.15-1 Representative Past Projects Considered in the Cumulative Effects Assessment

Project Name	Description	Regions Impacted	Geographic Relationship to Proposed Project
Crude Oil Pipelines and Storage Facilities			
Express-Platte Pipeline System	Two pipelines: the Express has been in operation since 1997, the Platte since 1952. Approximately 1,700 miles total of crude oil pipelines that are 20 (Platte) and 24 (Express) inches in diameter.	Southeastern Alberta; central Montana; northeastern Wyoming; south-central Nebraska; northeastern Kansas; north-central Missouri.	The Express-Platte system would be within the PCIC for the proposed Project near Steele City, Nebraska.
Keystone Mainline Oil Pipeline	Approximately 1,379-mile-long crude oil pipeline has a design capacity between 435,000 barrels per day (bpd) to 591,000 bpd.	Southeastern Alberta; southern Saskatchewan; southwestern Manitoba; eastern North Dakota; eastern South Dakota; eastern Nebraska; northeastern Kansas; central Missouri; central Illinois.	The Keystone Mainline Oil Pipeline would be within the PCIC near Steele City, Jefferson County, Nebraska.
Keystone Cushing Extension	298-mile-long, 36-inch-diameter crude oil pipeline from Steele City, Nebraska, to Cushing, Oklahoma.	Southern Nebraska; central Kansas; central Oklahoma.	The northern portion of the Cushing Extension would be within the PCIC in Steele City, Jefferson County, Nebraska.

Project Name	Description	Regions Impacted	Geographic Relationship to Proposed Project
True Company Pipelines and Crude Oil Storage Facility	A system of more than 3,400 miles of crude oil gathering and transportation pipelines, including Bridger Pipeline, LLC that owns and operates the Poplar, Little Missouri, Powder River, Butte, Belle Fourche, Four Bears, Parshall, and Bridger pipeline systems. Three collector pipelines to transport production from the north, west, and east into the Butte Pipeline near Baker are under construction.	Throughout Wyoming; eastern Montana; western and central North Dakota.	Portions of the pipeline systems owned and operated by True Companies would be within the PCIC in near Baker, Fallon County, Montana.
Refined/Finished Product Pipelines			
Cenex Pipeline	Eight-inch products pipeline running from Fargo, North Dakota, at Williams Pipeline Terminal to Laurel Station at the Cenex Refinery in Montana.	Western North Dakota and eastern Montana.	Within PCIC in southwestern Dawson County, Montana.
Magellan Pipeline	Total of 9,600 miles of refined product pipelines, including 50 terminals (four in Nebraska) and seven storage facilities.	The Magellan Pipeline system is located in the following states: North Dakota, Minnesota, South Dakota, Nebraska, Colorado, Iowa, Illinois, Missouri, Kansas, Oklahoma, Arkansas, and Texas.	Magellan Pipeline crosses the PCIC in southern York County, Nebraska.
NuStar Pipeline	Central East Region—East Refined Products Pipeline system transports refined petroleum products, including gasoline, diesel, and propane. The system includes 2,530 miles of pipelines that transport an average of 203,000 bpd and 21 distribution terminals (five in Nebraska, five in South Dakota) with a storage capacity of 4.8 million barrels.	Pipeline system runs north-south from central North Dakota to eastern South Dakota, western Iowa, eastern Nebraska, southern Nebraska, central Kansas.	NuStar Pipeline is within the PCIC in Fillmore and York counties, Nebraska.
Natural Gas Pipelines			
Williston Basin Interstate Pipeline Company System	A 3,364-mile-long natural gas pipeline transmission system.	Pipeline system runs through Montana, North Dakota, Wyoming, and South Dakota.	Portions of the Williston Basin System would be within the PCIC in Valley and Fallon counties, Montana and Harding County, South Dakota.
Northern Border Pipeline	A 1,249-mile-long interstate natural gas pipeline with a design capacity of approximately 2.4 billion cubic feet of gas per day (bcf/d).	Pipeline runs generally northwest to southeast through Montana, North Dakota, South Dakota, Minnesota, Iowa, Illinois, and Indiana.	Portions of the Northern Border Pipeline would be in the PCIC in Phillips and Valley counties, Montana, and would be near and parallel to the proposed Project for approximately 21.5 miles.

Project Name	Description	Regions Impacted	Geographic Relationship to Proposed Project
Northern Natural Gas	14,900 miles of pipeline, operational since 1930, 2- to 36-inch diameter. 2,357 receipt and delivery points.	Minnesota, Wisconsin, Michigan, Iowa, South Dakota, Nebraska, Kansas, Oklahoma, Texas, and New Mexico.	The Northern Natural Gas Pipeline system is within the PCIC in Jefferson and Saline counties, Nebraska.
Rockies Express West	A 713-mile-long 42-inch-diameter interstate natural gas transmission pipeline with a capacity of approximately 1.5 bcf/d. The project includes five compressor stations.	Colorado, Wyoming, southern Nebraska, northeastern Kansas, Missouri, Illinois, Indiana, and Ohio.	Rockies Express West is within the PCIC in a generally west-to-east direction in the vicinity of Steele City, Nebraska.
Bison Natural Gas Pipeline	A 302-mile-long, 30-inch-diameter pipeline with a capacity of 500 million cubic feet per day (MMcf/d). Pipeline system and related facilities that extend northeastward from the Dead Horse Region near Gillette, Wyoming, through southeastern Montana and southwestern North Dakota where the system connects with the Northern Border Pipeline system near Northern Border's Compressor Station No. 6 in Morton County, North Dakota. 407 MMcf/d capacity currently; with compression (approved but not yet built) capacity will be approx. 477 MMcf/d , with potential expandability to approx. 1 bcf/d.	Southwestern North Dakota, southeastern Montana, and northeastern Wyoming.	The Bison pipeline intersects the PCIC in southern Fallon County, Montana.
Kinder-Morgan Interstate Gas Transmis-sion (KMIGT)	Approximately 5,100 miles of transmission lines in Colorado, Kansas, Nebraska, Michigan, and Wyoming. The Huntsman natural gas storage facility, located in Cheyenne County, Nebraska, with approximately 10 billion cubic feet of firm capacity commitments is also part of the system.	Transmission system comprised of west zone (central Wyoming); central zone (southeastern Wyoming, southwestern Nebraska, and northeastern Colorado); east-north zone (southern and eastern Nebraska); and east-south zone (northwestern Kansas).	KMIGT within the PCIC in the following counties: northern Fillmore County, Nebraska; central York County, Nebraska; eastern Boone County, Nebraska; eastern Antelope County, Nebraska; and northern Holt County, Nebraska.
Trailblazer Pipeline	436 miles of 36-inch pipe. Certificated capacity of 522,000 decatherms per day (Dth/day). Expansion planned: Expand TB by 324,000 Dth/day to bring total capacity to 846,000 Dth/day.	Runs generally east-west from Cheyenne, Wyoming along the Wyoming/Colorado border through southern Nebraska.	Trailblazer Pipeline crosses the PCIC in southern Saline County, Nebraska.

Project Name	Description	Regions Impacted	Geographic Relationship to Proposed Project
Natural Gas Pipeline Co. of America—Amarillo Line	Total network: 10,000+ miles of pipelines, 265 billion cubic feet of working gas storage capacity. Amarillo Line (based on 2002 stats) produces 1.6 bcf/d.	Runs generally northeast to southwest from Chicago, Illinois through southern Iowa, across southeast Nebraska (at Steele City), central Kansas, western and southern Oklahoma, northwestern Texas, and southeastern New Mexico.	The line is within the PCIC at Steele City, Jefferson County, Nebraska.
Central City Gas System	Natural gas pipeline system owned and operated by the city of Central City, Nebraska. 2- to 6-inch-diameter transmission line.	Serves Central City, Nebraska.	Central City Gas Pipeline system is within the PCIC in southwestern Polk County, Nebraska.
SourceGas LLC	SourceGas - Nebraska transmission system consists of approximately 5,000 miles of transmission and distribution pipeline in 57 counties across Nebraska. The system has interconnections with or laterals off the KMIGT, Pony Express, and Trailblazer pipelines.	Serves the western 2/3 of Nebraska.	SourceGas pipelines within the PCIC in northwestern Holt County, Nebraska and southeastern Boone County, Nebraska.
Ammonia Pipelines			
NuStar Pipeline	2,000 miles total, ranging from 4- to 10-inch carrying anhydrous ammonia, with a terminal at Aurora, Nebraska.	Pipeline extends through Indiana, Illinois, Missouri, Arkansas, Louisiana, and Nebraska. Specific cities impacted in Nebraska: Blair, Fremont, and Aurora.	Anhydrous ammonia pipeline is within the PCIC in northwestern York County, Nebraska.
Water Delivery Systems			
Perkins County Rural Water System	Extension of Southwest Pipeline from Lake Sakakawea, North Dakota.	Map of pipeline or system area not readily available; however, project is in Perkins County, South Dakota.	Project route is through southwestern Perkins County, South Dakota. Water pipeline possibly within the PCIC depending on location.
Mni Wiconi Rural Water System[2]	4,400 miles of pipeline through southwest and south-central South Dakota. 12- to 24-inch PVC water pipeline, which provides water to Pine Ridge, Rosebud, and Lower Brule Indian Reservations, along with other communities. Federally funded project. Estimated delivery volume 8,591-12,474 acre feet per year. Water source is Missouri River. Portions are still under construction and are estimated to be completed by 2013.	Haakon, Stanley, Jones, Lyman, Mellette, Todd, Jackson, Bennett, and Shannon counties, South Dakota. Portions of Pennington and Tripp counties, South Dakota.	Mni Wiconi water pipeline possibly within the PCIC in Haakon, Jones, Lyman, and Tripp counties, South Dakota.

[2] Although some portions of the Mni Wiconi Rural Water System are expected to be completed in Fiscal Year 2013, the portions of the system that are crossed by the proposed Project have been completed.

Project Name	Description	Regions Impacted	Geographic Relationship to Proposed Project
Electrical Transmission Lines			
345-499-kilovolt (kV) Transmis-sion Lines	The U.S. electric grid consists of independently owned and operated power plants and transmission lines.	The transmission lines affect the entire United States.	Transmission lines would affect the PCIC in Boyd, Antelope, Boone, Holt, Nance, Merrick, Hamilton, York, Fillmore, and Jefferson counties in Nebraska. The PCIC would also be affected in Fallon and McCone counties in Montana. In South Dakota, the PCIC is affected in Perkins, Meade, Haakon, and Jones counties.
Railroads			
Union Pacific Railroad (UP)	The UP spans 31,900 miles and is the largest railroad network in the United States.	The UP operates in 23 states throughout the central and western United States.	Rail is within the PCIC in Jefferson and Merrick counties, Nebraska.
BNSF Railway (BNSF)	BNSF owns rail lines running through multiple areas of Montana, primarily east-west along the northern border; northwest to southeast across the central portion of the state; and southwest to northeast in the southeastern portion of the state. BNSF-owned lines also run generally northwest to southeast across Nebraska, with heavier rail line concentration around Lincoln.	The BNSF railway operates throughout the central and western United States.	The railway falls within the PCIC in Fillmore and York counties, Nebraska, and the following counties in Montana: Baker, Prairie, Dawson, and McCone.
Nebraska Central Railroad Company (NCRC)	The NCRC operates over 340 miles of track on three lines concentrated northwest of Lincoln.	The NCRC operates in northeastern and central Nebraska.	Rail is within the PCIC in Polk, Nance, and Boone counties, Nebraska.
Nebraska North-eastern Railway Company (NNRC)	The NNRC operates on approximately 120 miles of northeastern Nebraska. Runs generally east-west across northeastern Nebraska from the Missouri River to O'Neill, Nebraska.	The NNRC operates in northeastern Nebraska.	Rail is within the PCIC in Antelope County, Nebraska.
Canadian Pacific/ Dakota, Minnesota & Eastern	A 574-mile line that runs north-south along the western South Dakota border and east-west through central South Dakota.	Western and central South Dakota.	Rail is within the PCIC in Haakon County, South Dakota.
South Dakota Owned/ Dakota Southern Operated	A 190-mile line that runs generally east-west across south-central South Dakota.	South-central South Dakota.	Within the PCIC in Jones and Valley counties, South Dakota.

Project Name	Description	Regions Impacted	Geographic Relationship to Proposed Project
Wind Farms			
Diamond Willow Windfarm	Operated by Montana-Dakota Utilities. The first phase began commercial operation in 2008. Expanded in 2010, for a total capacity of 30 megawatts (MW), by 20 General Electric 1.5 MW turbines.	South of Baker, Montana in Fallon County.	Potentially within the PCIC in Fallon County (Baker), Montana.
Laredo Ridge	7,600 acre site. Approximately 3 miles northeast of Petersburg, Nebraska, in Boone County, Nebraska. 81 MW capacity.	North of Petersburg, Nebraska, in northern Boone County, Nebraska.	Possibly within the PCIC in Boone County, Nebraska.
Landfills			
City of Baker	Closed landfill, located approximately 2 miles southwest of the city of Baker, Montana.	Baker, Fallon County, Montana.	Closed landfill is within the PCIC near Baker, Fallon County, Montana.
Town of Nashua	Closed Class III Landfill located approximately 2 miles west of the town of Nashua, Montana.	Nashua, Valley County, Montana.	Closed landfill is within the PCIC near Nashua, Valley County, Montana.
City of O'Neill	Waste disposal area for construction and demolition debris, generally described as the SE 1/4 Nebraska 1/4 Section 29 Township 29 North Range 11 West of the 6th Principal Meridian, located in the City of O'Neill, Nebraska.	O'Neill, Holt County, Nebraska.	Landfill is potentially within the PCIC.
Power Plants			
Nebraska Public Power District Petroleum Plant	The Nebraska Public Power District operates a mobile petroleum plant within York, Nebraska. This plant provides a maximum of 3.1 MW of electricity generated from petroleum to the surrounding residential and industrial facilities.	York, Nebraska.	Within the PCIC in York, Nebraska.
Grazing Land			
Montana Grazing Lands	The state of Montana has extensive lands used by ranchers for the grazing of herds of animals.	Multiple	Grazing lands would fall within the PCIC in Valley, McCone, Dawson, Prairie, and Fallon counties.
South Dakota Grazing Lands	The use of lands for grazing herds of animals is widespread in the state of South Dakota.	Multiple	The PCIC would be affected by grazing lands in Harding, Butte, Perkins, Meade, Haakon, Jones, and Tripp counties.
Nebraska Grazing Lands	The state of Nebraska has extensive lands used by ranchers for the grazing of herds of animals.	Multiple	Grazing lands would fall within the PCIC in Keya Paha, Boyd, Holt, Antelope, Boone, Nance, Merrick, Polk, York, Fillmore, Saline, and Jefferson counties.

Project Name	Description	Regions Impacted	Geographic Relationship to Proposed Project
Oil and Gas Storage Facilities			
Baker Facility	Natural gas storage facility in Baker, Fallon County, Montana. Owned and operated by Williston Basin Interstate Pipeline Company, with a total capacity of 287.2 billion cubic feet.	Baker, Fallon County, Montana.	Baker natural gas storage facility is within the PCIC near Baker, Fallon County, Montana.
Oil and Gas Well Fields			
Wildcat and Buffalo	Oil and gas wells in central South Dakota.	Central South Dakota and northwestern Harding County, South Dakota.	Oil and gas wells within the PCIC in northwestern Tripp County, South Dakota; southeastern Jones County, South Dakota; south-central Jones County, South Dakota; northwestern Harding County, South Dakota; and north-central Meade County, South Dakota.
Wildcat Phillips, Fallon, Valley, McCone County fields	Oil and gas fields in Montana.	Southeastern Fallon County, southwestern Dawson County, southeastern McCone County, eastern Valley County, northeastern Phillips County, Montana.	Oil and gas wells within the PCIC (Gas Light, Plevna, Plevna South, Cedar Creek, Weldon, McCone, and Wildcat) in southeastern Fallon County, southwestern Dawson County, southeastern McCone County, Valley County, northeastern Phillips County, Montana.
Mine and Mineral Extraction Sites			
Montana gravel pits	Active surface gravel pits.	Southern Valley County, Southeastern McCone County, Montana.	Gravel pits within the PCIC through southern Valley County, Montana.
Weldon Timber Creek Coal Field	Active surface coal field in northwestern McCone County, Montana.	Northwestern McCone County, Montana.	Coal field within the PCIC through northwestern McCone County, Montana.
Abandoned coal fields	Eighteen abandoned coal fields.	Northwestern and southeastern McCone County, western and southwestern Dawson County, Montana.	Abandoned coal fields within the PCIC through northwestern and southeastern McCone County, western and southwestern Dawson County, Montana.
Fallon County Bentonite Deposit	Active bentonite surface mine in southeastern Fallon County, Montana.	Southeastern Fallon County, Montana.	Active bentonite mine within the PCIC through southeastern Fallon County, Montana.

Project Name	Description	Regions Impacted	Geographic Relationship to Proposed Project
Fallon County abandoned surface mines and coal fields	One abandoned coal field and five abandoned surface mines in southeastern Fallon County, Montana.	Southeastern Fallon County, Montana.	Abandoned coal field and surface mines within the PCIC through southeastern Fallon County, Montana.
Nebraska active sand and gravel mines	Active sand and gravel mines in Nebraska.	Northeastern Keya Paha County, northern and central Holt County, southern Jefferson County, Nebraska.	Active sand and gravel mines within the PCIC.
Nebraska abandoned sand and gravel pits	Abandoned sand and gravel pits in Nebraska.	Eastern Boyd County, northern and central Holt County, central and southern Antelope County, southern York County, eastern Fillmore County, southern Jefferson County, Nebraska.	Abandoned sand and gravel pits within the PCIC in northern and central Holt County, Nebraska.
Nebraska inactive sand and gravel pits	Inactive sand and gravel pits in Nebraska.	Southern Jefferson County, Nebraska.	Abandoned sand and gravel pits within the PCIC.
South Dakota active sand and gravel pits	Active sand and gravel pits in South Dakota	Southeastern and central Tripp County, southeastern Haakon County, eastern Haakon County, northeastern Meade County, northwestern Harding County, South Dakota.	Active sand and gravel pits within the PCIC.
South Dakota inactive sand and gravel pits	Inactive sand and gravel pits in South Dakota.	Southeastern Tripp County, central Jones County, southeastern Haakon County, northeastern Meade County, South Dakota.	Inactive sand and gravel pit within the PCIC.
Feedlots			
Nebraska Feedlots	A feedlot is a type of animal feeding operation which is used in farming. Very large feedlots are classified as concentrated animal feeding operations (CAFOs), and are used to increase the size of livestock before slaughter.	Feedlots are used across the state of Nebraska and have an impact throughout.	The PCIC of the proposed pipeline route would be affected by large feedlots, or CAFOs, southwest of Naper, north of Atkinson, northeast of O'Neill, east of Page, near Orchard, west of Tilder, north of Clarks, near McCool Junction, and near Milligan, Nebraska.
Mt. Echo Feedlot and Beaver Valley Pork	Additional CAFOs	Feedlots are used across the state of Nebraska and have an impact throughout.	The Mt. Echo feedlot falls within the PCIC near St. Edward, Nebraska. The Beaver Valley Pork feedlot falls within the PCIC near St. Edward, Nebraska.

Project Name	Description	Regions Impacted	Geographic Relationship to Proposed Project
Grain and Agronomy Hubs			
Central Valley Agriculture (CVA)—multiple locations	The CVA Clarks location is an agronomy hub that offers fertilizers, chemicals, insecticides, seed and seed treatments, custom application, and precision technology and scouting services to the agricultural sector in central Nebraska.	CVA is located throughout central Nebraska and affects multiple localities in Nebraska.	This CVA Clarks location falls within the PCIC for the proposed Project. The location of the agronomy hub is 2947 26th Road, Clarks, Nebraska

A summary of the residual impacts associated with the general types of projects listed in Table 4.15-1 as well as the potential for these residual effects to be cumulative with the effects of the proposed Project is presented below. While some residual effects associated with past projects may be long-term and/or permanent, many of the residual effects of past projects and effects of the proposed Project are localized. In these situations, the greatest potential for cumulative effects across a broad range of resources from the proposed Project occurs where there is geographic proximity of past projects with the proposed Project. Where appropriate, such as greenhouse gas (GHG) emissions and effects to threatened and endangered species, cumulative effects are considered across a larger geographic scale.

Pipeline and Storage Facility Projects

Pipeline and storage facility projects considered in the CEA include transportation and storage of crude oil, refined/finished products, natural gas, and ammonia. With respect to past (existing) pipeline and storage systems, such as those summarized above in Table 4.15-1, construction and operation of these types of systems may result in permanent alterations to terrestrial vegetation (primarily the conversion of forest cover), as well as impacts to wildlife habitat, land use, visual resources, noise, and air quality. These impacts are related to storage facilities, other aboveground facilities (such as compressor and pump stations) and maintained ROWs. Where multiple past (existing) pipeline and storage systems occur within geographic proximity of the proposed Project, cumulative impacts would be additive among the resource impacts described above. The nature and degree of cumulative impacts depends, in part, on the proximity of the proposed Project facilities to past (existing) facilities. For example, where the proposed Project is located within or directly adjacent to past (existing) pipeline ROWs and storage systems, the effects to terrestrial vegetation, with associated impacts to wildlife habitat, land use, and visual resources would represent a contiguous increase of existing impacts through the creation of a wider, permanent ROW. However, where the proposed Project is not within or directly adjacent to past (existing) pipeline ROWs and storage systems, there would be potential cumulative effects to vegetation, wildlife habitat, and land use that contribute to further habitat fragmentation and associated impacts.

Water Delivery Systems

Cumulative impacts associated with existing water delivery systems are similar in nature to those discussed above related to pipeline and storage facility projects. Impacts of operational water delivery systems include past alterations to terrestrial vegetation, wildlife habitat, land use, and visual resources. Cumulative impacts are possible across these resources where existing systems,

both aboveground facilities (e.g., pump stations, treatment facilities, and storage tanks) and water pipeline ROWs, occur within geographic proximity of the proposed Project.

Electrical Transmission Lines

The most notable impacts associated with existing electrical transmission lines are the permanent effects on terrestrial vegetation, land use, and visual resources. Additional minor impacts to soils (compaction and erosion), wetlands, and wildlife (particularly raptor and other avian species) could also be expected, as well as indirect air quality and GHG impacts in the region associated with the generation of electricity that would be transmitted through power lines. The potential for cumulative impacts exists where multiple or large existing electrical transmission lines occur within geographic proximity of the proposed Project. As discussed above related to pipeline and storage facility projects, the nature and degree of cumulative impacts depends, in part, on the proximity of the proposed Project facilities to existing electrical transmission line ROWs. Cumulative impacts would primarily be associated with permanent alterations to rangeland/grassland vegetation, land use, and visual resources.

Railroads

Cumulative impacts associated with existing railroad features are similar in nature to those discussed above related to various linear features. Impacts of operational railroads include past alterations to terrestrial vegetation, wildlife habitat, land use, noise, and visual resources. Cumulative impacts are possible across these resources where existing systems occur within geographic proximity of the proposed Project.

Wind Farms

Primary residual impacts associated with operating wind farms include effects on terrestrial vegetation, wildlife (notably avian species and bats) and habitat fragmentation, and visual resources. Additional minor impacts to soils (compaction and erosion), wetlands, noise, and land use could also be expected associated with existing wind farms; however, cumulative effects to these resources are not expected based on the minor nature of these residual impacts and the nature of the long-term and permanent impacts associated with the proposed Project. Cumulative impacts would primarily be associated with permanent alterations to terrestrial vegetation, habitat fragmentation, and visual resources where existing wind farms occur within geographic proximity of the proposed Project.

Landfills

Three landfills were identified within the PCIC of the proposed Project. Two of the landfills in Montana are closed, and one active landfill is located in Nebraska. Primary residual impacts associated with landfills include permanent alterations to land use and visual resources, as well as potentially long-term impacts to water resources. The likelihood of water resource impacts associated with landfills is in large part related to the age of the landfill. Historic landfills (in contrast to newer facilities) have a greater potential to contribute to cumulative effects to water resources as a result of potentially inadequate design and controls. Additional minor impacts to soils (compaction and erosion), terrestrial vegetation, wildlife, and wetlands could also be expected associated with existing landfills. Additional impacts associated with the active landfill would include effects on air quality (particularly dust) and noise from operations. Given the discrete and localized extent of landfills and their associated impacts, cumulative impacts would

primarily be associated with permanent alterations to land use and visual resources where existing landfills occur within geographic proximity of the proposed Project. Additional cumulative impacts to water resources, air quality, and noise could potentially occur in proximity to older active landfill sites.

Power Plants

One power generation facility was identified within the PCIC of the proposed Project in York, York County, Nebraska. Primary residual impacts associated with power plants include alterations to terrestrial vegetation, water resources (intakes and thermal discharges), fisheries, land use, air quality and GHG emissions, noise, and visual resources. Additional minor impacts to soils (compaction and erosion), wildlife, and wetlands could also be expected associated with existing power plants; however, cumulative impacts to these resources are not expected. The majority of the primary residual impacts associated with power plants are localized. As a result, potential cumulative impacts would primarily be associated with permanent alterations to land use, air quality, noise, and visual resources where existing power plants occur within geographic proximity of the proposed Project. Additional cumulative impacts to GHG emissions and climate change could occur on a regional scale.

Grazing Lands

Land use data indicate that the majority of undeveloped land in Nebraska, South Dakota, and Montana is used for grazing herd animals. Grazing lands are present within the PCIC in undeveloped portions of the counties through which the proposed pipeline would run. Primary residual impacts of the use of lands for grazing include alterations to soils (erosion), terrestrial vegetation, and water resources (water quality). Cumulative impacts are possible across these resources where existing grazing lands occur within geographic proximity of the proposed Project.

Oil and Gas Well Fields

Multiple oil and gas well fields are located in proximity to the proposed Project. The Williston Basin is located in northwestern South Dakota and northeastern Montana, and the Buffalo field, located in Harding County, South Dakota, contains many wells within the PCIC of the proposed Project. Primary residual impacts associated with oil and gas well field activities include alterations to geological resources, soils (erosion), terrestrial vegetation, water resources, land use, air quality and GHG emissions, noise, and visual resources. Additional minor impacts to wildlife and wetlands could also be expected associated with oil and gas well field activities; however, cumulative impacts to these resources are not expected. The majority of the primary residual impacts associated with oil and gas well field activities are localized. As a result, potential cumulative impacts would primarily be associated with permanent alterations to geological resources, soils (erosion), terrestrial vegetation, water resources, land use, air quality, noise, and visual resources where existing oil and gas well fields occur within geographic proximity of the proposed Project. Additional cumulative impacts to GHG emissions and climate change could occur on a regional scale.

Mine and Mineral Extraction Sites

Numerous active and abandoned mine and mineral extraction sites are located within the PCIC in Montana, South Dakota, and Nebraska. Primary residual impacts associated with mine and mineral extraction sites include alterations to geological resources, soils, terrestrial vegetation, water resources, land use, air quality, noise, and visual resources. Additional minor impacts to wildlife and wetlands could also be expected associated with mine and mineral extraction activities; however, cumulative impacts to these resources are not expected. The majority of the primary residual impacts associated with mine and mineral extraction sites are localized. As a result, potential cumulative impacts would primarily be associated with permanent alterations to geological resources, soils, terrestrial vegetation, fisheries, water resources, land use, air quality, noise, and visual resources where existing mine and mineral extraction activities occur within geographic proximity of the proposed Project.

Feedlots

A feedlot is a type of animal feeding operation which is used in high-density industrial farming (sometimes called factory farming). Very large feedlots are classified as concentrated animal feeding operations, or CAFOs, and are used to increase the size of livestock before slaughter (National Agricultural Statistics Service 2012). Primary residual impacts associated with feedlot sites include direct effects to soils (compaction and erosion), terrestrial vegetation, land use, air quality, noise, and visual resources, and potential indirect effects to fisheries, wetlands and water resources through storm water runoff. The majority of the primary residual impacts associated with feedlots are localized. Cumulative impacts are possible across these resources where existing feedlots occur within geographic proximity of the proposed Project.

Grain and Agronomy Hubs

Grain and agronomy hubs offer fertilizers, chemicals, insecticides, seed and seed treatments, custom application, precision technology, and scouting services to the agricultural sector in central Nebraska (Central Valley Agriculture 2011 and 2012). Primary residual impacts associated with grain and agronomy hubs include alterations to terrestrial vegetation, land use, and visual resources. Additional minor impacts to soils (compaction and erosion), wildlife, and wetlands could also be associated with grain and agronomy hubs; however, cumulative impacts to these resources are not expected. The majority of the primary residual impacts associated with grain and agronomy hubs are localized. As a result, potential cumulative impacts would primarily be associated with permanent alterations to terrestrial vegetation, land use, and visual resources where existing grain and agronomy hubs occur within geographic proximity of the proposed Project.

4.15.2.2 Cumulative Impacts from Present Projects

Present projects and activities considered in the CEA are those that have been approved and are under construction. Potential residual (i.e., long-term or permanent) effects from these projects/activities are considered to be potentially cumulative with the effects of the proposed Project. These projects are further described in Table 4.15-2 below.

Table 4.15-2 Representative Present Projects Considered in the Cumulative Effects Assessment

Project Name	Description	Localities Impacted	Geographic Relationship to Proposed Project
Crude Oil Pipelines and Storage Facilities			
TransCanada Gulf Coast Pipeline and Oil Storage Facility	The Gulf Coast Pipeline would construct 484 miles of new crude-oil pipeline from Cushing, Oklahoma, to Nederland, Texas, and a new tank farm on an approximately 74-acre site at Cushing, Oklahoma.	Oklahoma, Texas.	Approximately 393 miles (82 percent) would be within approximately 300 feet of existing pipelines, utilities, or road ROWs. The remaining 87 miles (18 percent) of the route would be in new ROWs. A tank farm would be constructed on an approximately 74-acre site at Cushing, Oklahoma, adjacent to the existing Cushing Oil Terminal.
Natural Gas Pipelines			
Bakken NGL Pipeline	An approximately 500-mile long natural gas liquids (NGL) pipeline running from northeastern Montana, south to Colorado. Currently under construction and estimated to begin operations in the first half of 2013.	Montana, Wyoming, Colorado.	Within the PCIC of the proposed pipeline route near Baker, Fallon County, Montana.
Water Delivery Systems			
Dry Prairie Rural Water System	System to provide drinking water to approximately 27,434 people in eastern Montana. The system would consist of 12- to 15-inch-diameter PVC water delivery pipelines throughout the service area. Project is 30% complete (off-reservation portions); fiscal year 2013 funded and construction on-going.	Montana: Daniels, Sheridan, and Roosevelt counties and portions of Valley County.	Portions of the water system west of the Fort Peck Indian Reservation may be within the PCIC in northeastern Montana, specifically in Valley County.
Highway Construction			
I-80 Construction	The State of Nebraska is undertaking highway repairs and maintenance along the I-80 interstate highway.	Along the I-80 route in Nebraska.	Highway construction would potentially be within the PCIC in Hamilton County, Nebraska.
US Route 85 Construction	The State of South Dakota is undertaking highway repairs and maintenance along the US-85 highway.	Along the US-85 route in South Dakota.	Highway construction would be within the PCIC in Harding County, north of Buffalo, South Dakota.
SD Route 79 Construction	The State of South Dakota is undertaking highway repairs and maintenance along the SD-79 highway.	Along the SD-79 route in South Dakota.	Highway construction would potentially be within the PCIC in Harding County, south of Reva, South Dakota.

Project Name	Description	Localities Impacted	Geographic Relationship to Proposed Project
I-90 Construction	The State of South Dakota is undertaking highway repairs and maintenance along the I-90 interstate highway.	Along the I-90 route in South Dakota.	Highway construction would be within the PCIC in Jones County, near Murdo, South Dakota.
Grain and Agronomy Hubs			
CVA—Royal Location	The CVA Royal location would be an agronomy and grain hub that would offer and ship grain, fertilizers, chemicals, insecticides, seed and seed treatments, custom application, and precision technology and scouting services to the agricultural sector in central Nebraska. CVA's Royal location would include rail terminals that would be constructed along the NENE Railway, which connects to the Burlington Northern.	CVA is located throughout central Nebraska and affects multiple localities. The Royal location affects Royal, Nebraska, in Antelope County.	This CVA location falls within the PCIC for the primary proposed pipeline route. The construction for this hub is taking place 3 miles west of Royal, Nebraska.

The impacts associated with the general types of other present projects listed in Table 4.15-2, as well as the potential for these impacts to be cumulative with the effects of the proposed Project, are discussed below.

For the Gulf Coast Pipeline and Natural Gas Pipelines, the residual impacts associated with operation of these types of facilities was previously described in the Pipeline and Storage Facility Projects section of Section 4.15.2.1, Cumulative Impacts from Past Projects. However, additional details on the construction of Gulf Coast Pipeline project are provided below. The residual impacts associated with operation of the water delivery system projects and grain and agronomy hubs presented in Table 4.15-2 were previously described in Section 4.15.2.1 related to past (existing) projects, and are not repeated here. The remaining projects in Table 4.15-2 are highway construction projects. A summary of the residual impacts associated with existing highway construction projects is provided below.

In addition to operational residual impacts associated with the projects listed in Table 4.15-2, when considering the cumulative impacts of these projects in terms of present activities, additional short-term impacts associated with concurrent and/or successive construction schedules also needs to be addressed. Cumulative impacts associated with concurrent construction projects within geographic proximity of the proposed Project include short-term alterations to soils, terrestrial vegetation, wildlife, wetlands, land use, visual resources, water resources, air quality (primarily dust), noise, and socioeconomics (predominantly positive impacts on local economies). Where construction projects are successive (as opposed to concurrent) and within geographic proximity of the proposed Project, similar short-term impacts would occur across these resources. While successive construction timeframes would result in reduced magnitude of concurrent short-term impacts, the time period over which short-term impacts would occur would increase.

Crude Oil Pipelines and Storage Facilities

Construction on the TransCanada Gulf Coast pipeline began in August 2012 and is anticipated to be complete and operational by mid- to late 2013. The Gulf Coast project would construct 484 miles of new pipeline through Oklahoma and Texas, and would transport crude oil from Cushing, Oklahoma, south to Nederland, Texas. Approximately 82 percent of the total pipeline length would be within approximately 300 feet of existing pipelines, utilities, or road ROWs. The Gulf Coast project would affect approximately 8,542 acres during construction. After project completion the temporary 110-foot ROW that is necessary during construction activities would be reduced to a 50-foot-wide permanent ROW, which would be maintained for the life of the project. Total acreage that would be permanently affected is 3,121 acres. Additionally, the pipeline would require the construction of several ancillary facilities such as pump stations, tank farms, intermediate mainline valves, and access roads.

The vast majority of the impacts associated with the construction and operation of the Gulf Coast pipeline project would be short-term, temporary impacts caused during pipeline installation. Extensive effort went into routing pipeline around sensitive areas such as wetlands and critical habitats to minimize potential impacts to these resources. After completion, the temporary ROW would be restored, and permanent wetland impacts would be approximately 217 acres. The Gulf Coast pipeline project would impact several diverse land areas known to be or potentially inhabited by federally and state-protected species of flora and fauna. Most impacts would be short term and related to construction activities; however, conversion of mature forest to other habitat types would cause long-term to permanent effects on species that rely on this habitat. Careful planning was done to ensure that the timing of intrusive construction activities does not coincide with critical migration or mating periods.

Highway Construction Projects

Present highway construction projects include highway repairs and maintenance and not the construction of large-scale new infrastructure projects. Primary impacts of these highway construction projects are similar to those discussed above for general construction projects and include short-term alterations to soils, visual resources, water resources, air quality (primarily dust), and noise. Cumulative impacts are possible across these resources where highway construction projects occur within geographic proximity of the proposed Project.

4.15.2.3 Cumulative Impacts from Reasonably Foreseeable Future Projects

Future projects and activities considered in the CEA are those that are reasonably likely to be constructed or take place in the foreseeable future (based on permit applications or similar indication of significant intent). Potential residual (i.e., long-term or permanent) effects from these projects/activities are considered to be cumulative with the effects of the proposed Project. These projects are further described in Table 4.15-3 below. The impacts associated with the general types of projects listed in Table 4.15-3, as well as the potential for these impacts to be cumulative with impacts of the proposed Project, are discussed by resource in Section 4.15.3, Cumulative Impacts by Resource, below. For the types of projects presented in table 4.15-3, the residual impacts associated with construction and operation of these facilities were previously described in the discussion above regarding past and present projects. Cumulative impacts of these projects in terms of future activities would occur where long-term and permanent residual impacts of the proposed Project are additive with long-term and permanent impacts of construction and operation of the above projects.

Table 4.15-3 Representative Future Projects Considered in the Cumulative Effects Assessment

Project Name	Description	Regions Impacted	Geographic Relationship to Proposed Project
Crude Oil Pipelines and Storage Facilities			
BakkenLink Pipeline (connected action)	Approximately 144-mile-long,12-inch-diameter oil gathering system to move Bakken crude within North Dakota to a rail loading station that is being developed near Fryburg, about 30 miles west of Dickinson in southwestern North Dakota.	Western North Dakota and southeastern Montana.	The BakkenLink Pipeline would be within the PCIC near Baker, Fallon County, Montana.
Bakken Crude Express Pipeline	A 1,300-mile-long pipeline from North Dakota to Cushing, Oklahoma.	North Dakota, Montana, Wyoming, Colorado, Kansas, and Oklahoma.	The Bakken Crude Express pipeline would be within the PCIC in eastern Montana.
Water Delivery Systems			
Dry-Redwater Water Authority	Proposed water pipeline with initial feasibility study and appraisal investigation completed; currently working with Bureau of Reclamation on a feasibility study.	Richland, Dawson, McCone, Garfield, and Prairie counties, Montana.	Proposed water pipeline route falls within the PCIC in McCone and Dawson counties, Montana.
Electrical Transmission Lines			
Big Bend to Witten 230-kV Transmission Line (connected action)	Proposed 70-mile transmission line from a new substation near the Big Bend Dam to an existing substation in Witten, South Dakota.	Lyman and Tripp counties, South Dakota	The proposed transmission line would cross the PCIC of the proposed Project route.
Chinook Project (proposed, on hold)	A 500-kV electrical transmission line over 1,000 miles long. Estimated in-service date is 2015. The line would be rated approximately 3,000 MW.	Montana, Idaho, and Nevada.	The Chinook project would extend to southeastern Montana, and is not likely within the PCIC. No specific city is provided as the starting point for the transmission line.
New 765-kV Lines (proposed)	Proposed expansion of the U.S, electric grid that would create new 765-kV lines throughout the country.	Multiple.	The PCIC would be affected in Fallon, Prairie, Dawson, and McCone counties, Montana; Haakon, Jones, and Lyman counties, South Dakota; and Greeley and York counties, Nebraska.

Project Name	Description	Regions Impacted	Geographic Relationship to
Wind Farms			
New Underwood North & South	Proposed wind farms located in southeastern Haakon County, South Dakota. Planned capacity of 10 to 50 MW each.	Southeastern Haakon County, South Dakota.	New Underwood North is potentially located north of the proposed Project, and possibly within the PCIC. New Underwood South is potentially located south of the proposed route, and possibly within the PCIC in Haakon County, South Dakota.
Basin Electric SD-2	Proposed wind farm located in central Tripp County, South Dakota, with generating power of 125 to 200 MW	Central Tripp County, South Dakota.	Potentially within PCIC through Tripp County, South Dakota.
Basin Electric SD-3	Proposed wind farm located in south-central Jones County, South Dakota, with generating power of 125 to 200 MW.	South-central Jones County, South Dakota.	Potentially within PCIC through Jones County, South Dakota.
Grand Prairie	50,000+ acre site. Approximately 12 miles northeast of O'Neill, Nebraska, in Holt County, Nebraska. Proposed project is in process of completing EIS and public review. Project construction is expected to begin in early 2014, with the farm operational by fall 2014.	Holt County, Nebraska.	Within the PCIC in Holt County, Nebraska.
Unnamed Wind Farm Project	Proposed to be constructed on state-owned land and is anticipated to have a 100-299 MW capacity.	Valley County, Montana.	Potentially within the PCIC.
Oil and Gas Well Fields			
Wildcat Fields	Oil and natural gas wells outside of high-production field areas. Located throughout South Dakota and Montana.	Throughout South Dakota and Montana.	New wells permitted on a regular basis by Montana and South Dakota regulators. Possibility for future well installation and development within the PCIC through South Dakota and Montana.
Buffalo	Oil and gas field in western South Dakota.	Northwestern Harding County, South Dakota.	New wells permitted on a regular basis by South Dakota regulators. Possibility for future well installation and development within the PCIC in northwestern Harding County, South Dakota.

Project Name	Description	Regions Impacted	Geographic Relationship to
Fallon County Fields	Gas Light, Plevna, Plevna South, Cedar Creek, and Wildcat Fallon oil and gas fields in southeastern Fallon County, Montana.	Southeastern Fallon County, Montana.	Oil and gas wells within the PCIC in southeastern Fallon County, Montana.
McCone County Fields	Weldon and Wildcat McCone oil and gas wells in central and southeastern McCone County, Montana.	Southeastern McCone County, Montana.	Oil and gas wells within the PCIC of the proposed Project in southeastern McCone County, Montana.

4.15.2.4 Cumulative Impacts from Connected Actions

There are three actions that are separate from the proposed Project that are included in the evaluation of potential cumulative impacts to the extent that information on the projects is available:

- Bakken Marketlink Project: Consists of constructing approximately a 5-mile-long pipeline and three crude oil storage tanks and associated facilities near Baker, Montana, adjacent to the proposed Pump Station 14 to store and deliver Bakken oil production from producers in North Dakota and Montana into the proposed Project pipeline for delivery to Cushing, Oklahoma.
- Big Bend to Witten 230-kV Transmission Line: Consists of constructing approximately 2 miles of double-circuit 230-kV transmission line from the south side of the Big Bend Dam to the new Lower Brule Substation in south-central South Dakota, and then 74 miles south-southwest to the existing Witten Substation.
- Electrical Distribution Lines and Substations associated with proposed pump stations.

Connected action project details are presented in Section 2.1.12, Connected Actions, and also in Appendix V, Past, Present, and Reasonably Foreseeable Future Project Descriptions.

Cumulative impacts of these projects in terms of future activities would occur where long-term and permanent residual impacts of the proposed Project are additive with long-term and permanent impacts of construction and operation of the above projects. The residual impacts associated with operation of these types of facilities were previously described in Section 4.15.2.1, Cumulative Impacts from Past Projects, related to past (existing) projects; a summary of general construction impacts was previously described in Section 4.15.2.2, Cumulative Impacts from Present Projects.

4.15.2.5 Summary of Key Geographically Overlapping Project Areas

Past, present, and future projects and development activities are heavily concentrated in key areas of the PCIC. These key areas are characterized by larger populations, which generally have greater transportation (road, rail), energy source (oil, gas, wind, mineral, electrical) generation and transmission, and waste disposal demands.

Montana

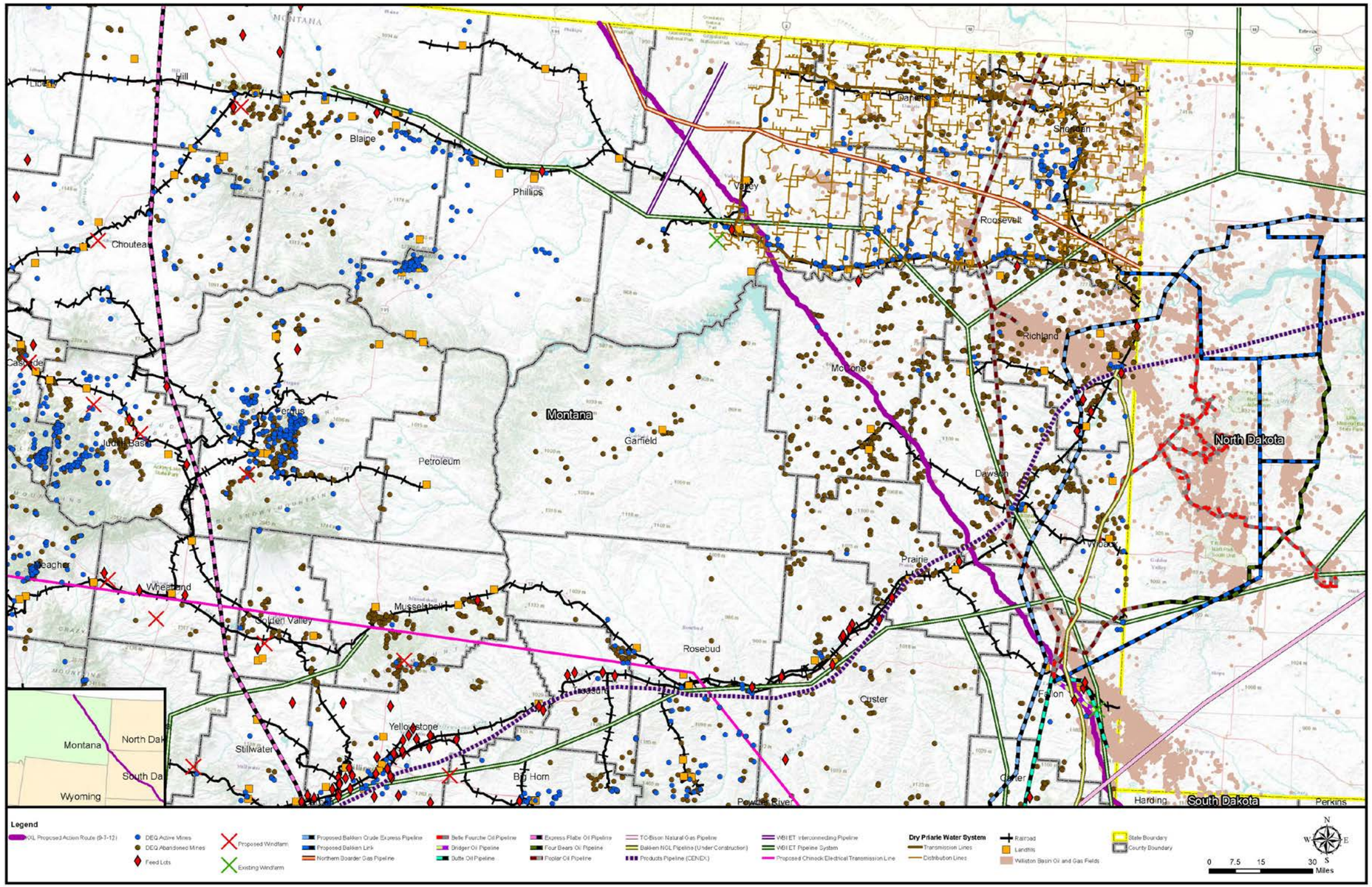
Fallon County, Montana, has been identified as a primary area for the occurrence of cumulative impacts because of its proximity to the Williston Basin oil and gas fields and its population center of Baker. One closed landfill associated with the town of Baker is located within the PCIC of the proposed Project. The area is also served by the BNSF rail line, which runs northwest-

southeast across Fallon County. The area also supports mining, and one active bentonite mine and six abandoned coal fields were identified within the PCIC in Fallon County. Fallon County also supports wind farm developments, including the Diamond Willow Wind Farm, located southeast of Baker and within the PCIC.

The Williston Basin oil and gas fields extend from South Dakota, through North Dakota and Montana, and into Canada. Several highly productive gas fields are located in Fallon County, and as a result a large number of gas wells are located within the PCIC of the proposed Project route in the county. Because of the proximity to these well fields, a number of natural gas and oil-related transmission, storage, and associated facilities are also located in Fallon County. An underground natural gas storage field is operated by WBI Energy Transmission (formerly Williston Basin Interstate Pipeline Company) near Baker, which is tied in with WBI's total of 3,700 miles of natural gas transmission lines, portions of which also cross the PCIC in and around Baker (WBI Energy Transmission 2012). A portion of another natural gas pipeline, the Bison pipeline, also crosses the PCIC of the proposed project in southeastern Fallon County. Lastly, Oneok Partners is currently constructing an approximately 500-mile-long NGL pipeline that would cross the PCIC near Baker, Montana.

In addition to natural gas, crude oil from the Williston Basin is transported via a number of pipelines owned and operated by True Companies, which include the Belle Fourche, Butte, Four Bears, and Poplar pipelines (Bridger Pipeline LLC 2012). These pipelines converge in Fallon County, Montana, at the Bridger Gathering station near Baker and cross within the PCIC at several locations. Oneok Partners has proposed to construct a crude oil pipeline, the Bakken Crude Express, through Fallon County, near Baker. The town of Nashua, in southern Valley County, Montana, is also a primary cumulative impact area. Linear and non-linear projects within the PCIC in southern Valley County include a section of the BNSF rail line, portions of the WBI Energy Transmission natural gas pipeline system, a closed landfill, three active surface gravel pits, a wind farm, and several water delivery pipelines associated with the Dry Prairie Rural Water system, which is currently under construction.

It should be noted that Keystone was issued a Certificate of Compliance in 2008 by the Montana Department of Environmental Quality under the Major Facility Siting Act, Section 75-20-101, et seq., Montana Code Annotated. The Certificate of Compliance authorizes the construction, operation, and maintenance of the Montana portion of the proposed Project. The certification report indicates that an increase in the development of wind power projects in the central plains region, as well as increased need for electrical power, is likely to increase the number of electrical transmission lines in the vicinity of the proposed Project. Cumulative impacts of the proposed Project and operation of new transmission lines could include impacts to air quality, viewshed degradation, changes to land uses and vegetation, and impacts to migratory birds. The Montana Department of Environmental Quality specifies the mitigation measures to be implemented in order to minimize potential impacts. Their findings concluded that final location for the proposed Project would result in fewer cumulative adverse environmental impacts and economic cost than siting the facility in another reasonable location. Figure 4.15.2-1 shows the known locations of past, present, and reasonably foreseeable future projects in Montana.



Source: See Appendix V, Past, Present, and Reasonably Foreseeable Future Project Descriptions.

Figure 4.15.2-1 Known Locations of Past, Present, and Reasonably Foreseeable Future Projects in Montana

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South Dakota

In general, the proposed Project route through South Dakota does not coincide with other past, present, and future projects and development areas. Therefore, the potential for cumulative impacts within South Dakota is not anticipated to be significant. Figure 4.15.2-2 shows the known locations of past, present, and reasonably foreseeable future projects in South Dakota.

Nebraska

Due to its central location between northern oil and gas fields and southern refineries, numerous natural gas, crude oil, and refined product pipelines crisscross the state of Nebraska. Specifically, existing infrastructure/development is concentrated in the southern portion of the PCIC, which is the primary area for the occurrence of cumulative impacts.

Steele City, in Jefferson County, Nebraska, is a natural gas and oil transfer location through which the proposed Project crosses, and through which the Rockies Express West, Express-Platte, Northern Natural Gas Company, and Natural Gas Pipeline Co. of America pipelines cross. A segment of the UP rail line also passes through Steele City and within the PCIC of the proposed Project. Additionally, several abandoned and one active sand and gravel pit were identified within the PCIC in southern Jefferson County, near Steele City.

Other areas of concentrated infrastructure occur in Nebraska. Projects within the PCIC of the proposed Project in Saline County, Nebraska, include the Trailblazer and Northern Natural Gas Company natural gas transmission lines, the Keystone Mainline crude oil pipeline, a section of BNSF rail line, abandoned sand and gravel pits, and highway construction on US-6 and I-80. Projects with cumulative impact within the PCIC of the proposed Project in Fillmore County, Nebraska, include the KMIGT system, NuStar refined products pipeline, BNSF rail line, and abandoned sand and gravel pits. Projects within the PCIC of the proposed Project in York County, Nebraska, include the Magellan and NuStar refined petroleum products pipelines, the NuStar anhydrous ammonia pipeline, portions of the KMIGT, the BNSF rail line, a petroleum-operated power generation facility, and abandoned sand and gravel pits. Cumulative impact projects within the PCIC of the proposed Project in Merrick County, Nebraska, include sections of the UP and NCRC rail lines, and abandoned sand and gravel pits. Cumulative impact projects within the PCIC of the proposed Project in Boone County, Nebraska, include portions of the KMIGT, SourceGas natural gas transmission lines, the NCRC rail line, and the Laredo Ridge wind farm. Figure 4.15.2-3 shows the known locations of past, present, and reasonably foreseeable future projects in Nebraska.

4.15.3 Cumulative Impacts by Resource

An analysis of the resources potentially sensitive to cumulative effects from past, present, and reasonably foreseeable future projects is addressed in this section. To organize the discussion, a CEA matrix is presented at the beginning of each resource section that identifies the primary resource components that are subject to potential adverse effects from the proposed Project and connected action activities, whether these effects are direct or indirect, and the anticipated duration and geographic extent of the effects. The last column in the CEA matrix indicates if the resource component is potentially subject to cumulative impacts based on this information.

The discussion that follows the matrix focuses on the identified resource areas with potential cumulative impacts and their significance, both for the proposed Project, as well as overall in the

context of effects from past, present, and reasonably foreseeable future projects described in Section 4.15.2, Past, Present, and Reasonably Foreseeable Projects. The CEA matrix serves as a tool for the consistent and transparent documentation of the CEA process, and supports the conclusions regarding the assessment of cumulative effects to important resource areas. It should be noted that the matrices provide a preliminary indication as to the potential for cumulative effects based on whether or not long-term or permanent impacts are anticipated for a particular resource area. This does not represent a conclusive determination that cumulative effects are, in fact, occurring. Rather, it directs the discussion of the resource area that follows, where an indication of the significance of the potential for cumulative effects is provided.

Potential spills are not discussed on a resource-specific level. For an assessment of the potential short- and long-term effects of oil releases to the environment, see Section 4.13, Potential Releases; for a discussion of potential cumulative effects of oil releases to the environment, see Section 4.15.3.13, Potential Releases.

4.15.3.1 Geology

A summary of potential environmental consequences of the proposed Project and connected action activities to geological resources is presented in Table 4.15-4. As further discussed below, the anticipated overall absence of long-term or permanent impacts to geological resources from the proposed Project indicates that cumulative effects to this resource area are not expected. Although, as indicated in Table 4.15-4, permanent access restrictions to mineral/fossil fuel resources within the pipeline ROW may occur, these effects are considered negligible in the context of the amounts available for extraction underneath the proposed Project permanent ROW and ancillary facilities. Where long-term or permanent impacts are absent, the potential for additive cumulative effects with other past, present, and reasonably foreseeable future projects is also negligible.

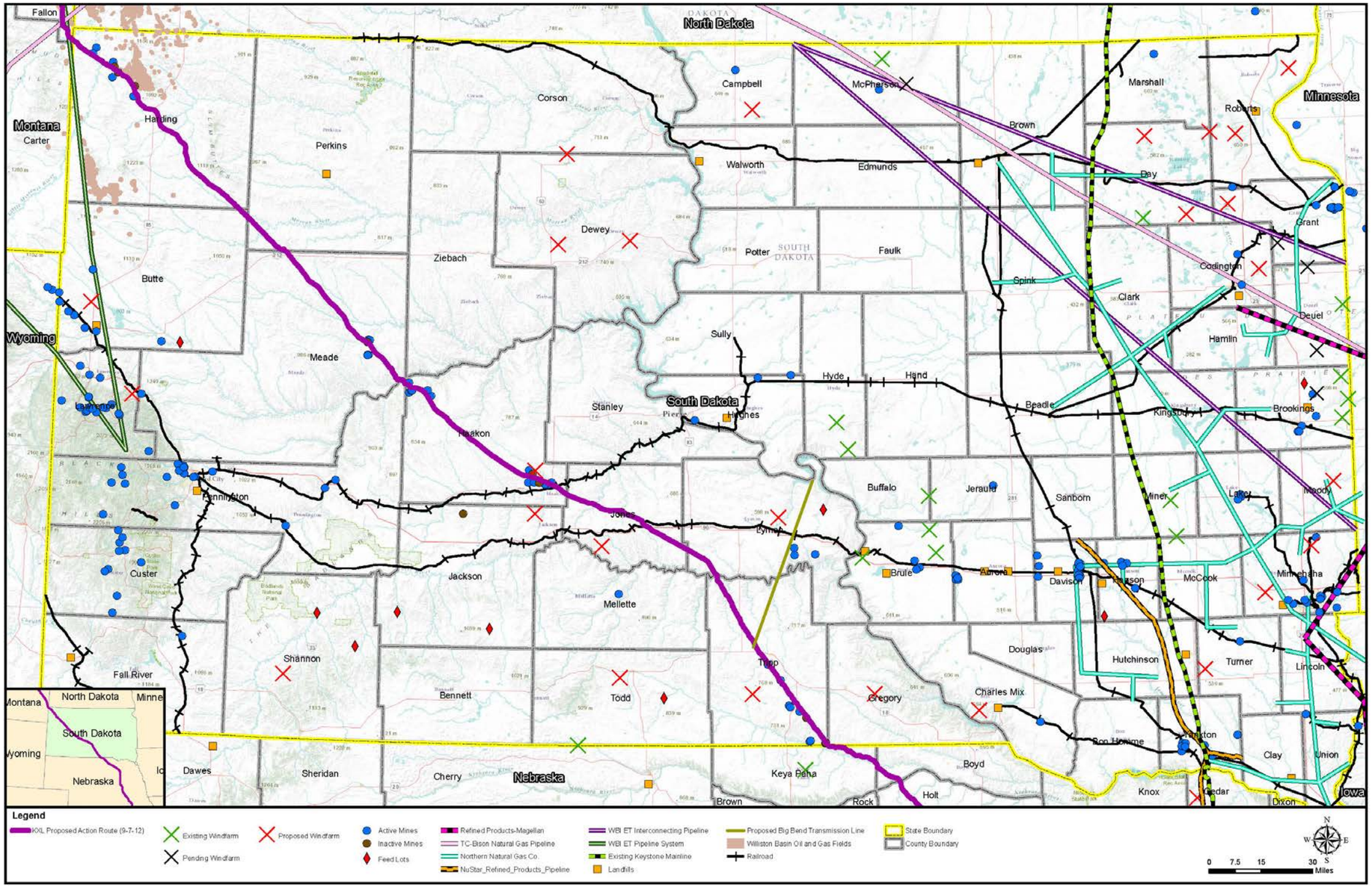
Table 4.15-4 CEA Matrix—Geology

Potential Impact Area	Proposed Project and Connected Action Impacts		Geographic Extent	Cumulative Impact Potential (Yes/No)
	Construction	Operation		
Rock Ripping/Horizontal Directional Drilling	D	N	PA	No
Access to Mineral/Fossil Fuel Resources	D	D	PA	Yes
Paleontological Resources	(D)	N	PA	No
Geologic Hazards (seismic, landslides, subsidence, floods)	(I)	N	PA	No

Duration of Impact
—Negligible
—Temporary/Short Term (<3 yr.)
—Long-Term (>3 yr.)
—Permanent

Type of Impact
N —Negligible Impact
D —Direct Impact
I —Indirect Impact

Notes: Parentheses around impact indicates that it would be addressed by implementation of CMRP, additional mitigations, and/or existing laws and regulations.
Geographic Extent of Potential Impact: Project Area (PA)—Defined by limits of ROW and ancillary facilities, e.g., access roads, pump stations, and construction camps.



Source: See Appendix V, Past, Present, and Reasonably Foreseeable Future Project Descriptions.

Figure 4.15.2-2 Known Locations of Past, Present, and Reasonably Foreseeable Future Projects in South Dakota

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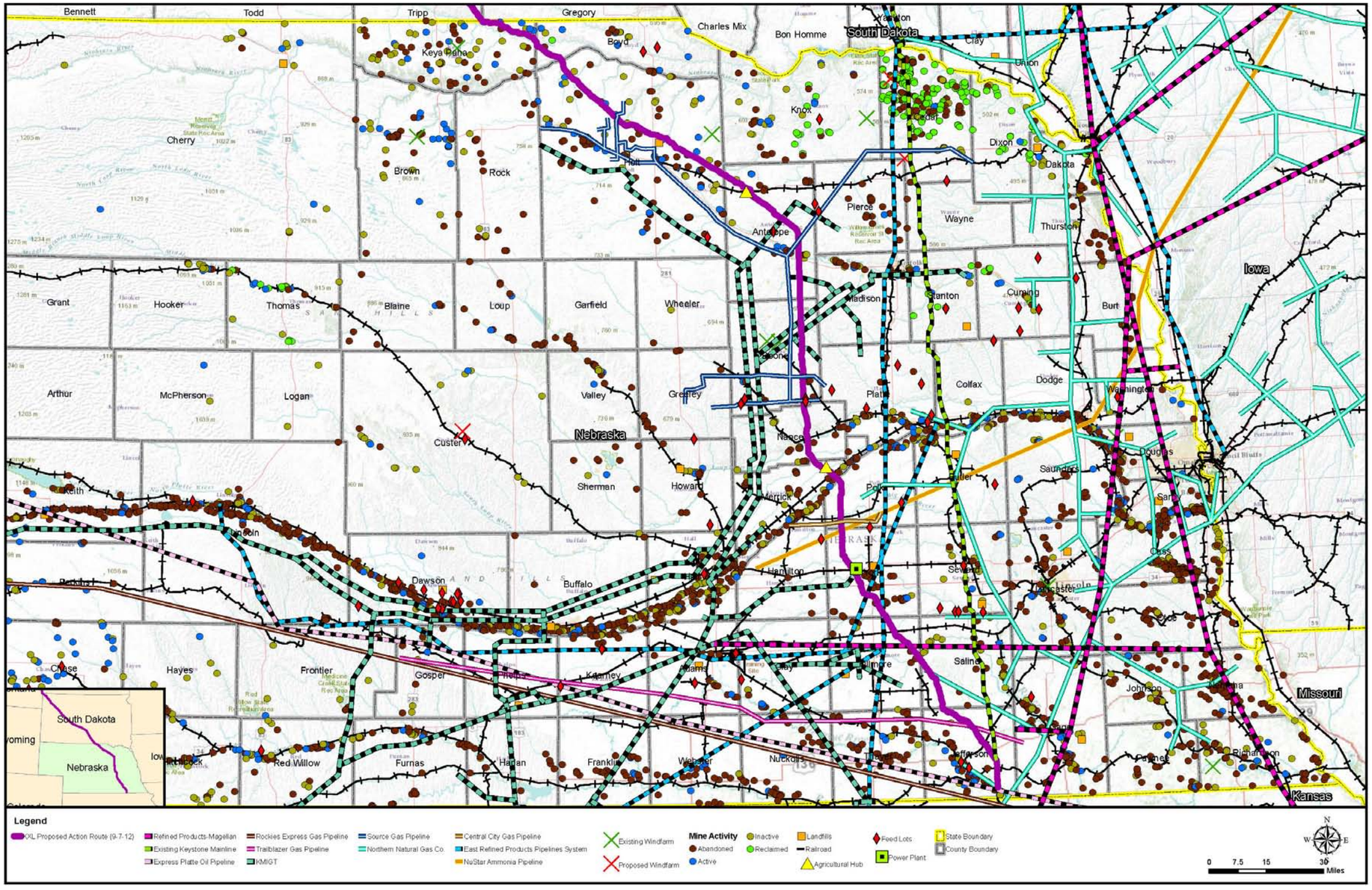

Source: See Appendix V, Past, Present, and Reasonably Foreseeable Future Project Descriptions.

Figure 4.15.2-3 Known Locations of Past, Present, and Reasonably Foreseeable Future Projects in Nebraska

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The majority of the potential effects to geological resources are short term, limited in geographic extent, and associated with the construction phase of the proposed Project only. Potential effects to geological resources could include direct impacts to the subsurface through rock ripping (the break up and removal of rock material with an excavator) or horizontal directional drilling (HDD). These activities would involve some disturbance and modification of the shallow subsurface geology but would not have substantive impacts to the local geology. Although the proposed Project would cross oil- and gas-producing areas, it would not cross any active surface mines or quarries, or the well-pads of any active oil and gas wells.

The proposed Project route would cross underlying coal-bearing formations in South Dakota. Therefore, although not currently planned, if surface mining was proposed for this area in the future, the proposed Project could limit access to these resources. Overall, however, the acreage of deposits covered by the proposed Project and ancillary facilities is minimal when compared to the amounts available for extraction throughout the proposed Project route. Paleontological resources can be damaged or destroyed during construction by excavation activities, erosion of fossil beds exposed due to grading, and unauthorized collection (i.e., direct impacts to paleontological resources). Keystone would prepare a Paleontological Monitoring and Mitigation Plan prior to construction on federal and certain state and local government lands to offset the potential for these impacts. In addition, several existing laws and regulations apply to paleontological resources to offset the potential for these impacts. Paleontological resources identified on federal lands are managed and protected under the Paleontological Resources Preservation Act as part of the Omnibus Public Land Management Act of 2009, and both Montana and South Dakota have enacted legislation to manage and protect paleontological resources on state-managed lands. With these mitigations and regulations in place, direct impacts to paleontological resources are considered minimal.

Based on the evaluation of potential seismic hazards along the proposed Project, the risk of the proposed Pipeline rupture from earthquake ground motion is considered to be minimal. The proposed Project route would not cross any known active faults and is located outside of known zones of high seismic hazard. In addition, the pipeline would be constructed to withstand probable seismic events within the seismic risk zones crossed by the proposed Project (according to existing regulations). Erosion control measures such as trench breakers, slope breakers or water bars, erosion control matting, and mulching would reduce the likelihood of construction-triggered landslides. In addition, areas disturbed by construction along the proposed Project would be revegetated consistent with the Keystone's CMRP (Appendix G) and specific landowner or land manager requirements. Further, regulations require that pipeline facilities are designed and constructed in a manner to provide adequate protection from washouts, floods, unstable soils, landslides, or other hazards that could cause the proposed pipeline facilities to move or sustain abnormal loads. Because there no appreciable limestone areas in states along the proposed Project route, the risk of subsidence from karst features along the proposed Pipeline route is negligible.

Impacts to geological resources from the construction and operation of the connected actions (Bakken Marketlink Project, Big Bend to Witten 230-kV Transmission Line, and Electrical Distribution Lines and Substations) are not substantially different from the proposed Project. The duration of impacts are primarily temporary and short term, with negligible effects on geological resources, with the possible exception of access to mineral and/or fossil fuel resources located below permanent structures. In summary, with respect to geological resources, long term/permanent impacts are limited to the restriction of access to mineral and/or fossil fuel

resources located within the permanent pipeline ROW (50 feet wide) and under ancillary facilities. Thus, this is the only potential area for cumulative impacts to occur with other past, present, and reasonably foreseeable future projects.

Past projects would concurrently affect this aspect of geological resources to the extent that there is a high density of past project activity in a geographic area having a similar impact. As shown on Figures 4.15.2-2 and 4.15.2-3, southern and eastern Nebraska and the east/southeastern region of Montana are candidate areas for cumulative impacts associated with concurrent projects, including the proposed Project. For current projects, although not geographically connected, construction of the TransCanada Gulf Coast pipeline project would also permanently limit access to mineral resources in Oklahoma and Texas. Approximately 82 percent of the Gulf Coast pipeline project is planned to be constructed within approximately 300 feet of existing pipelines, utilities, or road ROWs, which could potentially increase the area of restricted access to mineral and/or fossil fuel resources beyond the typical 50-foot ROW width. No other current projects identified have a potential to significantly add to cumulative impacts to geological resources with the proposed Project.

Future projects could potentially contribute to cumulative impacts to mineral and/or fossil fuel resources including the BakkenLink pipeline, the Bakken Marketlink, and the Bakken Crude Express pipeline projects, in addition to water delivery and wind power projects, particularly where they might overlap geographically with the proposed Project in east/southeastern Montana and southeastern Nebraska. Overall, however, with respect to the proposed Project in combination with the past, present, and foreseeable future projects, including the Gulf Coast pipeline project, the acreage of restricted mineral and/or fossil fuel resources is minimal when compared to the amounts available for extraction surrounding the areas directly affected.

4.15.3.2 Soils

A summary of potential environmental consequences of the proposed Project activities to soil resources is presented in Table 4.15-5.

Table 4.15-5 CEA Matrix—Soils

Potential Impact Area	Proposed Project and Connected Action Impacts		Geographic Extent	Cumulative Impact Potential (Yes/No)
	Construction	Operation		
Soil Erosion	(D)	I	PA	No
Soil Compaction	(D)	N	PA	No
Loss of Topsoil/Topsoil Degradation	(I)	N	PA	No
Agricultural, Range, Pasture Land Soil Degradation	(I)	N	PA	No
Fragile Soils	(D)	N	PA	No
Soil Productivity (Temperature)	N	D	PA	Yes

Duration of Impact
—Negligible
—Temporary/Short Term (<3 yr.)
—Long-Term (>3 yr.)
—Permanent

Type of Impact
N —Negligible Impact
D —Direct Impact
I —Indirect Impact

Notes: Parentheses around impact indicates that it would be addressed by implementation of Keystone's CMRP, additional mitigations, and/or existing laws and regulations.
Geographic Extent of Potential Impact: Project Area (PA)—Defined by limits of ROW and ancillary facilities, e.g., access roads, pump stations, and construction camps.

Potential effects to soil resources from the proposed Project are limited to the general footprint of the Project ROW and ancillary facilities. As a result, the potential for additive cumulative effects to these resources is also limited. Change to soil productivity due to localized increased temperature is the one area considered to have potential permanent effects when the pipeline is in operation. Potential effects on other aspects of soil resources from the proposed Project are limited in geographic extent and the majority are associated with the construction phase of the proposed Project only. As further discussed below, potential cumulative effects to soil resources are localized and otherwise considered negligible. Due to the relatively high temperature of the oil in the pipeline, increased pipeline operation temperatures may cause a localized increase in soil temperatures and a decrease in soil moisture content, causing indirect affects to terrestrial vegetation. This is the only potential impact to soil that is considered permanent for the design life of the proposed Project. Permanent changes to soil productivity within the pipeline ROW are considered to have low cumulative impact, assuming effective restoration efforts and when considered in the context of the large soil resources throughout the proposed Project route.

Outside of productivity issues, potential direct effects to soil resources include clearing, grading, trench excavation, backfilling, equipment traffic, and restoration along the proposed Project ROW and ancillary facilities during construction activities. Potential impacts could include temporary and short-term direct impacts associated with soil erosion and soil compaction; and short- to long-term direct and indirect impacts associated with topsoil loss and/or degradation (including fragile soils and agriculture, range, or pasture soils). Impacts to soil resources during operation include temporary and short-term indirect impacts associated with soil erosion (from pipeline maintenance traffic and incidental repairs). However, Keystone's proposed Project CMRP (Appendix G) includes construction procedures that are designed to reduce the likelihood and severity of proposed Project impacts to soil resources. For example, the CMRP requires the use of erosion control measures (such as the installation of sediment barriers, trench plugs, temporary slope breakers, drainage channels or ditches, and mulching), as well as soil compaction control and topsoil salvage measures. Special handling and additional soil salvage techniques would be implemented to conserve agricultural soil capability where appropriate. Special considerations and measures would also be undertaken in proposed Project areas in southern South Dakota and northern Nebraska where the soils are fragile (i.e., sandy soils that are highly susceptible to erosion by wind). These embedded controls would serve to reduce the severity and duration of potential impacts to soil resources during construction and operation activities.

Impacts to soil resources from the construction and operation of the connected actions (Bakken Marketlink Project, Big Bend to Witten 230-kV Transmission Line, and Electrical Distribution Lines and Substations) are not substantially different from the proposed Project with the exception of impacts associated with soil temperature, and impacts to fragile soils and agriculture, range, or pasture soils. These soil resources would not be impacted by the connected actions to the proposed Project. Where remaining impacts listed in Table 4.15-5 overlap between the proposed Project and the connected actions, these are considered collectively in the overall discussion of the proposed Project.

In summary, long-term/permanent impacts are limited to potential productivity issues (defined as localized increases in soil temperatures and decrease in soil moisture content), which are localized to the area of the permanent pipeline ROW and ancillary facilities. Past projects would concurrently affect soil productivity and its indirect effect on terrestrial vegetation to the extent that there is a high density of activity in a geographic area having a similar impact. As shown on

Figures 4.15.2-2 and 4.15.2-3, southern and eastern Nebraska and the east/southeastern region of Montana are candidate areas for cumulative impacts associated with concurrent projects, including the proposed Project. The project type affecting soil productivity through temperature would be limited to crude oil pipelines. However, to the extent that past projects also have soil productivity concerns through other direct or indirect alteration of terrestrial vegetation, they could also be considered cumulative. However, reclamation measures are available for this resource within the context of all of these activities, thus reducing the possibility for permanent impacts, and lessening their significance to overall cumulative impacts.

Currently, although not geographically connected, construction of the TransCanada Gulf Coast pipeline project is included in the consideration of soil productivity impacts. However, year-round soil surface temperatures over the Gulf Coast pipeline route would remain unchanged in Oklahoma and Texas. Other current projects such as water delivery systems and highway maintenance and repair are also not expected to result in permanent impacts to terrestrial vegetation. Therefore, current projects would not contribute to cumulative impacts to soil productivity, or the associated indirect impacts to terrestrial vegetation.

Future projects that could potentially contribute to cumulative impacts to soil productivity include the BakkenLink pipeline, the Bakken Marketlink, and the Bakken Crude Express pipeline projects. Electrical transmission lines, wind power projects, and oil and gas mining activities may also contribute to cumulative impacts to soil productivity through the indirect alteration of terrestrial vegetation, particularly where projects could overlap geographically with the proposed Project in east/southeastern Montana and southeastern Nebraska.

Overall, however, with respect to the proposed Project in combination with the past, present, and foreseeable future projects, including the Gulf Coast pipeline project, permanent changes to soil productivity within the pipeline ROW are considered negligible assuming effective restoration efforts and in the context of the large extent of soil resources throughout the proposed Project route. Where restoration efforts are not feasible, landowner compensation for demonstrated losses from decreased productivity resulting from pipeline operations would be implemented to the extent required by easement or ROW agreements.

4.15.3.3 Water Resources

Surface Water

A summary of potential environmental consequences of the proposed Project activities to surface water resources is presented in Table 4.15-6. As further discussed below, routine proposed pipeline operation and maintenance activities would have negligible effect on surface water resources with properly implemented and maintained mitigations; therefore, the overall potential for cumulative effects to surface water resources is considered low. No permanent effects during the operation of the pipeline are expected. Generally speaking, the proposed Project route has been selected and modified to minimize the potential for impacts to surface water resources, as well as other sensitive environments, by avoiding them whenever possible and shifting the route to limit the area affected. There are a number of waterbodies that would be crossed by the proposed pipeline where mitigation measures would be used to reduce or minimize impacts. To the extent that one or more projects cross the same waterbody in the same watershed, implementation of appropriate construction practices and permit processes through the U.S. Army Corps of Engineers would minimize the potential for localized cumulative impacts. The introduction and transportation of invasive aquatic and plant species, respectively, are considered

the only potential long-term, indirect impacts when the pipeline is in operation. The remaining surface water resource areas are potentially affected on a long-term basis primarily during the period of construction, with low potential to persist in the pipeline operation phase.

Table 4.15-6 CEA Matrix—Surface Water

Potential Impact Area	Proposed Project and Connected Action Impacts		Geographic Extent	Cumulative Impact Potential (Yes/No)
	Construction	Operation		
Bank Stability	(D)	N	PA	No
Channel Morphology	(D)	N	LA	No
Channel Bed Scour	(D)	N	LA	No
Increased Sedimentation	(D)	(I)	LA	No
Water Temperature Alteration (Channel Construction)	D	N	LA	No
Water Temperature Alteration (Pipe Testing)	I	N	LA	No
Reduced Flow	(D)	N	LA	No
Dewatering	D	N	LA	No
Transportation of Invasive Plant Species	(I)	(I)	R	Yes
Introduction of Invasive Aquatic Species	(I)	I	R	Yes
Increased Total Dissolved Solids	(D)	I	R	No
Increased Total Suspended Solids (Riparian)	(D)	(D)	R	No
Increased Total Suspended Solids (General ROW)	(D)	(I)	R	No

Duration of Impact
—Negligible
—Temporary/Short Term (<3 yr.)
—Long-Term (>3 yr.)
—Permanent

Type of Impact
N —Negligible Impact
D —Direct Impact
I —Indirect Impact

Notes: Parentheses around impact indicates that it would be addressed by implementation of Keystone's CMRP, additional mitigations, and/or existing laws and regulations.
Geographic Extent of Potential Impact: Project Area (PA)—Defined by limits of ROW and ancillary facilities, e.g., access roads, pump stations, and construction camps; Local Area (LA)—Defined as a 2-mile distance on either side of the pipeline ROW and ancillary facilities; Regional (R)—Defined by resource, e.g., home ranges of wildlife species, bird migration corridor, regional airshed, etc.

Depending on the type of stream crossing, one of six construction methods would be used: non-flowing open-cut, flowing open-cut, dry flume, dry dam-and-pump, HDD, or horizontal bore crossing. At the 15 major and sensitive waterbody crossings, the HDD method would be used. Where conditions warrant the use of the HDD crossing method, waterbody impacts of construction would be minimal since no direct contact would occur with stream banks, channel bed, or waters. In the event that a frac-out (accidental release of drilling fluids from the borehole up to the surface) were to occur during HDD, there would be short-term impacts within the proposed Project cumulative impact corridor, but conditions would be expected to return to pre-construction conditions after mitigation and restoration measures were implemented, making their overall contribution to cumulative impacts negligible.

Potential impacts on surface water resources during construction activities would include temporary increases in total suspended solids concentrations and sedimentation during non-HDD stream crossings or at upland locations with soil erosion and transport to streams; temporary to long-term changes in channel morphology and stability caused by channel and bank modifications; temporary to long-term decrease in bank stability and resultant increase in total suspended solids concentrations from bank erosion as vegetation removed from banks during

construction is re-establishing; and temporary reduced flow in streams and potential other adverse effects during hydrostatic testing activities and stream crossing construction. Full shrub and vegetation restoration in riparian areas is expected to take more than 3 years; however, the establishment of herbaceous ground cover and other temporary stabilization measures very soon after completion of crossings would ensure that there are no long-term effects to bank stability and sedimentation.

Keystone's proposed Project CMRP (see Appendix G) includes construction procedures that are designed to reduce the likelihood and severity of proposed Project impacts to surface water resources. For example, the CMRP identifies procedures to limit erosion and land disturbances, including the use of buffer strips, drainage diversion structures, sediment barrier installations, and clearing limits, as well as procedures for waterbody restoration at crossings. In floodplain areas adjacent to waterbodies, the contours would be restored to as close to previously existing contours as practical and the disturbed area would be revegetated during construction of the ROW in accordance with the CMRP. Implementation of CMRP construction and operating requirements would lead to minimal impacts to waterbodies under normal construction and operating conditions; therefore, the contribution to cumulative impact would be negligible.

Potential surface water impacts are fundamentally the same for the proposed Project construction components and the connected actions. Where remaining impacts listed in Table 4.15-6 overlap between the proposed Project and the connected actions, these are considered collectively in the overall discussion of the proposed Project.

In summary, with respect to surface water resources, permanent impacts are not expected. The introduction and transportation of invasive aquatic and plant species is the primary long-term impact concern, and is the only potential area for cumulative impacts to occur with other past, present, and reasonably foreseeable future projects. Past projects would concurrently affect invasive species to the extent that there is a high density of activity in a geographic area having a similar impact. As shown on Figures 4.15.2-2 and 4.15.2-3, southern and eastern Nebraska and the east/southeastern region of Montana are candidate areas for cumulative impacts associated with concurrent projects, including the proposed Project. Although existing projects are not noted to have had long-term impacts to surface water with respect to invasive species, mitigation and restoration measures are available to address these concerns within the context of all of these project activities; thus the overall significance to cumulative impacts is low.

Currently, although not geographically connected, construction of the TransCanada Gulf Coast pipeline project is included in the consideration of invasive species impacts on surface water resources. However, similar to that described above, mitigation and restoration measures are available to address these concerns. Other current projects such as water delivery systems and highway maintenance and repair are also not expected to result in long-term impacts with respect to invasive species. Therefore, current projects would not contribute to cumulative impacts to surface water resources.

Future projects that could potentially contribute to cumulative impacts to surface water resources with respect to invasive species include the BakkenLink pipeline, the Bakken Marketlink, and the Bakken Crude Express pipeline projects. Other future projects such as electrical transmission lines, wind power projects, and oil and gas mining activities may also contribute to cumulative impacts where projects could overlap geographically with the proposed Project in east/southeastern Montana and southeastern Nebraska. However, similar to that described above, mitigation and restoration measures are available to address these concerns.

Overall, with respect to the proposed Project in combination with the past, present, and foreseeable future projects, including the Gulf Coast pipeline project, permanent changes to surface water resources within the pipeline ROW are considered negligible assuming effective mitigation and restoration efforts with the proposed Project and other projects throughout the proposed Project route.

Groundwater/Hydrogeology

A summary of potential environmental consequences of the proposed Project activities to groundwater resources and hydrogeology is presented in Table 4.15-7. Permanent direct impacts to groundwater/hydrogeology from the proposed Project include the direct continuous or intermittent contact of the pipeline with groundwater in shallow water settings. In addition, permanent impacts would occur to existing wells that are in conflict with the proposed Project ROW or ancillary facilities, which would be decommissioned. Long-term impacts to groundwater could result from groundwater mixing (between aquifers) during HDD, although this would be minimized by the drilling fluids and muds that would seal the pipe in place. These aspects, however, are not considered significant with respect to cumulative effects because they would be generally localized to the footprint of proposed Project activities and are not likely to be additive between past, present, or future projects. Groundwater/hydrogeology impacts are further discussed below.

Table 4.15-7 CEA Matrix—Groundwater/Hydrogeology

Potential Impact Area	Proposed Project and Connected Action Impacts		Geographic Extent	Cumulative Impact Potential (Yes/No)
	Construction	Operation		
Water used for HDD	(D)	N	LA	No
Water extraction and use for construction housing camps and hydrostatic testing	D	N	LA	No
Groundwater mixing	I	I	PA	Yes
Dust suppression along access roads	(D)	N	PA	No
Dewatering during construction	(D)	N	PA	No
Decommissioning of existing wells in conflict with alignment	(D)	(D)	PA	Yes
Water disposal during hydrostatic testing of pipeline and at the construction camps	(D)	(D)	R	No
Changes to characteristics of shallow groundwater aquifers	I	I	LA	No
Pipeline in direct contact with shallow groundwater	D	D	PA	Yes

Duration of Impact
—Negligible
—Temporary/Short Term (<3 yr.)
—Long-Term (>3 yr.)
—Permanent

Type of Impact
N —Negligible Impact
D —Direct Impact
I —Indirect Impact

Notes: Parentheses around impact indicates that it would be addressed by implementation of Keystone's CMRP, additional mitigations, and/or existing laws and regulations.
Geographic Extent of Potential Impact: Project Area (PA)—Defined by limits of ROW and ancillary facilities, e.g., access roads, pump stations, and construction camps; Local Area (LA)—Defined as a 2-mile distance on either side of the pipeline ROW and ancillary facilities; Regional (R)—Defined by resource, e.g., home ranges of wildlife species, bird migration corridor, regional airshed, etc.

The remaining potential impacts to groundwater/hydrogeological resources are short term in duration. In addition, Keystone's proposed Project CMRP includes construction procedures that are designed to reduce the likelihood and severity of proposed Project impacts to water resources. The proposed Project would be required to adhere to applicable local, state, and federal regulations and permit conditions. All water resources used for hydrostatic testing, construction camp use, dust suppression, or HDD would be approved by the appropriate permitting agencies prior to initiation of any withdrawal activities. As described in the proposed Project CMRP, surface and/or groundwater withdrawal methods would be implemented and followed, including screening of intake hoses to prevent the entrainment of fish or debris, keeping the hose at least 1 foot off the bottom of the water resource, prohibiting the addition of chemicals into the test water, and avoiding discharging any water that contains visible oil or sheen (from pipe manufacturing activities) following testing activities. Required water analyses would be obtained prior to any water discharging operations associated with hydrostatic testing or construction camp water disposal.

Impacts to groundwater/hydrogeological resources from the construction and operation of the connected actions (Bakken Marketlink Project, Big Bend to Witten 230-kV Transmission Line, and Electrical Distribution Lines and Substations) are not substantially different from the proposed Project. No significant large-scale potable water aquifers underlie the Bakken Marketlink Project area, and well depths are typically greater than 50 feet. Because of the limited amount of potable water directly beneath the Bakken Marketlink Project area and the significant depth to groundwater in this area, it is not likely that potential releases would significantly impact groundwater resources in the area. Where remaining impacts listed in Table 4.15-7 overlap between the proposed Project and the connected actions, these are considered collectively in the overall discussion of the proposed Project.

In summary, with respect to groundwater/hydrogeological resources, long-term/permanent impacts are related to contact of the pipeline with groundwater in shallow water settings, the decommissioning of existing wells that are in conflict with the proposed Project, and groundwater mixing (between aquifers) during HDD. Where avoidance of an existing groundwater well is not feasible, compensation for the loss resulting from pipeline and ancillary facility construction would be implemented to the extent required by easement or ROW agreements. Pipeline contact with shallow groundwater and groundwater mixing between aquifers are localized impacts with little to no significant cumulative impact potential with other projects. Therefore, with respect to the proposed Project in combination with the past, present, and foreseeable future projects, including the Gulf Coast pipeline project, cumulative impacts to groundwater resources are considered negligible.

4.15.3.4 Wetlands

A summary of potential environmental consequences of the proposed Project activities to wetland resources is presented in Table 4.15-8 below. Table 4.15-8 summarizes the estimated duration, geographic extent, and cumulative impact potential for Project-related wetland impacts. This discussion focuses on those wetlands that would be affected on a long-term or permanent basis and could potentially contribute to cumulative wetland impacts regionally. Refer to Section 4.4, Wetlands, for a detailed discussion of the wetlands that would be affected by the proposed Project as well as the proposed impact minimization and restoration measures. Temporary, short-term, and long-term impacts discussed here and in Section 4.4 are based on the assumption that post-construction restoration efforts would be successful and no unforeseen conditions resulting

from proposed pipeline operations (e.g., pipeline soil temperature effects, potential spills) delay anticipated recovery rates. Note that a long-term or permanent effect or impact does not necessarily mean a permanent loss of wetland habitat. For example conversion of scrub-shrub or forested wetlands to herbaceous wetlands is considered a permanent impact to those woody wetland classes, but does not represent a complete loss of wetland habitat, whereas a permanent wetland loss would be a conversion of a wetland community to an upland as a result of the construction of a pump station or access road.

Table 4.15-8 CEA Matrix—Wetlands

Potential Impact Area	Proposed Project and Connected Action Impacts		Geographic Extent	Cumulative Impact Potential (Yes/No)
	Construction	Operation		
Wetland loss (conversion of wetland to upland communities)	(D)	(D)	PA	Yes
Conversion of forested to emergent wetlands	(D)	D	PA	Yes
Conversion of scrub-shrub to emergent wetlands	(D)	D	PA	Yes
Loss of or change in hydrology	(I)	(I)	LA	No
Loss of or change in hydric soil integrity	(I)	(I)	PA	No
Change in forested wetland function (non-HDD areas)	(D)	D	LA	Yes
Change in forested wetland function (HDD areas)	(D)	(D)	LA	Yes
Change in scrub-shrub wetland function (non-HDD areas)	(D)	D	LA	Yes
Change in scrub-shrub wetland function (HDD areas)	(D)	(D)	LA	Yes
Change in emergent wetland function	(D)	(D)	LA	Yes
Change in wetland species diversity (not including PFO or PSS conversion issues)[a]	(D) and (I)	(D) and (I)	LA	No
Changes in water quality	(D) and (I)	(D) and (I)	PA	No
Soil biological, chemical, hydrologic conditions/activity (above pipeline resulting from pipe-generated heat)	N	D	PA	Yes
Increased weed infestation	(I)	(I)	LA	Yes

Duration of Impact
—Negligible
—Temporary/Short Term (<3 yr.)
—Long-Term (>3 yr.)
—Permanent

Type of Impact
N —Negligible Impact
D —Direct Impact
I —Indirect Impact

Notes: Parentheses around impact indicates that it would be addressed by implementation of Keystone's CMRP, additional mitigations and/or existing laws and regulations.
Geographic Extent of Potential Impact: Project Area (PA)—Defined by limits of ROW and ancillary facilities, e.g., access roads, pump stations, and construction camps; Local Area (LA)—Defined as a 2-mile distance on either side of the pipeline ROW and ancillary facilities.
[a] PFO = palustrine forested wetland; PSS = palustrine scrub shrub wetland.

Impacts to emergent wetlands affected within the proposed construction corridor width, which would encompass the permanently maintained operations ROW, would likely be short-term to long-term, with likely successful re-establishment within 3 to 5 years, assuming mitigation is successful and near pre-construction conditions are restored and maintained within the anticipated timeframes. All impacted emergent wetlands within the construction and permanent

ROW would be restored to near pre-construction conditions following proposed pipeline installation. Emergent wetlands would be allowed to persist outside of and within the permanent operations ROW for the life of the proposed Project. Herbaceous wetland vegetation in the proposed pipeline ROW generally would not be mowed or otherwise maintained, although the CMRP (Appendix G) allows for annual maintenance of a 30-foot-wide strip centered over the pipeline to mow or clear tall vegetation if necessary. The only permanent loss of emergent wetlands would be associated with the construction of permanent ancillary facilities such as permanent access roads, emergency response staging areas, and pump stations.

In forested and scrub-shrub wetlands, the effects of proposed construction would be extended due to the longer period needed to regenerate a mature forest or shrub community. Prior to proposed pipeline installation, scrub-shrub and forested wetland vegetation within the construction corridor (area between the approximate 30-foot permanently maintained strip within the operations ROW and 110-foot construction corridor limit) would be cut to ground level and root systems would be left in place. Once construction activities were completed, woody vegetation outside of the permanent wetland operations ROW would be restored to near pre-construction conditions and woody vegetation would be allowed to regrow. This would be considered a long-term impact based on the slower growth rate of trees and shrubs, which may require decades for complete regeneration. Within the operations ROW, a 30-foot-wide strip centered over the pipeline would be kept free of tall vegetation for the life of the project. Woody vegetation and rootmass within this 30-foot strip would be completely removed and not allowed to regrow. Scrub-shrub and forest wetlands within this 30-foot-wide strip would be converted to emergent wetlands, which represents a permanent impact to the woody wetland class, but does not necessarily represent a permanent loss of wetland habitat. The only exception to this would be at HDD locations where shrubs and trees would be allowed to regenerate within the permanent ROW after construction activities are complete. In this case, impacts to scrub-shrub and forested wetlands at HDD locations would be considered long-term. The only permanent conversion of scrub-shrub and forested wetlands to uplands would be associated with the construction of permanent ancillary facilities such as permanent access roads, emergency response staging areas, and pump stations.

Construction and operation of ancillary facilities would result in short-term, long-term, and permanent impacts. Impacts associated with non-permanent ancillary facilities (i.e., temporary access roads) would be similar to those described above for emergent wetlands (short-term to long-term with recovery in 3 to 5 years), and long-term to permanent for scrub-shrub and forested wetlands. The construction of permanent ancillary facilities (i.e., permanent access roads, emergency response staging areas, and pump stations) would require wetland fills and represent a permanent wetland loss (wetland to upland conversion); however, these areas are small. Permanent wetland losses due to operational ancillary facilities are estimated to be 0.82 acres in Montana, 1.2 acres in South Dakota, and no acres in Nebraska (see Wetland to Upland Conversion in Table 4.4-2).

With respect to long-term and permanent impacts in Montana, there is an estimated 32.3 acres of wetlands (herbaceous, scrub-shrub, forested, and riverine-openwater) that would be affected by the permanent operations of the proposed Project (see Table 4.4-1 in Section 4.4, Wetlands). Of the 32.3 acres, approximately 4.3 acres of scrub-shrub and forested wetlands would be converted to emergent wetlands, and 0.82 acre of wetlands (all types) would be permanently filled and converted to upland as a result of the construction of ancillary facilities. Similarly in South Dakota, there is an estimated 56.1 acres of wetlands that would be affected by the permanent

operations of the proposed Project. Of these 56.1 acres, approximately 5.1 acres of scrub-shrub and forested wetlands would be converted to emergent wetlands, and 1.2 acres of wetlands (all types) would be permanently filled and converted to upland as a result of the construction of ancillary facilities (Table 4.4-1 in Section 4.4, Wetlands). In Nebraska, approximately 32 acres of wetlands would be affected by the permanent operations of the proposed Project. Of that total, approximately 6.5 acres of scrub-shrub and forested wetlands would be converted to emergent wetlands. Where required, all permanent wetland impacts would be mitigated by following standard U.S. Army Corps of Engineers-required mitigation protocols and ratios, negotiated during the proposed Project permitting.

The long-term and permanent impacts described above and presented in Table 4.15-8 have the potential to contribute towards the cumulative impacts on wetlands as summarized below:

- Potential cumulative effects associated with wetland to upland conversion would be considered to have low overall cumulative significance considering the relatively small total for wetland loss due to proposed Project. In addition, the proposed Project would mitigate for these losses per federal and state requirements.
- Potential cumulative effects associated with conversion of forested to emergent wetlands would be considered to have a greater overall cumulative significance because forested wetlands are a limited resource within the proposed Project area. The proposed Project would mitigate for these losses according to the CMRP and in accordance with state and federal requirements.
- Potential cumulative effects associated with conversion of scrub-shrub to emergent wetlands would be considered to have low overall cumulative significance considering the relatively small area of foreseeable conversion due to proposed Project. In addition, the proposed Project would mitigate for these losses according to the CMRP and in accordance with state and federal requirements.
- Change in forested wetland function would be long-term (>3 years) in areas where regrowth would be allowed and permanent in areas where regrowth would be prohibited. Impacts to function would be minimized and restored according to the CMRP. There is a greater potential for cumulative impacts due to forested wetland conversion because forested wetlands are a limited resource in the proposed Project area.
- Change in scrub-shrub wetland function would be long-term (>3 years) in areas where regrowth would be allowed and permanent in areas where regrowth would be prohibited. Impacts to function would be minimized and restored according to the CMRP. Potential cumulative effects would be considered to have low overall cumulative significance considering the relatively small area of foreseeable functional change due to proposed Project.
- Emergent wetland vegetation would be allowed to regrow in the construction and operations ROW with recovery expected in 3 to 5 years; therefore, impacts to emergent function would be long term, but not permanent. Impacts to function would be minimized and restored according to the CMRP. Potential cumulative effects would be considered to have low overall cumulative significance considering the shorter recovery period of affected emergent wetlands.

- Weeds would be controlled during the construction and operational phases per the CMRP. Weeds have the potential to encroach within disturbed areas despite control efforts over the long-term and spread into areas adjacent to the proposed Project area. Potential cumulative effects would be considered to have low overall cumulative significance considering the Project's stated commitments to controlling weeds.

The potential for a given impact to contribute to cumulative impacts is based on the assumption that the CMRP (Appendix G) is successful and near pre-construction conditions are restored and maintained within the anticipated timeframes. Impacts to wetland resources from the construction and operation of the connected actions (Bakken Marketlink Project, Big Bend to Witten 230-kV Transmission Line, and Electrical Distribution Lines and Substations) are not substantially different from the proposed Project. Most wetlands would be spanned, avoided, minimized, and/or mitigated.

In summary, with respect to wetland resources, the primary impact concern with respect to potential cumulative effects is the conversion of wetlands to uplands, and the conversion of forested wetlands to emergent wetlands. These impacts represent the primary area for cumulative impacts to occur with other past, present, and reasonably foreseeable future projects. As described above, the proposed Project would mitigate for wetland losses per federal and state requirements, as well as the CMRP (Appendix G). However, it is noted that there is a greater potential for cumulative impacts as a result of forested wetland conversion, because forested wetlands are a limited resource in the proposed Project area. Historical activities and past projects are linked to wetland losses (although the proportion of forested wetland acres impacted is unknown). In the mid-1950s through the mid-1970s, there were major wetland losses, although since then the rate of loss has decreased dramatically, primarily through the implementation and enforcement of wetland protection measures, public outreach/education, and restoration programs (U.S. Environmental Protection Agency [USEPA] 2012a). In Montana (particularly in north-central and eastern Montana), South Dakota (notably in the prairie pothole region), and Nebraska, wetlands conversion to agricultural use (assumed to include livestock grazing) accounts for most historic wetland losses (U.S. Geological Survey [USGS] 1996); other development activities and urbanization follow in significance.

The relatively low numbers of wetland acres permanently impacted by the proposed Project heavily influences the evaluation of cumulative effects to wetlands overall. The relative contribution to wetland loss or conversion by the proposed Project in the larger regional context is negligible (<1–2 acres wetland to upland conversion in Montana, South Dakota, and Nebraska each; 4.3, 5.1, and 6.5 acres forested wetland conversion to emergent wetland in Montana, South Dakota, and Nebraska, respectively). Therefore, even though the southeastern Nebraska and east/southeastern Montana regions are candidate areas for cumulative impacts associated with past projects including the proposed Project (as shown on Figures 4.15.2-2 and 4.15.2-3), the incremental effect of the proposed Project is negligible.

Although not geographically connected, wetland impacts associated with the concurrent construction of the TransCanada Gulf Coast pipeline project are considered. Similar to that described above, these pipeline projects would mitigate for wetland losses per federal and state requirements. Impacts to forested wetlands are the highest in Texas (156 acres), whereas forested wetland impacts in Oklahoma are expected to affect 8 acres. It should be noted that these acres represent forest to emergent wetland conversions and not loss. The relative contribution to wetland loss or conversion from these projects is not significant enough to produce incremental cumulative impacts on wetland resources, as there are 5,973,000 acres of bottomland hardwood and other forested riparian vegetation, and 95,000 acres of swamps in Texas (Texas Parks and

Wildlife Division 1994). Other current projects such as water delivery systems and highway maintenance and repair in Montana, South Dakota, and Nebraska are also not expected to result in permanent impacts to wetlands. Therefore, current projects would not contribute to cumulative impacts to wetlands resources.

Future projects that could potentially contribute to cumulative impacts to wetland resources include the BakkenLink pipeline, the Bakken Marketlink, and the Bakken Crude Express pipeline projects. Other future projects such as electrical transmission lines, wind power projects, and oil and gas mining activities may also contribute to cumulative impacts where projects could overlap geographically with the proposed Project in east/southeastern Montana and southeastern Nebraska. However, similar to that described above, future projects would be required to implement avoidance and mitigation measures designed to minimize potential impacts to wetland resources, which would limit the contribution of those projects to cumulative impacts.

Overall, with respect to the proposed Project in combination with the past, present, and foreseeable future projects, including the Gulf Coast pipeline project, permanent changes to wetland resources within the pipeline ROW are considered negligible assuming effective mitigation and restoration efforts with the proposed Project and other projects throughout the proposed Project route.

4.15.3.5 Terrestrial Vegetation

A summary of potential environmental consequences of the proposed Project activities to terrestrial vegetation resources is presented in Table 4.15-9.

Table 4.15-9 CEA Matrix—Terrestrial Vegetation

Potential Impact Area	Proposed Project and Connected Action Impacts: Construction	Proposed Project and Connected Action Impacts: Operation	Geographic Extent	Cumulative Impact Potential (Yes/No)
General Vegetation Impacts				
Cultivated Crops	D	D	PA	No
Grassland/Pasture	(D)	(D)	PA	Yes
Upland Forest	(D)	D	PA	Yes
Open Water	D	D	PA	No
Forested Wetlands	(D)	D	PA	Yes
Herbaceous Emergent Wetlands	(D)	(D)	PA	No
Shrub/Scrub	(D)	(D)	PA	Yes
Developed Land	D	D	PA	No
Potential Impacts to Biologically Unique Landscapes and Vegetation Communities of Conservation Concern				
Forest Communities	(D)	D	PA	Yes
Riparian Forest	(D)	D	PA	Yes
Native Grasslands	(D)	(D)	PA	Yes
Sagebrush Steppe	(D)	(D)	PA	Yes

Duration of Impact
—Negligible
—Temporary/Short Term (<3 yr.)
—Long-Term (>3 yr.)
—Permanent

Type of Impact
N —Negligible Impact
D —Direct Impact
I —Indirect Impact

Notes: Parentheses around impact indicates that it would be addressed by implementation of Keystone's CMRP, additional mitigations, and/or existing laws and regulations. Geographic Extent of Potential Impact: Project Area (PA)—Defined by limits of ROW and ancillary facilities, e.g., access roads, pump stations, and construction camps.

Permanent effects to terrestrial vegetation resources from the proposed Project are limited to the general footprint of the Project ROW and ancillary facilities. As a result, the potential for additive cumulative effects to these resources is also limited. Forested habitats, including biologically unique forested habitats, could be permanently impacted by the construction and operation of the pipeline. Additionally, shrublands (including Sagebrush Steppe communities) and grasslands could be impacted for the long term due to the slow recovery from the impacts of construction. However, most of the land affected by the proposed Project is used for agriculture and rangeland (approximately 90 percent). Disturbed agricultural land and rangeland would be returned to approximate pre-construction use and capability. Permanent impacts to only 47.3 acres of forested areas spaced across Montana, South Dakota, and Nebraska (includes forested upland and wetland acres) would occur within the 30-foot-wide permanent easements centered on the pipeline. It should be noted that this acreage represents forest conversion to other habitat and not habitat loss.

Forested habitats within the ROW of the proposed Project would be permanently converted to herbaceous habitats so that pipeline access and maintenance is manageable. During the construction phase, larger expanses of habitat would be cleared for access and use. Forested areas that are not within the permanent ROW would be replanted, reseeded, and restored. The proposed pipeline route would also cross an estimated 355 miles of 1,054 individual native grassland communities through Montana, South Dakota, and Nebraska. Clearing of native grasslands along portions of the proposed Project ROW could contribute to the cumulative decline of native grasslands. Although most native grasslands would be restored, the effects of land clearing on previously untilled native prairies may be irreversible. Although native grasslands would be reseeded with native seed, shortgrass prairie and mixed-grass prairie areas could take up to 100 years to become re-established due to poor soil conditions and low moisture levels. Construction would also involve removal of woody shrubs in sagebrush grasslands. Restoration of these habitats would be long term. Conservation efforts implemented to offset potential losses would reduce the cumulative impacts associated with the proposed Project.

The proposed pipeline route would cross an estimated 55.5 miles of Inter Mountain Basins Big Sagebrush Steppe ecosystem habitat. Construction through this ecosystem habitat would remove sagebrush shrubs. The sagebrush shrubland disturbed in the construction phase would typically become re-established within 5 to 15 years. The sagebrush shrubland in the permanent easement would not be regularly mowed and would also be allowed to revegetate with sagebrush. Although minimal maintenance would be necessary, sagebrush may require 20 to 50 years to re-establish in the permanent ROW.

Introduced, non-native species and noxious weeds can compete with native vegetation in native habitats. Invasive plants and noxious weeds can be introduced into habitats and can be spread by improperly cleaned vehicles and equipment. Some invasive organisms can live in dry equipment for several days. To reduce the potential for transfer of non-native species and noxious weeds, mitigation measures would be implemented. Mitigation efforts implemented would reduce the cumulative impacts associated with the proposed Project. Any additional projects located within the vicinity would likely require similar conservation methods and mitigations, thus reducing overall cumulative impacts associated with the spread of invasive species and noxious weeds.

Impacts to terrestrial vegetation resources from the construction and operation of the connected actions (Bakken Marketlink Project, Big Bend to Witten 230-kV Transmission Line, and Electrical Distribution Lines and Substations) are not substantially different from the proposed Project.

In summary, with respect to terrestrial vegetation resources, the primary impact concern with respect to potential cumulative effects is the conversion of forested uplands to herbaceous habitats (reducing and fragmenting forested habitats) and long-term impacts to shrublands and grasslands (which would be restored). These impacts represent the primary areas for cumulative impacts to occur with other past, present, and reasonably foreseeable future projects. Past projects in the area that have historically reduced and fragmented forested habitat may provide the potential for additive cumulative effects; however, the relatively low numbers of forested acres permanently impacted by the proposed Project heavily influences the evaluation of cumulative effects to this habitat overall. The relative contribution to forested wetland loss or conversion (as discussed in the Section 4.15.3.4, Wetlands) or upland forest conversion (3.4, 3.0, and 12.1 acres in Montana, South Dakota, and Nebraska, respectively) by the proposed Project in the larger regional context is negligible. Therefore, even though southeastern Nebraska and east/southeastern Montana are candidate areas for cumulative impacts associated with past projects including the proposed Project (as shown on Figures 4.15.2-2 and 4.15.2-3), the incremental effect of the proposed Project is negligible. Long-term impacts to shrublands and grasslands (which would be restored) are considered to have low cumulative significance overall when considered in combination with the effects of other past projects based on the assumption that "near pre-construction" conditions are restored and maintained within the anticipated timeframes.

Although not geographically connected, terrestrial vegetation impacts associated with the concurrent construction of the TransCanada Gulf Coast pipeline project are also considered. Impacts to forested wetland conversions were discussed in Section 4.15.3.4, Wetlands, and were not considered to be significant with respect to cumulative impacts. Forested upland impacts are greater for the TransCanada Gulf Coast pipeline project (approximately 900 acres permanently impacted). Forest fragmentation in Oklahoma and Texas is mitigated by the fact that large portions of the TransCanada Gulf Coast pipeline project would use existing pipeline ROWs, minimizing new impacts in undeveloped areas. In addition, the total amount of forested upland vegetation that may be affected is relatively small compared to the abundance of similar vegetation in these areas. Forest fragmentation and conversion impacts are not directly cumulative with the proposed Project, since impacts are limited to the footprint of pipeline operations. Other current projects such as water delivery systems and highway maintenance and repair in Montana, South Dakota, and Nebraska are also not expected to result in significant impacts to forested habitats. These projects would be required to implement mitigation and conservation measures designed to minimize potential impacts to forested habitats, which would limit the contribution of those projects to cumulative impacts. Therefore, current projects would not contribute to cumulative impacts to terrestrial vegetation resources.

Future projects that could potentially contribute to cumulative impacts to terrestrial vegetation include the BakkenLink pipeline, the Bakken Marketlink, and the Bakken Crude Express pipeline projects. Other future projects such as electrical transmission lines, wind power projects, and oil and gas mining activities may also contribute to cumulative impacts where projects could overlap geographically with the proposed Project in east/southeastern Montana and southeastern Nebraska. Although the predominant vegetation type is agriculture and rangeland through much of the geographic region (which would be restored to pre-construction conditions), where reductions and fragmentation of forested habitat occurs, this could result in cumulative impacts to this resource. However, similar to that described above, future projects would be required to implement avoidance, mitigation, and conservation measures designed to minimize potential

impacts to terrestrial vegetation resources, which would limit the contribution of those projects to cumulative impacts.

Overall, with respect to the proposed Project in combination with the past, present, and foreseeable future projects, including the Gulf Coast pipeline project, changes to terrestrial vegetation within the pipeline ROW are considered to have low cumulative impact significance, assuming effective mitigation and restoration efforts with the proposed Project and other projects throughout the proposed Project route. It should be noted that the potential for a given impact to contribute to cumulative impacts is based on the assumption that the CMRP (Appendix G) is successful and near pre-construction conditions are restored and maintained within the anticipated timeframes.

4.15.3.6 Wildlife

A summary of potential environmental consequences of the proposed Project activities to wildlife resources is presented in Table 4.15-10. Impacts associated with threatened and endangered species are addressed in Section 4.15.3.8, Threatened and Endangered Species. The anticipated overall absence of permanent impacts to wildlife resources from the proposed Project indicates that cumulative effects to this resource area are expected to be minimal. Although, as indicated in Table 4.15-10, anticipated long-term impacts include the increase in invasive plants, animals, and nest parasites; creation of edge effects; and the facilitation of predator movements, these indirect effects to the local area may be negligible given the mitigation efforts associated with the proposed Project as well as the small size of the affected areas. Where long-term or permanent impacts are absent, the potential for additive cumulative effects with other past, present, and reasonably foreseeable future projects is also negligible. These conclusions are further discussed below.

The majority of the potential effects to wildlife resources are indirect, short term or negligible, limited in geographic extent, and associated with the construction phase of the proposed Project only. Indirect and short-term impacts associated with construction of the proposed Project may include reduced wildlife use due to increase human interaction; habitat fragmentation, alteration, and loss; stress and reduced breeding success due to noise, vibration, and human activity; creation of barriers to movement; and reduction in patch size of available habitat.

The only potential direct impacts to wildlife resources are the short-term direct impacts associated with small and immobile wildlife that may not be able to relocate out of construction activities. The overall impacts to populations of wildlife species are not expected to be significant and cumulatively should be negligible.

The proposed Project would produce a minor contribution to the cumulative effects on resident and migrant wildlife potentially resulting in somewhat reduced abundance and productivity within the proposed Project cumulative impact corridor. Displacement of wildlife that depends on the carrying capacity of habitats that would be disturbed by the proposed Project could result in reduction of reproductive effort or survival, thus producing a minor contribution to cumulative impacts on wildlife within the proposed Project cumulative impact corridor. This potential is greater for wildlife for which suitable habitat is limited in the Project area or that are otherwise sensitive to disturbance.

Table 4.15-10 CEA Matrix—Wildlife

Potential Impact Area	Proposed Project and Connected Action Impacts: Construction	Proposed Project and Connected Action Impacts: Operation	Geographic Extent	Cumulative Impact Potential (Yes/No)
Habitat loss, alteration, and fragmentation	I	I	LA	No
Direct mortality during construction and operation	D	N	PA	No
Indirect mortality because of stress or avoidance of feeding due to exposure to construction and operations noise, low-level helicopter or airplane monitoring overflights, and from increased human activity	I	I	LA	No
Reduced breeding success from exposure to construction and operations noise and from increased human activity	I	I	LA	No
Reduced survival or reproduction due to less edible plants or reduced cover	I	I	LA	No
Reduction in patch size of remaining available habitats	I	I	LA	No
Creation of edge effects	I	I	LA	Yes
Creation of barriers to movement	I	I	PA	No
Intrusion of invasive plants, animals, and nest parasites	(I)	(I)	LA	Yes
Facilitation of predator movements	I	I	LA	Yes
Habitat disturbance	I	I	LA	No
Intrusion of humans	I	I	PA	No

Duration of Impact
—Negligible
—Temporary/Short Term (<3 yr.)
—Long-Term (>3 yr.)
—Permanent

Type of Impact
N —Negligible Impact
D —Direct Impact
I —Indirect Impact

Notes: Parentheses around impact indicates that it would be addressed by implementation of Keystone's CMRP, additional mitigations, and/or existing laws and regulations.
Geographic Extent of Potential Impact: Project Area (PA)—Defined by limits of ROW and ancillary facilities, e.g., access roads, pump stations, and construction camps; Local Area (LA)—Defined as a 2-mile distance on either side of the pipeline ROW and ancillary facilities; Regional (R)—Defined by resource, e.g., home ranges of wildlife species, bird migration corridor, regional airshed, etc.

Impacts to wildlife resources from the construction and operation of the connected actions (Bakken Marketlink Project, Big Bend to Witten 230-kV Transmission Line, and Electrical Distribution Lines and Substations) are not substantially different from the proposed Project. The duration of impacts are all temporary and short term, with negligible effects on wildlife resources. The issues that may cause a cumulative effect are an increase in invasive plants, animals, and nest parasites; creation of edge effects; and the facilitation of predator movements.

As indicated in the Final EIS, commenters have suggested that mitigations for cumulative effects to migratory bird species should be considered. In response to these suggestions, the Department requested that Keystone provide a synopsis of activities at the corporate level that TransCanada supports to provide broad scale mitigations for cumulative impacts to migratory species. In response, TransCanada provided the information below.

TransCanada has partnered with Ducks Unlimited to provide assistance for the Oak Hammock Marsh Interpretative Centre, educational laboratories, and the Watershed Legacy program, all located in Winnipeg, Manitoba. TransCanada has contributed $1 million to Ducks Unlimited as

part of a 5-year commitment running from 2009-2013 to launch the Ducks Unlimited/TransCanada Partnership regarding Habitat Conservation in the Missouri Coteau conservation in Saskatchewan and the Grand Bayou Hydrology Restoration project in Louisiana.

The Missouri Coteau is a 25,000-square-mile tract stretching across south-central Saskatchewan and is internationally recognized as a critical wildlife habitat area. The region consists mainly of native grassland and pothole wetlands capable of supporting vast populations of breeding waterfowl and providing prime habitat for other wildlife. This project would focus on retaining existing uplands and wetland habitat through conservation easements and land purchases; restoring lost habitats through forage conversion programs; and delivering rangeland stewardship programs by working with landowners to improve ecological function and reduce the risk of native habitat loss.

The Grand Bayou project is located on the Pointe-aux-Chenes Wildlife Management area in Louisiana and includes two management units totaling 4,568 acres of coastal marsh habitat. The area is managed for furbearers, waterfowl, alligators, and other wildlife as well as being open to the public for recreational purposes. The area has seen significant habitat deterioration due, in part, to damaged levees from Hurricane Rita and to increased salinity levels and excessive tidal fluctuations. Coastal marsh restoration would involve the installation of levees and installation of new water control structures in order to manage salinity and water levels and encourage production of desirable vegetation. This project would focus on restoration of approximately 4,575 acres of coastal marsh; construction of one 24,000-foot earthen levee and one 25,000-foot earthen levee; installation of three new water control structures, and backfilling portions of an abandoned oilfield access canal.

In summary, with respect to wildlife, permanent impacts are not expected. Indirect effects associated with invasive plants, animals, and nest parasites; creation of edge effects; and the facilitation of predator movements are the primary long-term impact concerns, and these are the potential areas for cumulative impacts to occur with other past, present, and reasonably foreseeable future projects.

Past projects would concurrently affect invasive species, edge effects, and predator movements to the extent that there is a high density of activity in a geographic area having similar impacts. As shown on Figures 4.15.2-2 and 4.15.2-3, the southeastern region of Nebraska and the east/southeastern region of Montana are candidate areas for cumulative impacts associated with concurrent projects, including the proposed Project. Existing pipelines, active and abandoned mining sites, Williston Basin oil and gas fields, railroads, and landfill sites could have long-term impacts to these wildlife resource aspects; however, mitigation and restoration measures are available to address these concerns within the context of all of these project activities, and the anticipated area of potential impacts as a result of the proposed Project is relatively small and not expected to be permanent, thus reducing the possibility for long-term impacts and lessening their significance to overall cumulative impacts.

Although not geographically connected, the current construction of the TransCanada Gulf Coast pipeline project is included in the consideration of wildlife impacts. Long-term impacts associated with invasive species, edge effects, and predator movements are considered to have low overall cumulative significance. In addition, similar to that described above, mitigation and restoration measures are available to address these concerns. Other current projects such as water delivery systems and highway maintenance and repair are also not expected to result in

permanent impacts with respect to wildlife. Therefore, current projects would not contribute to cumulative impacts to wildlife resources.

Future projects that could potentially contribute to cumulative impacts to wildlife with respect to invasive species include the BakkenLink pipeline, the Bakken Marketlink, and the Bakken Crude Express pipeline projects. Other future projects such as electrical transmission lines, wind power projects, and oil and gas mining activities may also contribute to long-term impacts where projects could overlap geographically with the proposed Project in east/southeastern Montana and southeastern Nebraska. However, similar to that described above, mitigation and restoration measures are available to address these concerns.

Overall, with respect to the proposed Project in combination with the past, present, and foreseeable future projects, including the Gulf Coast pipeline project, permanent changes to wildlife resources within the pipeline ROW are considered cumulatively negligible assuming effective mitigation and restoration efforts with the proposed Project and other projects throughout the proposed Project route.

4.15.3.7 Fisheries

A summary of potential environmental consequences of the proposed Project activities to fisheries resources is presented in Table 4.15-11.

Table 4.15-11 CEA Matrix—Fisheries

Potential Impact Area	Proposed Project and Connected Action Impacts		Geographic Extent	Cumulative Impact Potential (Yes/No)
	Construction	Operation		
Increased sedimentation	(D)	(I)	LA	No
Increase in total suspended sediment	(D)	(I)	R	No
Streambed scouring and disturbance	(D)	N	PA	No
Fish behavioral changes, avoidance, stress	(D)	N	PA	No
Restriction or delay of fish movement	(D)	N	LA	No
Disruption of fish spawning	(D)	N	LA	No
Direct mortality of fish, eggs, and larvae	(D)	N	LA	No
Direct mortality of other aquatic organisms	(D)	N	LA	No
Water temperature alteration	(D)	(D)	PA	Yes
Transfer of non-native or invasive plants, animals or pathogens	(D)	(D)	R	Yes
Bank/flood plain alteration, loss of shading, nutrients, cover	(D)	(D)	PA	Yes
Reduction of aquatic habitat	(D)	N	LA	No

Duration of Impact
—Negligible
—Temporary/Short Term (<3 yr.)
—Long-Term (>3 yr.)
—Permanent

Type of Impact
N —Negligible Impact
D —Direct Impact
I —Indirect Impact

Notes: Parentheses around impact indicates that it would be addressed by implementation of Keystone's CMRP, additional mitigations, and/or existing laws and regulations.
Geographic Extent of Potential Impact: Project Area (PA)—Defined by limits of ROW and ancillary facilities, e.g., access roads, pump stations, and construction camps; Local Area (LA)—Defined as a 2-mile distance on either side of the pipeline ROW and ancillary facilities; Regional (R)—Defined by resource, e.g., home ranges of wildlife species, bird migration corridor, regional airshed, etc.

Potential long-term and permanent effects to fisheries resources from the proposed Project are limited to a potential rise in water temperature; loss of shading, nutrients, and cover; transfer of non-native or invasive plants, animals, and pathogens. However, the potential impacts to these fisheries resources would be reduced through protection, mitigation, and remediation measures in the CMRP. The aggregate contribution of impacted fisheries resources during the life of the proposed Project would be small in relation to the overall resources available within the cumulative project impact corridor. As a result, the potential for additive cumulative effects to these resources is limited. Potential effects on other aspects of fisheries resources from the proposed Project are either short term or negligible and cover a limited geographic extent. As further discussed below, potential cumulative effects to fisheries resources are localized and otherwise considered negligible.

With regard to the permanent effects of a potential rise in water temperature due to the pipeline temperature, an increase in water temperature can affect fish by decreasing oxygen supply, causing premature movements of juvenile fish and reduced food supply. Aquatic insects could mature more rapidly and be less available as food for the local fish population outside the immediate vicinity of the crossing. The burial depth of the proposed pipeline could mitigate these potential temperature impacts. Typical pipeline burial depth is 48 inches; however, Keystone has indicated that burial depth under streams would be a minimum of 60 inches. Additionally, HDD would bury the pipeline well below the river bottom, further mitigating potential impacts. If impacts were to occur, they would be expected to be minor to fish populations because of the isolated nature of the potential impact stream section and the likelihood of few fish in the stream reaches. Larger rivers would not be affected by water temperature changes because the volume of water flowing over the proposed pipeline would be great enough to compensate for any increases in the local temperature profile. Therefore, the cumulative impact associated with water temperature increases on fisheries is expected to be negligible.

Removal of bank vegetation (including overhead cover) could lead to bank instability and erosion. Loss of riparian vegetation reduces shading, causing an increase in water temperature and a reduction in dissolved oxygen, nutrient input, food input, and hiding cover (Brown et al. 2002, Ohmart and Anderson 1988). A reduction in escape cover can increase vulnerability of certain species to predation. Loss of riparian vegetation and disturbance to the bank and substrate can alter benthic communities and change food availability (Brown et al. 2002). Planned mitigation measures include revegetation of riparian areas upon construction completion (as described in Section 4.5, Terrestrial Vegetation), limiting the extent of riparian vegetation loss during construction, maintaining a narrow ROW width, and crossing intermittent or ephemeral streams when they are dry. These mitigation measures would minimize the potential impacts associated with the loss of shading, nutrients, and cover by making them short term. Therefore, the cumulative impact associated with the loss of shading, nutrients, and cover on fisheries is expected to be negligible.

Introduced non-native species can compete with native species and transmit diseases (e.g., whirling disease) that could adversely impact sensitive fish species. Invasive aquatic species (either plant or animal) can be introduced into waterways and wetlands and can be spread by improperly cleaned vehicles and equipment operating in water, stream channel, or wetlands (Cowie and Robinson 2003, Fuller 2003). Some invasive organisms can live in dry equipment for several days. To reduce the potential for transfer of aquatic pathogens, temporary vehicle bridges would be used to cross waterbodies to limit vehicle contact with surface waters and

sediments. During open-cut pipeline installation, in-stream activities would be conducted outside of the waterbody channel as much as practical and would limit the use of equipment within waterbodies. Workspaces would be located at least 10 feet from waterbodies and would implement erosion-control measures to reduce suspended sediment loading in waterbodies. These measures would also limit waterbody contact with vehicles and mud that could potentially serve as vectors for invasive species and whirling disease.

Impacts to fisheries resources from the construction and operation of the connected actions (Bakken Marketlink Project, Big Bend to Witten 230-kV Transmission Line, and Electrical Distribution Lines and Substations) are not substantially different from the proposed Project. Impacts listed in Table 4.15-11 overlap between the proposed Project and the connected actions, and are considered collectively in the overall discussion of the proposed Project.

Overall, considerations such as fish life history stage timing, construction impact mitigation, site-specific crossing techniques, seasonal conditions, contingency plans, water quality testing, and water quality compliance would result in the proposed Project having low potential to adversely affect recreationally or commercially important fisheries as a result of construction and normal operation. As discussed in Section 4.15.3.3, Water Resources, past projects would concurrently affect invasive species to fisheries resources to the extent that there is a high density of activity in a geographic area having a similar impact. As shown on Figures 4.15.2-2 and 4.15.2-3, southeastern Nebraska and east/southeastern Montana are candidate areas for cumulative impacts associated with concurrent projects, including the proposed Project. Existing pipelines, active and abandoned mining sites, Williston basin oil and gas fields, and landfill sites are not noted to have had long-term impacts to fisheries with respect to invasive species. However, mitigation and restoration measures are available to address these concerns within the context of all of these project activities, thus the overall significance to cumulative impacts is low.

Potential impacts to fisheries associated with the current construction of the TransCanada Gulf Coast pipeline project are considered to have low overall cumulative significance. The low potential for cumulative impacts is based on the assumption that the planned mitigation measures are successful and near pre-construction conditions are restored and maintained within the anticipated timeframes. Similarly, other current water delivery system or highway maintenance and repair projects that would be constructed within or in the vicinity of the proposed Project cumulative impact corridor could result in small cumulative impacts to fisheries resources to the extent that projects are temporally concurrent. However, concurrent activities are not generally expected and mitigation measures are available to address these concerns within the context of all of these project activities, thus the overall significance to cumulative impacts is low.

Similarly, future projects could be constructed within or in the vicinity of the proposed Project cumulative impact corridor. However, future projects would occur after streams impacted by the proposed Project have recovered; therefore cumulative impacts on fisheries from reasonably foreseeable future projects are not anticipated. This conclusion is based on the assumption that the planned mitigation measures are successful and near pre-construction conditions are restored and maintained within the anticipated timeframes.

4.15.3.8 Threatened and Endangered Species

Consultation with the U.S. Fish and Wildlife Service, Bureau of Land Management, and state natural heritage programs and wildlife agencies identified 13 federally protected or candidate species that could be impacted by the proposed Project. Federally protected species are listed as

threatened or endangered under the Endangered Species Act (ESA); candidate species are actively being considered for listing. In addition, 13 state-listed species could also be impacted by the proposed Project.

Types of potential impacts to threatened and endangered (special status) species include:

- Habitat loss, alteration, and fragmentation3;
- Direct mortality during construction and operation, including collision with power lines;
- Indirect mortality due to stress or avoidance of feeding, and/or reduced breeding success due to exposure to noise and/or increased human activity; and
- Reduced survival or reproduction due to decreased abundance of food species or reduced cover.

A detailed discussion of the types of potential impacts to threatened and endangered listed above is provided in Section 4.8, Threatened and Endangered Species and Species of Conservation Concern, and a summary of these potential impacts of the proposed Project are presented in Table 4.15-12. As indicated in Table 4.15-12, the anticipated overall absence of long-term and permanent impacts to most of the threatened and endangered species resources from the proposed Project indicates that cumulative effects to these species are expected to be minimal. However, the proposed Project may cumulatively contribute to impacts to the whooping crane (*Grus americana*) and the American burying beetle (*Nicrophorus americanus*), as further discussed below.

Table 4.15-12 CEA Matrix—Threatened and Endangered Species

Potential Species Impacted[a,b,c]	Proposed Project and Connected Action Impacts		Geographic Extent	Cumulative Impact Potential (Yes/No)
	Construction	Operation		
Mammals:				
Black-footed ferret (*Mustela nigripes*)—F	(I)	(I)	PA	No
Gray wolf (*Canis lupus*)—F	(I)	(I)	LA	No
River otter (*Lontra canadensis*)—SD, NE	(I)	(I)	PA	No
Swift fox (*Vulpes velox*)—MT, SD, NE	(I)	(I)	PA	No
Birds:				
Eskimo curlew (*Numenius borealis)*—F	N	N	*	No
Greater sage grouse (*Centrocercus urophasianus*)—F	(D)	(I)	R	No
Least tern (*Sterna antillarum*)—F, MT, SD, NE, KS	(I)	(I)	LA	No
Piping plover (*Charadrius melodus)*—F	(I)	(I)	LA	No
Sprague's pipit (*Anthus spragueii)*—F	(I)	(I)	LA	No
Whooping crane (*Grus americana*)—F	(I)	(D)	LA	Yes
Bald eagle (*Haliaeetus leucocephalus*)—MT, SD, KS	(I)	(I)	LA	No
Mountain plover (*Charadrius montanus)*—NE	(I)	(I)	LA	No

[3] Fragmentation is the splitting of a large continuous expanse of habitat into numerous smaller patches of habitat with a smaller total habitat area, and isolation within a matrix of habitats that are unlike the original (Wilcove et al. 1986).

Potential Species Impacted[a,b,c]	Proposed Project and Connected Action Impacts: Construction	Proposed Project and Connected Action Impacts: Operation	Geographic Extent	Cumulative Impact Potential (Yes/No)
Peregrine falcon (*Falco peregrinus*)—MT, SD	(I)	(I)	LA	No
Fish:				
Pallid sturgeon (*Scaphirhynchus albus)*—F	(I)	(I)	PA	No
Topeka shiner (*Notropis topeka)*—F	(I)	(I)	PA	No
Black nose shiner (*Notropis heterolepis*)—SD, NE	(I)	(I)	PA	No
Blackside darter (Percina maculata)—KS	(I)	(I)	PA	No
Finsecale dace (*Phoxinus neogaeus*)—SD, NE	(I)	(I)	PA	No
Northern redbelly dace ((*Phoxinus eos*)—MT, SD, NE	(I)	(I)	PA	No
Pearl dace (*Margariscus margarita*)—MT, SD	(I)	(I)	PA	No
Sicklefin chub (*Macrhybopsis meeki*)—MT, SD, KS	(I)	(I)	PA	No
Sturgeon chub (*Macrhybopsis gelida*)—MT, SD, NE, KS	(I)	(I)	PA	No
Invertebrates:				
American burying beetle (*Nicrophorus americanus)*—F	(D)	(D)	LA	Yes
Reptiles:				
Massasauga (*Sistrurus catenatus*)—NE	(D)	(I)	LA	No
Plants:				
Blowout penstemon (*Penstemon haydenii)*—F	(I)	(I)	LA	No
White fringed prairie orchid (*Platanthera praeclara)*—F	(D)	(I)	LA	No
White lady's slipper (*Cypripedium candidum*)—NE	(D)	(I)	LA	No

Duration of Impact
—Negligible
—Temporary/Short Term (<3 yr.)
—Long-Term (>3 yr.)
—Permanent

Type of Impact
N —Negligible Impact
D —Direct Impact
I —Indirect Impact

Notes: Parentheses around impact indicates that it would be addressed by implementation of Keystone's CMRP, additional mitigations, and/or existing laws and regulations.
Geographic Extent of Potential Impact: Project Area (PA)—Defined by limits of ROW and ancillary facilities, e.g., access roads, pump stations, and construction camps; Local Area (LA)—Defined as a 2-mile distance on either side of the pipeline ROW and ancillary facilities; Regional (R)—Defined by resource, e.g., home ranges of wildlife species, bird migration corridor, regional airshed, etc.; *—The Eskimo curlew has not been found in Nebraska since 1926 (Gollop et al. 1986).
[a] Federally listed species are presented in alphabetical order first, followed by the state-listed species in alphabetical order.
[b] An F following the species name indicates a federal listing or proposed federal listing (may or may not also be a state-listed species).
[c] MT, SD, NE, KS following the species name indicates the state(s) in which the species is state-listed.

The American burying beetle could likely experience some direct mortality during construction with reduced habitat causing long-term impacts and a delay in population recovery. To minimize this impact several avoidance and mitigation measure (as discussed in Section 4.8, Threatened and Endangered Species and Species of Conservation Concern) would be implemented. Additionally, in compliance with the ESA, Keystone has agreed to develop, in conjunction with the U.S. Fish and Wildlife Service, an American Burying Beetle Trust. This trust would provide

monetary compensation that would be used by a third-party nonprofit organization for habitat acquisition or other conservation measures as compensatory mitigation. Funds would be used to support conservation efforts of the American burying beetle within its historical range. Conservation efforts implemented to offset potential losses would reduce the cumulative impacts associated with the proposed Project. Any future projects in the area that reduce and fragment preferred habitat for the American burying beetle may provide the potential for additive cumulative effects to this species. Any additional potential losses would likely require similar conservation methods and mitigations, thus reducing overall cumulative impacts on the American burying beetle.

The whooping crane may experience long-term impacts associated with riparian areas that may be used for roosting and feeding. The use of the HDD method at major river crossings would reduce the probability of roosting and feeding habitat loss or alteration. In other areas along the corridor, revegetation (particularly within riparian zones and in wetland habitats) would reduce habitat impacts. The regeneration of revegetated areas may be slow, which may cause long-term roosting and feeding habitat loss. Future projects in the area that reduce and fragment preferred roosting and feeding habitat for the whooping crane may provide the potential for additive cumulative effects to this species.

Other than the whooping crane and the American burying beetle, the majority of the potential Project effects to threatened and endangered species resources would be indirect, short term or negligible, limited in geographic extent, and associated with the construction phase of the proposed Project only. Indirect and short-term impacts associated with construction of the proposed Project may include reduced threatened and endangered species use due to increased human interaction; habitat fragmentation, alteration, and loss; stress and reduced breeding success due to noise, vibration, and human activity; creation of barriers to movement; and reduction in patch size of available habitat. Thus, there is limited potential for cumulative effects of these impacts to be cumulative with other projects; however, additional discussion of threatened and endangered species of concern is presented below.

Incremental loss or alteration of black-tailed prairie dog colonies through prior project construction and operation in addition to similar effects from the proposed Project could lead to cumulative impacts on the black-footed ferret and the mountain plover in Montana and South Dakota. However, the black-tailed prairie dog colonies that would be crossed by the proposed Project were determined to be too small to support black-footed ferrets. Short, medium, or long-term loss or alteration of native grassland and sagebrush habitats through the spread of invasive plants in Montana and South Dakota from previous projects in addition to similar impacts from the proposed Project could contribute to cumulative habitat impacts for federal candidate-for-listing birds, including the greater sage-grouse and Sprague's pipit.

Incremental impacts to streams and riparian habitats from future linear project construction and the accidental spread of exotic aquatic invasive plants and animals could increase cumulative impacts to threatened and endangered species habitat. Increased competition from invasive species could contribute to cumulative impacts to native freshwater mollusks and prairie stream fishes, which have been increasingly recognized as vulnerable. Multiple stream and wetland crossings, especially those associated with small clear springs and streams or freshwater mussel beds, could result in impacts to habitat quality that could, in conjunction with the impacts of the proposed Project, affect federally protected aquatic species of conservation concern. The spread of invasive plants could also result in cumulative habitat impacts to federally and state-listed

plants, if present, including the western prairie fringed orchid (*Platanthera praeclara*) and the small white lady's slipper (*Cypripedium candidum*).

The proposed Project could potentially affect migratory birds within their migration range from Texas to Montana and/or within their breeding habitats. Conservation measures proposed for three of these birds (i.e., whooping crane, piping plover, and interior least tern) include protection of river and riparian nesting and migration staging habitats through use of HDD crossing methods and site-specific surveys to avoid disturbance to migration staging, nesting, and brood-rearing individuals. Habitat and disturbance impacts at major river crossings from future linear projects would likely incorporate similar conservation measures to avoid and minimize affects to these birds.

Implementation of appropriate conservation measures as determined through consultations with federal, state, and local agencies for state-protected sensitive species and federally protected threatened, endangered, or candidate species for the proposed Project and for future projects would include habitat restoration, impact avoidance, and impact minimization, which would ameliorate long-term cumulative impacts. Proposed Project reclamation includes restoration of native vegetation and soil conditions and prevention of spread and control of noxious weeds for disturbed areas. Unavoidable alteration and maintenance of vegetation structure to ensure pipeline safety and to allow for visual inspection would result in some conversion of tall shrub and forested habitats to herbaceous habitats. These conversions are not expected to adversely affect or contribute to cumulative impacts for any federally protected threatened or endangered species.

Impacts to threatened and endangered species from the construction and operation of the connected actions (Bakken Marketlink Project, Big Bend to Witten 230-kV Transmission Line, and Electrical Distribution Lines and Substations) would be long term or permanent. The greater sage-grouse, Sprague's pipit, and threatened, endangered, or otherwise special-status species may be impacted by habitat loss resulting from construction of the Bakken Marketlink project, along with future projects in the area that reduce and fragment preferred habitat for these species. However, habitat loss would be mitigated and any additional potential habitat loss would likely require similar conservation methods and mitigations, thus reducing overall cumulative impacts on these species.

The transmission line, electrical distribution lines, and substations could result in long-term increased bird collisions, bird predation, and habitat loss. However, with implementation of mitigation measures described in Section 4.8, Threatened and Endangered Species and Species of Conservation Concern, it is not expected that these lines would have cumulative impacts on birds protected under the U.S. Migratory Bird Treaty Act or Bald and Golden Eagle Protection Act. Future electrical power transmission lines and the distribution lines that would serve pump stations and mainline valves (MLVs) of the proposed Project or any other future projects could incrementally increase the collision hazard for protected or candidate migratory birds. Cumulative collision mortality affects would be most detrimental to the whooping crane, interior least tern, and piping plover; while perches provided by towers and poles could increase the cumulative predation mortality for ground-nesting birds, including the greater sage-grouse, interior least tern, mountain plover, piping plover, and Sprague's pipit.

In summary, the primary impact concerns with respect to potential cumulative effects to threatened and endangered species is the direct mortality of the American burying beetle during construction and operation of the proposed Project, and the reduction and fragmentation of

preferred roosting and feeding habitat (riparian areas) for the whooping crane. These impacts represent the primary areas for cumulative impacts to occur with other past, present, and reasonably foreseeable future projects and could occur where there is potential geographic overlap. Occurrences of these species, along with the known locations of past, present, and reasonably foreseeable future projects are shown on Figure 4.15.3-1 and Figure 4.15.3-2 for South Dakota and Nebraska, respectively (these species are not of concern in Montana). Other past, present, and foreseeable future projects in South Dakota (as indicated on Figure 4.15.3-1) are relatively sparse with significant geographic separation. However, American burying beetle locations in Nebraska occur within the proposed Project in addition to there being several other projects in proximity to these locations. Furthermore, there are potential impacts to the American burying beetle associated with the concurrent construction of the TransCanada Gulf Coast pipeline project. Construction of new pipelines or other ground-disturbing projects through southern South Dakota and north-central Nebraska could contribute to cumulative mortality and loss of habitat. Any additional potential losses within this species would likely require conservation methods and mitigations, thus reducing overall cumulative impacts on the American burying beetle. The central flyway whooping crane migration corridor overlaps with the proposed Project in Nebraska. Cumulative impacts to the whooping crane associated with the concurrent construction of the TransCanada Gulf Coast pipeline project are also considered. If construction periods between the TransCanada Gulf Coast pipeline project overlap with the proposed Project, they would likely do so for a short period of time only. It should be noted that the potential for a given impact to contribute to cumulative impacts is based on the assumption that the CMRP (Appendix G) is successful and 'near pre-construction' conditions are restored and maintained within the anticipated timeframes.

4.15.3.9 Land Use, Recreation, and Visual Resources

A summary of potential environmental consequences of the proposed Project activities to land use, recreation, and visual resources is presented in Table 4.15-13.

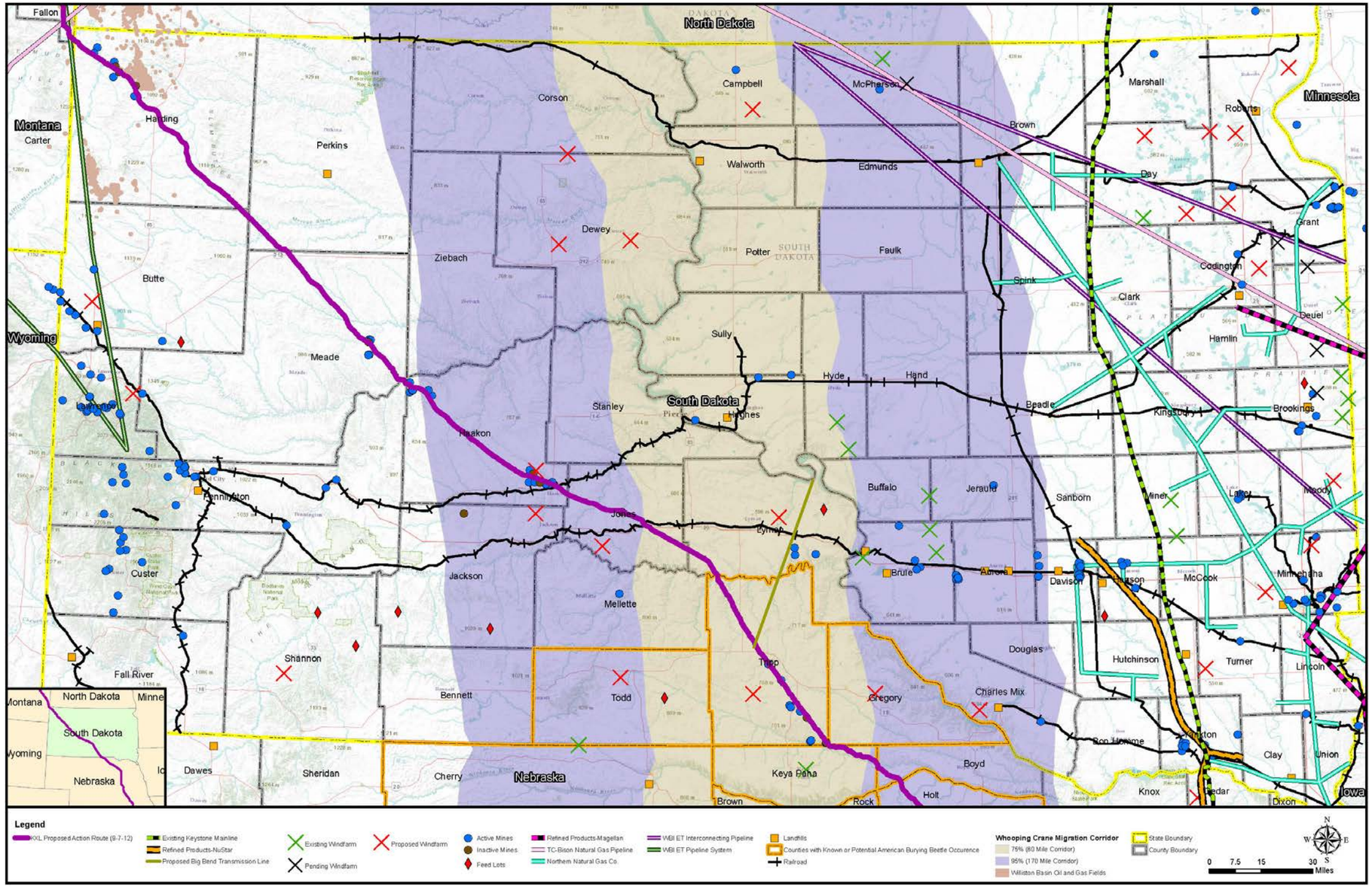
Table 4.15-13 CEA Matrix—Land Use, Recreation, and Visual Resources

Potential Impact Area	Proposed Project and Connected Action Impacts		Geographic Extent	Cumulative Impact Potential (Yes/No)
	Construction	Operation		
Land Ownership	(D)	(D)	PA	Yes
Agricultural Land, Rangeland, Prime Farmland	(D)	(D)	PA	No
Developed Land	(D)	(D)	PA	No
Forest	(D)	(D)	PA	Yes
Recreation and Special Interest Areas	(D)	(D)	PA	No
Visual Resources	(D)	(D)	LA	Yes

Duration of Impact
—Negligible
—Temporary/Short Term (<3 yr.)
—Long-Term (>3 yr.)
—Permanent

Type of Impact
N —Negligible Impact
D —Direct Impact
I —Indirect Impact

Notes: Parentheses around impact indicates that it would be addressed by implementation of Keystone's CMRP, additional mitigations, and/or existing laws and regulations.
Geographic Extent of Potential Impact: Project Area (PA)—Defined by limits of ROW and ancillary facilities, e.g., access roads, pump stations, and construction camps; Local Area (LA)—Defined as a 2-mile distance on either side of the pipeline ROW and ancillary facilities.



Source: See Appendix V, Past, Present, and Reasonably Foreseeable Future Project Descriptions.

Figure 4.15.3-1 Known Locations of Past, Present, and Reasonably Foreseeable Future Projects in South Dakota with American Burying Beetle Areas of Potential Occurrence and Central Flyway Whooping Crane Migration Corridor

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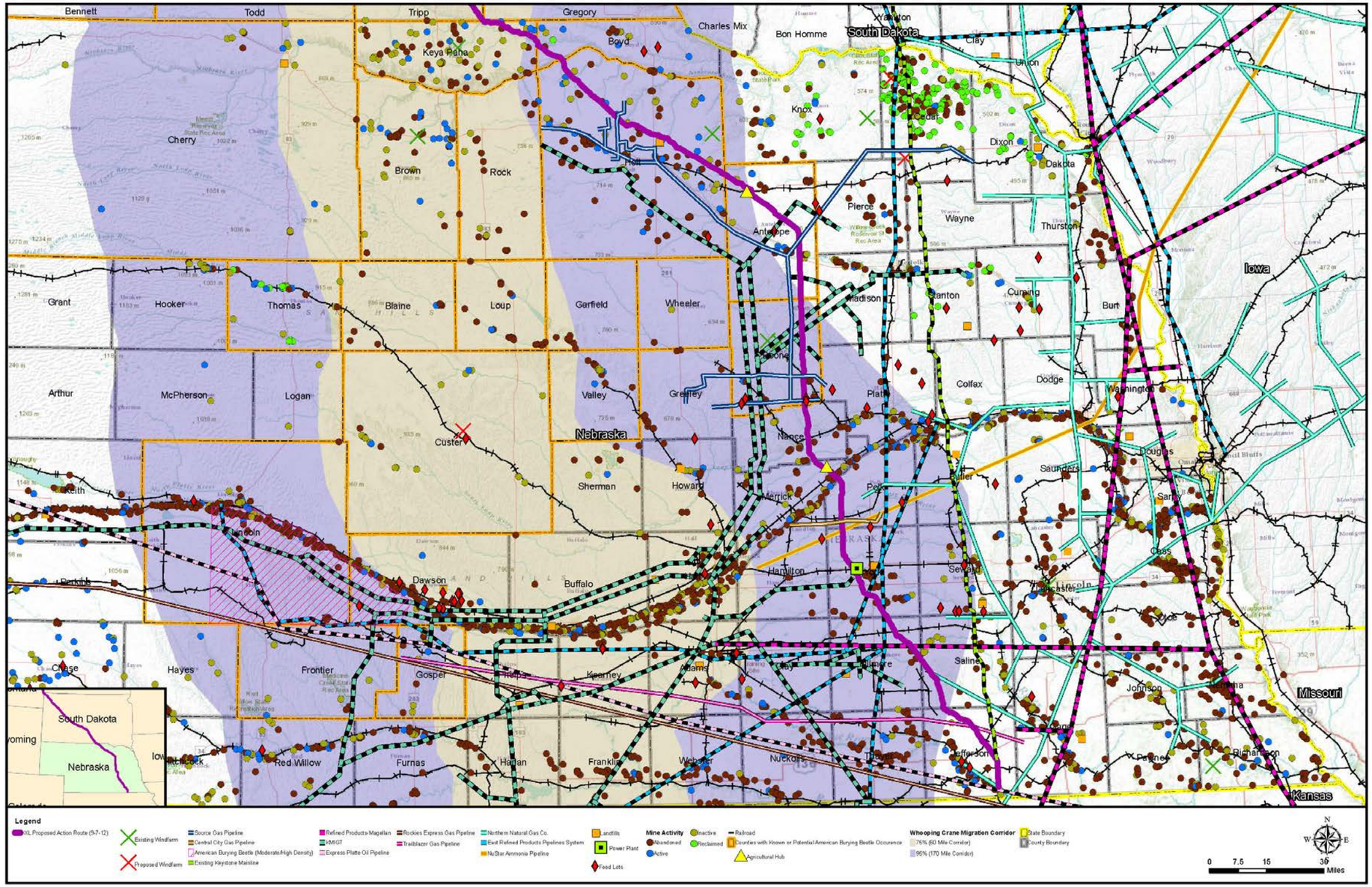

Source: See Appendix V, Past, Present, and Reasonably Foreseeable Future Project Descriptions.

Figure 4.15.3-2 Known Locations of Past, Present, and Reasonably Foreseeable Future Projects in Nebraska with American Burying Beetle Areas of Potential Occurrence and Central Flyway Whooping Crane Migration Corridor

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The proposed Project would require the acquisition of permanent easements from landowners and land managers along the pipeline ROW and at the locations of proposed ancillary facilities (approximately 5,501 acres). Long-term impacts are associated with changes in land use; however, most of the land affected by the proposed Project is used for agriculture and rangeland (approximately 90 percent). Disturbed agricultural land and rangeland would be returned to approximate pre-construction use and capability. Therefore, potential cumulative effects to land use are primarily localized and are considered to have low overall significance.

Permanent impacts to forested lands are associated with the clearing of trees and shrubs within the ROW, and permanent impacts to visual resources are associated with aboveground structures such as pump stations and transmission lines associated with connected actions to the proposed Project. These aspects are further discussed below.

Visual effects, particularly those associated with ROW disturbance in agricultural areas, would likely be substantially reduced with the first crop growth. Over the long-term, perceptible visible changes resulting from construction and operation would contribute, in the presence of similar facilities from past or future projects, to an intensified industrial character within the proposed Project cumulative impact corridor that could adversely affect the visual quality of the area. However, the proposed Project alignment has been selected to reduce adverse aesthetic impacts where possible, and measures to reduce long-term visual impacts to insignificant levels would be implemented as described in the proposed Project CMRP (see Appendix G). Visual effects would largely be limited to travelers along the major transportation corridors in the vicinity of the proposed Project. Their views would typically be limited to short periods of time and small portions of the ROW. Overall, as further discussed below, potential cumulative effects to land use, recreation, and visual resources are primarily localized and are considered to have low overall significance

Temporary changes in land use due to construction would include loss of agricultural productivity, potential damage to drain tiles or other irrigation systems, visual impacts from the removal of vegetation within the ROW, increased noise and dust, and disturbance of contracted conservation benefits during the construction period and until any contracted conservation benefits are restored. If the ROW requires maintenance, it may not be possible to restore certain types of contracted conservation benefits. Sightseers, hikers, wildlife viewers, fishers and hunters, and other recreationists would be temporarily dislocated, although impacts are expected to be short term. There are no major recreation areas in the vicinity of the proposed route; recreational use access would not be affected by proposed Project operations within special management areas; and the proposed Project would not cross rivers within any reaches that have been designated by federal, state, or local authorities as wild and/or scenic. Therefore, few recreationists would be affected. The proposed Project alignment has been selected to reduce adverse aesthetic impacts where possible, and measures to reduce long-term visual impacts to insignificant levels would be implemented as described in the proposed Project CMRP. In addition, potential adverse impacts to forestland would be reduced through protection, reclamation, and remediation measures in the CMRP. The aggregate contribution of lands committed to industrial uses during the life of the proposed Project would be small in relation to the number of acres available for these land uses.

Impacts to land use, recreation, and visual resources from the construction and operation of the connected actions (Bakken Marketlink Project, Big Bend to Witten 230-kV Transmission Line, and Electrical Distribution Lines and Substations) are not substantially different from the proposed Project. Potential impacts to land use, recreation, or visual resources of the Bakken

Marketlink Project would be evaluated and avoided, minimized, or mitigated in accordance with applicable regulations during the environmental reviews for these projects. The analysis of environmental effects associated with the proposed 230-kV transmission line would be handled under a separate environmental review. Based on currently available information, it is likely that changes to visual resources would be both temporary (e.g., digging the foundations for power poles) and permanent (e.g., erection of power poles and lines). Most of the landscape changes caused by the proposed Project would be visible as linear changes to vegetation patterns. Due to the need for a cleared power distribution line ROW, operational impacts in forested lands are greater than for other land uses. As above, however, the aggregate contribution of forest lands converted to other land uses during the life of the proposed Project would be small in relation to the number of acres available. Where remaining impacts listed in Table 4.15-5 overlap between the proposed Project and the connected actions, these are considered collectively in the overall discussion of the proposed Project.

In summary, with respect to land use, recreation, and visual resources, long-term/permanent impacts include land use, forested lands within the ROW (already addressed in Section 4.15.3.4, Wetlands, and 4.15.3.5, Terrestrial Vegetation, and not further discussed here), and visual resources associated with aboveground structures such as pump stations and transmission lines associated with connected actions to the proposed Project. These are potential areas for cumulative impacts to occur with other past, present, and reasonably foreseeable future projects.

Past projects would concurrently affect land use and visual resources to the extent that there is a high density of activity in a geographic area having a similar impact. As shown on Figures 4.15.2-2 and 4.15.2-3, southeastern Nebraska and east/southeastern Montana are candidate areas for cumulative impacts associated with concurrent projects, including the proposed Project. Existing and abandoned mining sites, Williston basin oil and gas fields, railroads, and landfill sites may all have a mixture of long-term to permanent impacts on land use and visual resources. However, given that most of the land affected by the proposed Project is used for agriculture and rangeland (approximately 90 percent), which would be returned to approximate pre-construction use and capability, potential cumulative effects to land use and visual resources are considered to have low overall significance. Although not geographically connected, current construction of the TransCanada Gulf Coast pipeline project is included in the consideration of land use and visual resource impacts. However, effects to land use and visual resources are primarily evaluated on a local level, and would not contribute to a geographically meaningful cumulative impact. Other current projects such as highway maintenance and repair (which does not involve new construction) would not cumulatively combine with land use and visual resources of the proposed Project. Water delivery systems are also not expected to result in significant impacts to land use and visual resources due to limited associated aboveground structures. Therefore, current projects would not contribute to cumulative impacts on land use and visual resources.

Future projects that could potentially contribute to cumulative impacts to land use and visual resources include the BakkenLink pipeline, the Bakken Marketlink, and the Bakken Crude Express pipeline projects. In addition, electrical transmission lines, wind power projects, and oil and gas mining activities could all have perceptible changes to land use and visual resources resulting from construction and operation, and would contribute to an intensified industrial character within the proposed Project cumulative impact corridor that could adversely affect the visual quality of the area. This effect may be particularly prominent where projects overlap geographically with the proposed Project in east/southeastern Montana and southeastern Nebraska.

4.15.3.10 Socioeconomics

The focus of the CEA is long-term or permanent adverse cumulative effects, and as noted at the beginning of this section, cumulative beneficial impacts are not addressed in this CEA. However, as discussed in Sections 3.10, Socioeconomics (Affected Environment), and 4.10, Socioeconomics (Environmental Consequences), it is noted that the positive economic impacts of the proposed Project as well as past and most present projects (up to 2010) are already reflected in existing conditions. Insufficient information is available for other present and reasonably foreseeable projects to quantify cumulative positive impacts of these projects in combination with the proposed Project; however, it should be noted that the proposed Project alone has significant temporary positive impacts (Section 4.10, Socioeconomics (Environmental Consequences)). A summary of potential environmental consequences of the proposed Project activities to socioeconomic resources is presented in Table 4.15-14.

Table 4.15-14 CEA Matrix—Socioeconomics

Potential Impact Area	Proposed Project and Connected Action Impacts: Construction	Proposed Project and Connected Action Impacts: Operation	Geographic Extent	Cumulative Impact Potential (Yes/No)
Population	N	N		No
Housing	N	N		No
Economic Activity	D	N	R	No
Environmental Justice	(D)	D	LA	No
Public Services, Tax Revenues, Property Values	D	D	R	Yes
Traffic and Transportation	(D)	N	PA	No

Duration of Impact
—Negligible
—Temporary/Short Term (<3 yr.)
—Long-Term (>3 yr.)
—Permanent

Type of Impact
N —Negligible Impact
D —Direct Impact
I —Indirect Impact

Notes: Parentheses around impact indicates that it would be addressed by implementation of Keystone's CMRP, additional mitigations, and/or existing laws and regulations.
Geographic Extent of Potential Impact: Project Area (PA)—Defined by limits of ROW and ancillary facilities, e.g., access roads, pump stations, and construction camps; Local Area (LA)—Defined as a 2-mile distance on either side of the pipeline ROW and ancillary facilities; Regional (R)—Defined by resource, e.g., home ranges of wildlife species, bird migration corridor, regional airshed, etc.

The only permanent socioeconomic impacts associated with the proposed Project, under normal operations would be the beneficial effects associated with property tax revenues and the small amount of employment and earnings associated with operations and maintenance of the pipeline. During construction, with respect to employment, the construction, accommodations and food services, professional services and manufacturing sectors would be the largest beneficiaries of the proposed Project, followed trade, and health and social services. Other industries with impacts exceeding 1,000 jobs would be real estate and rental, administrative and waste services, finance and insurance, transportation and warehousing, and other services. As further discussed below, the anticipated overall absence of long-term or permanent adverse socioeconomic impacts from the proposed Project indicates that adverse cumulative effects to this resource area are not expected. Where long-term or permanent adverse impacts are absent, the potential for additive cumulative effects with other past, present, and reasonably foreseeable future projects is also negligible.

The proposed Project area is predominantly rural and sparsely populated. The population density for the pipeline corridor counties is approximately eight persons per square mile. Keystone proposes to meet the housing need through a combination of construction camps and local housing. The influx of construction workers into local communities has the potential to generate additional demands on local public services (e.g., emergency response, medical, police, and fire protection services). The construction camps would reduce impacts on basic public services in nearby communities that could otherwise be incurred without construction camps. Therefore, impacts to proposed Project area population and housing during construction would be minor and temporary. Operation of the proposed Project would require relatively few permanent employees; thus, there would be little contribution to long-term cumulative impacts on population, housing, municipal services, or traffic in the proposed Project area.

Construction of the proposed Project could lead to short-term impacts to property values due to short-term visual, noise, and land disturbance effects. Land disturbed by the proposed Project would be restored to the extent practicable; to repair or restore drain tiles, fences, and land productivity damaged or adversely affected during construction; and to compensate property owners for any additional damages caused by proposed Project construction. The Final EIS concluded it did not appear that the proposed Project would have a major impact on residential and agricultural property values, and the analysis in this Supplemental EIS does not change this conclusion. Therefore, long-term impacts, and the potential for cumulative impacts to property values with other past, present, and reasonably foreseeable future projects are considered negligible.

Keystone would work with local law enforcement, fire departments, and emergency service providers, including medical aid facilities, to establish appropriate and effective emergency response measures. This information would be included in the emergency response plan developed prior to the implementation of the proposed Project with special emphasis on considerations of low income and minority communities in those preparedness efforts.

Similarly, construction activities could result in short-term impacts to traffic and transportation infrastructure. However, these impacts would be minor and temporary. Keystone's proposed Project CMRP includes measures to reduce or avoid traffic and transportation impacts on local communities. In addition, Keystone would submit a road use plan prior to mobilization of construction vehicles, and a monitoring plan that would include inspection of roadways and roadway structures, repair of damage that may occur to those facilities, establishment of an approved Traffic Management Plan, and coordination with state and local transportation agencies. Permanent access roads constructed as part of the proposed Project would not change traffic patterns on public roads.

With respect to environmental justice considerations, impacts to minority and low-income populations during construction could include exposure to construction dust and noise, disruption to traffic patterns, and increased competition for medical or health services in underserved populations. A total of 16 areas with environmental justice populations were identified as being potentially affected by construction activity or by the pipeline itself after it became operational. In areas in Montana, South Dakota, and Nebraska where construction camps would be provided, minor medical needs of workers would be handled in these camps, thus reducing the potential need for medical services from the surrounding communities. As a result, the impact of increased demand for medical services on local minority and low-income populations would be small and short term. In addition to avoidance and mitigation measures that Keystone proposes to minimize negative impacts to all populations in the proposed Project area, specific mitigation for

environmental justice communities would involve ensuring that adequate communication in the form of public awareness materials regarding the construction schedule and construction activities is provided.

Socioeconomic impacts, including environmental justice considerations, from the construction and operation of the connected actions (Bakken Marketlink Project, Big Bend to Witten 230-kV Transmission Line, and Electrical Distribution Lines and Substations) are not substantially different from the proposed Project. Where impacts listed in Table 4.15-5 overlap between the proposed Project and the connected actions, these are considered collectively in the overall discussion of the proposed Project.

In summary, with respect to socioeconomics, permanent impacts associated with the proposed Project, under normal operations, would be the beneficial effects associated with property tax revenues and the small amount of employment and earnings associated with operations and maintenance of the pipeline. Additional consideration of beneficial impacts in combination with the effects of past, present, or reasonably foreseeable future projects is not addressed in this CEA. With respect to adverse effects, short-term impacts to minority and low-income populations may occur during construction of the proposed project. When considered in combination with other past, cumulative impacts would only occur where concurrent and/or successive construction schedules of other geographically overlapping projects. Thus environmental justice cumulative impacts are not expected associated with past and future projects where construction is complete or proposed in the future. With respect to short-term cumulative impacts associated with concurrent construction of geographically overlapping present projects, these projects include water delivery systems, highway maintenance and repair projects, and grain and agronomy hubs, and potential cumulative impacts are expected to be small and short-term. In addition to avoidance and mitigation measures that Keystone proposes to minimize negative impacts to all populations in the proposed Project area, specific mitigation for environmental justice communities would involve ensuring that adequate communication in the form of public awareness materials regarding the construction schedule and construction activities is provided.

4.15.3.11 Cultural Resources

A summary of potential environmental consequences of the proposed Project activities to cultural resources is presented in Table 4.15-15. Direct permanent impacts to cultural resources could include damage to cultural resources within the construction footprint, the loss of community access to cultural resources, and visual impacts to properties such as historic or traditional cultural properties within or immediately adjacent to the permanent ROW and ancillary facilities. However, the proposed Project route was designed to avoid disturbing historic properties to the maximum extent possible. Therefore, only a small number of properties designated as culturally significant are potentially impacted by the proposed Project, based on current survey information.[4] As a result, the potential for additive cumulative effects in terms of direct damage, access, and visual impacts to cultural resources is also limited. This is further discussed below

[4] Additional cultural resources surveys within the proposed Project corridor, access roads, and ancillary facilities are ongoing. The Department will continue to consult with state and federal agencies and Native American tribes about the significance of the sites and work to avoid any adverse effects to the resources, to the extent practicable.

Table 4.15-15 CEA Matrix—Cultural Resources

Potential Impact Area	Proposed Project and Connected Action Impacts: Construction	Proposed Project and Connected Action Impacts: Operation	Geographic Extent	Cumulative Impact Potential (Yes/No)
Damage/destruction of cultural resources, including previously undiscovered	(D)	(D)	PA	Yes
Vibrations from equipment during earthmoving activities	I	I	PA	No
Loss of access to cultural resources	(D)	(D)	PA	Yes
Visual impacts to cultural resources	I	(I)	LA	Yes
Increased dust and noise	(I)	(I)	PA	No

Duration of Impact
—Negligible
—Temporary/Short Term (<3 yr.)
—Long-Term (>3 yr.)
—Permanent

Type of Impact
N —Negligible Impact
D —Direct Impact
I —Indirect Impact

Notes: Parentheses around impact indicates that it would be addressed by implementation of Keystone's CMRP, additional mitigations, and/or existing laws and regulations.
Geographic Extent of Potential Impact: Project Area (PA)—Defined by limits of ROW and ancillary facilities, e.g., access roads, pump stations, and construction camps; Local Area (LA)—Defined as a 2-mile distance on either side of the pipeline ROW and ancillary facilities.

The determination of significance for cultural resources is determined by a resource's eligibility for inclusion in the National Register of Historic Places (NRHP), although it should be noted that the NRHP status of some cultural resources remains undetermined in much of the proposed Project area, and surveying is ongoing. Direct impacts, such as unanticipated discovery of previously unknown cultural resources during construction, could have a permanent impact on that resource. For all cultural resources listed in the NRHP, considered to be eligible for the listing in the NRHP, or unevaluated, avoidance would continue to be the preferred mitigation strategy. For any historic properties unavoidably adversely affected by the proposed Project, mitigation measures would be developed as part of a Treatment Plan to be incorporated into the Programmatic Agreement.

To mitigate potential impacts, Keystone has committed, whenever feasible, to avoid known cultural resources, minimize impacts when avoidance is not possible, and mitigate impacts when minimization is not sufficient. Avoidance would be achieved by keeping construction activities away from NRHP-eligible properties, limiting the effect on existing demonstrated disturbance areas, and avoiding cultural resources by boring or HDD. In addition, the proposed Project plans to implement Unanticipated Discovery Plans, to minimize impacts to unknown cultural resources that may be inadvertently encountered during construction or operation of the proposed Project. Should a cultural resource discovered in this fashion appear to be significant, additional mitigation measures would be considered, as feasible and appropriate.

Indirect potential impacts during proposed construction such as noise, dust, vibrations, and heavy equipment traffic would be temporary, and would be expected to last for the duration of construction in specific areas for discrete periods of time. Given the temporary nature of construction of the pipeline and ancillary facilities, such as pipe and contractor yards, no permanent noise, dust, vibrations, and heavy equipment traffic effects to cultural resources, specifically historic structures, are anticipated.

During operation of the proposed Project, only previously disturbed areas would be expected to require periodic disturbance; therefore, the potential for additional direct impacts to cultural

resources would be very limited. Indirect impacts during operations could consist of a permanent change in viewshed to historic or traditional cultural properties near permanent ancillary facilities, such as pump stations and MLVs, and a periodic increase in noise, vibration, and dust created by pump stations or vehicular traffic conducting operation and maintenance activities. Given the nature, location, and setting of permanent ancillary facilities, however, these facilities are unlikely to significantly visually impact the setting and feeling of historic or traditional cultural properties, due to their distance, the low-lying nature of these facilities, and various vegetative and topographic elements of the landscape in such areas. Similarly, periodic increase in noise, vibration, and dust created by ancillary facilities or vehicular traffic conducting operation and maintenance activities would not be expected to cause any adverse effects to such cultural resources.

Cultural resource impacts from the construction and operation of the connected actions (Bakken Marketlink Project, Big Bend to Witten 230-kV Transmission Line, and Electrical Distribution Lines and Substations) are not substantially different from the proposed Project. Where impacts listed in Table 4.15-15 overlap between the proposed Project and the connected actions, these are considered collectively in the overall discussion of the proposed Project.

In summary, permanent impacts to cultural resources could include direct damage to cultural resources within the construction footprint, the loss of community access to cultural resources, and visual impacts to properties such as historic structures or traditional cultural properties within or immediately adjacent to the permanent ROW and ancillary facilities. These are potential areas for cumulative impacts to occur with other past, present, and reasonably foreseeable future projects.

Past projects in the area that have historically impacted cultural resources may provide the potential for additive cumulative effects; however, the relatively low likelihood of cultural resource impacts by the proposed Project, combined with the implementation of Unanticipated Discovery Plans (minimizing impacts to unknown cultural resources that may be inadvertently encountered), heavily influences the evaluation of cumulative effects to cultural resources overall[5]. There would be little incremental additive effect to cultural resources from the proposed Project with other past projects; therefore, overall cumulative significance is considered low.

Currently, although not geographically connected, construction of the TransCanada Gulf Coast pipeline project is included in the consideration of impacts to cultural resources. However, effects to cultural resources are primarily evaluated on a local level, and would not contribute to a geographically meaningful cumulative impact. Other current projects such as highway maintenance and repair (which does not involve new construction) would not cumulatively combine with land use and visual resources of the proposed Project. In addition, known sites would be avoided or mitigated to the degree practicable as required by Section 106 of the NHPA during implementation of all current projects.

Contribution to cumulative impacts on cultural resources could result from future projects to the extent that they disturb known or currently unidentified archaeological sites and historic structures, or degrade in-place mitigation for previously disturbed historical properties. However, known sites would be avoided or mitigated to the degree practicable as required by Section 106

[5] Additional cultural resources surveys within the proposed Project corridor, access roads, and ancillary facilities are ongoing. The Department will continue to consult with state and federal agencies and Native American tribes about the significance of the sites and work to avoid any adverse effects to the resources, to the extent practicable.

of the NHPA during future project implementation. Therefore, future projects are not expected to significantly contribute to cumulative impacts on cultural resources.

Overall, with respect to the proposed Project in combination with the past, present, and foreseeable future projects, including the Gulf Coast pipeline project, permanent changes to cultural resources within the pipeline ROW are considered negligible assuming effective mitigation and restoration efforts with the proposed Project and other projects throughout the proposed Project route.

4.15.3.12 Air Quality and Noise

A summary of potential environmental consequences to air quality and due to noise from the proposed Project activities is presented in Table 4.15-16.

Table 4.15-16 CEA Matrix—Air Quality and Noise

Potential Impact Area	Proposed Project and Connected Action Impacts		Geographic Extent	Cumulative Impact Potential (Yes/No)
	Construction	Operation		
Combustion emissions from contractor camp back-up emergency generators (criteria pollutants and hazardous air pollutants)	(D)		R	No
Combustion emissions from non-road and on-road sources and open burning (criteria pollutants and hazardous air pollutant s)	(D)		R	No
Fugitive dust emissions from disturbed land and paved roads (PM, PM_{10} and $PM_{2.5}$)[a]	(D)		R	No
Fugitive volatile organic compound (VOC) emissions from storage tanks, valves, pumps, flanges, and connectors	**N**	**N**	R	No
Combustion emissions from offsite electricity usage at construction camps and pump stations (as CO_2 equivalents)	(I)	(I)	R	Yes
Fugitive methane emissions from valves, pumps, flanges and connectors (as CO_2 equivalents)	**N**	**N**	R	No
Noise from heavy construction equipment and vehicles	(D)		LA	No
Noise from HDD	(D)		LA	No
Noise from blasting	(D)		LA	No
Noise from pump stations	(D)	(D)	LA	Yes
Noise from substations	(D)		LA	No

Duration of Impact
—Negligible
—Temporary/Short Term (<3 yr.)
—Long-Term (>3 yr.)
—Permanent

Type of Impact
N —Negligible Impact
D —Direct Impact
I —Indirect Impact

Note: Parentheses around impact indicates that it would be addressed by implementation of Keystone's CMRP, additional mitigations, and/or existing laws and regulations.
Geographic Extent of Potential Impact: Local Area (LA)—Defined as a 2-mile distance on either side of the pipeline ROW and ancillary facilities; Regional (R)—Defined by resource, e.g., home ranges of wildlife species, bird migration corridor, regional airshed, etc.
[a] PM = particulate matter; PM_{10} = particulate matter with aerodynamic diameter of 10 microns and less; $PM_{2.5}$ = particulate matter with aerodynamic diameter of 2.5 microns and less.

Noise

As further discussed below, the anticipated overall absence of permanent impacts due to noise generated from the proposed Project indicates that cumulative effects to this resource area are not expected. As indicated in Table 4.15-16, there may be long-term impacts due to noise from pump stations; however, these effects are considered negligible due to the low levels of noise generated at the pump stations throughout the proposed Project route. Where long-term or permanent impacts are absent, the potential for additive cumulative effects with other past, present, and reasonably foreseeable future projects is also negligible.

Most of the potential effects from noise are short term and associated with the construction phase of the proposed Project only. Short-term noise impacts may be generated during the construction phase by construction equipment and vehicles, HDD, blasting, pump stations, and substations. Potential effects from noise could include direct impacts to wildlife, residences, recreation, special interest areas, and livestock. The noise levels could be perceived as moderately loud with a significant effect over existing levels; however, any peak noise levels would be temporary and intermittent, generally limited to daylight hours, and would decrease with distance. Nighttime noise levels would normally be unaffected because most construction activities would be limited to daylight hours. Potential exceptions include completion of critical tie-ins on the ROW; HDD operations if determined by the contractor to be necessary; and other work if determined necessary based on weather conditions, safety, or other proposed Project requirements. To protect property and livestock, Keystone would provide adequate notice to adjacent landowners or tenants in advance of blasting. Blasting activity would be performed during daylight hours and in compliance with federal, state, and local codes and ordinances and manufacturer-prescribed safety procedures and industry practices. In areas near residences and businesses where construction activities or noise levels may be considered disruptive, pipeline work schedules would be coordinated to minimize disruption. In addition, noise mitigation would be implemented in accordance with Keystone's CMRP (see Appendix G) and specific landowner or land manager requirements.

Noise generated from the pump stations may be a source of long-term impacts to nearby resources. Keystone would consider the following noise abatement options: aboveground pipe lagging, pump blankets, motor air intake enclosures, and engineering sound barriers. To the extent practicable, Keystone would not site pump stations close to noise-sensitive receptors. For all pump stations, Keystone would observe the USEPA noise standard of 55 decibels on the A-weighted scale (day-night sound level) for each pump station. Recommended noise mitigation measures from operating the pump stations listed in Section 4.12.4.3, Noise, would be implemented. Mitigation efforts implemented to offset noise impacts would reduce the cumulative impacts associated with the proposed Project.

Impacts from noise associated with the construction and operation of the connected actions (Bakken Marketlink Project, Big Bend to Witten 230-kV Transmission Line, and Electrical Distribution Lines and Substations) are not substantially different from the proposed Project. The duration of noise impacts are all temporary and short term and associated with construction activities.

In summary, there is the potential for noise impacts from the long-term operation of pump stations to be cumulative with other past, present, and reasonably foreseeable future projects. However, because of planned mitigation measures (Section 4.12.4.3, Noise), only low levels of noise would be generated at the pump stations throughout the proposed Project route, and the

relative contribution (and incremental additive effect) of noise generated by the proposed Project is negligible. Currently, although not geographically connected, construction of the TransCanada Gulf Coast pipeline project is included in the consideration of impacts to noise. However, because noise impacts are primarily evaluated on a local level, they would not contribute to a geographically meaningful cumulative impact, in combination with the proposed Project. Other current or future projects in the area with potential long-term/permanent noise impacts may provide the potential for additive cumulative effects of noise. Here too, the relative contribution (and incremental additive effect) of noise generated by the proposed Project is negligible. Furthermore, additional potential noise contributors would likely implement similar mitigations, thus reducing overall cumulative impacts from noise.

Overall, with respect to the proposed Project in combination with the past, present, and foreseeable future projects, including the Gulf Coast pipeline project, permanent changes to noise levels within the pipeline ROW are considered negligible assuming effective mitigation efforts with the proposed Project and other projects throughout the proposed Project route.

Air Quality

Pipeline Construction and Operation

Contribution to cumulative air quality impacts resulting from construction of the proposed Project would be from activities that generate fugitive dust (e.g., excavation and materials handling) and combustion air emissions (criteria pollutants and GHGs) from construction camp generators, non-road sources, on-road sources, and open burning. Commercial power supply would be available for the construction camps, so indirect GHG emissions from electricity usage at the camps could be significant, and direct GHG emissions from backup generators would be negligible. Contractors would be required to implement dust-minimization practices to control fugitive dust during construction as described in Section 4.12.3.1, Air Quality, and follow local or state ordinances, including the application of water sprays and surfactant chemicals and the stabilization of disturbed areas. Contractors would also be required to maintain all fossil-fueled construction equipment in accordance with manufacturer's recommendations to minimize construction-related emissions. In general, construction activity would occur over a 6- to 8-month seasonal construction period; however, the majority of pipeline construction activity associated with land disturbance (clearing, trenching, and excavation) would generally pass by a specific location within a 30-day period before final grading, seeding, and mulching takes place, thereby resulting in minor short-term contributions to cumulative air quality impacts.

There would be no current contribution to cumulative impacts from the construction of past or future projects since the impacts of these projects are short-term and occur at the time of construction only. As a result, contributions to cumulative air quality impacts within the proposed Project cumulative impact corridor from construction of the proposed Project and past or future reasonably foreseeable projects would be negligible.

Contribution to cumulative air quality impacts resulting from operation of the proposed Project would include minimal fugitive emissions from intermediate MLVs along the proposed pipeline route and from valves, pumps, flanges, and connectors at the pump stations. Proposed pipeline pumps would be electric-powered. MLVs would have backup emergency generators, which would only be used during times of power interruption; therefore, emissions from these sources would be negligible. The use of mobile sources such as maintenance vehicles (at least twice per year) and aircraft for aerial inspections (once every 2 weeks) during proposed Project operations

would be infrequent, so emissions from these maintenance/mobile sources would be negligible and were not calculated.

Contribution to cumulative air quality impacts from ongoing operations of past projects within the proposed Project cumulative impact corridor, including existing oil and natural gas pipelines, and reasonably foreseeable future projects would likely be limited to emissions from any project facilities (pump stations, intermediate MLVs) and from vehicles and aircraft used during inspection and maintenance of project facilities.

As described in Section 4.12.3.2, Greenhouse Gases, the total annual GHG emissions from operation of the pipeline amount to 3.19 million metric tons per year or 3.52 million tons per year of carbon dioxide equivalent (CO_2e) (Table 4.12-6).[6] This is equivalent to annual GHG emissions from the combustion of fuels in approximately 626,000 passenger vehicles or the CO_2 emissions from combusting fuels used to provide the electricity consumed by approximately 398,000 homes for one year.[7]

Refineries

While the proposed Project does not include construction, retrofit, or operation of any refineries that could receive crude oil transported through the proposed Project, refinery operations could contribute to increased cumulative impacts to air quality in the vicinity of the proposed Project and/or in the areas around the refineries if changes in the type or quantity of refinery emissions occurred in the future as a direct result of refining crude oil transported by the proposed Project. Such changes could occur if the proposed Project induced construction of a new refinery, induced expansions of capacity in existing refineries, induced existing refineries to add new downstream processing units (such as cokers or fluid catalytic converters), and/or induced the refineries to process a different crude oil slate (e.g., one that was higher in sulfur content and lower in American Petroleum Institute (API) gravity with different heavy metals content).

As discussed in Sections 1.2, Overview of Proposed Project, and 1.4, Market Analysis, crude oil delivered to Petroleum Administration for Defense District (PADD) 2 and PADD 3 refineries would replace domestic crude oil supplies processed at these refineries or supplant existing supplies from overseas that are less stable, more costly, or otherwise less desirable to the refineries.

PADD 2 Refineries

The proposed Project would supply up to 155,000 bpd to the proposed Cushing tank farm in PADD 2. While the specific receiving refineries are not known at this time, there are some refineries or geographic areas proximal to the proposed Project that would be more likely to receive crude oil transported through the proposed Project. There are 27 refineries in PADD 2 that have a 2012 capacity to process almost 4 million bpd of crude oil (Table 4.15-17), and heavy crude oil deliveries to these refineries totaled 3.38 million bpd in 2011 (U.S. Energy Information Administration [EIA] 2012a). A significant portion of the heavy crude oil supply to PADD 2 is provided via pipelines from Canada.

[6] In 2010 total U.S. GHG emissions (CO_2e from anthropogenic activities) amounted to 6,821.2 million metric tons. Globally, approximately 30,313 million metric tons of CO_2 emissions were added to the atmosphere via the combustion of fossil fuels in 2009 (USEPA 2012b).
[7] Equivalencies based on USEPA's GHG Equivalency calculator (USEPA 2012c).

Table 4.15-17 PADD 2 Refinery Crude Capacity: 2012

Refineries	Crude Oil Capacity (thousand bpsd)[a]
ExxonMobil, Joliet, Illinois	248
Marathon, Robinson, Illinois	215
PDV Midwest Refining, Lemont, Illinois	171
WRB Refining, Wood River, Illinois	322
BP, Whiting, Indiana	430
Countrymark, Mount Vernon, Indiana	28
Coffeyville Resources, Coffeyville, Kansas	120
Frontier, El Dorado, Kansas	140
NCRA, McPherson, Kansas	88
Marathon, Catlettsburg, Kentucky	253
Continental, Somerset, Kentucky (idle)	0
Marathon, Detroit, Michigan	114
Flint Hills, Saint Paul, Minnesota	320
St. Paul Park, Saint Paul, Minnesota	85
Tesoro, Mandan, North Dakota	62
BP-Husky, Toledo, Ohio	160
Lima Refining, Lima, Ohio	170
Marathon, Canton, Ohio	87
Toledo Refining, Toledo, Ohio	175
ConocoPhillips, Ponca City, Oklahoma	215
Holly Refining, Tulsa (East), Oklahoma	76
Holly Refining, Tulsa (West), Oklahoma	90
Valero, Ardmore, Oklahoma	87
Ventura, Thomas, Oklahoma (idle)	0
Wynnewood Refining, Wynnewood, Oklahoma	75
Premcor, Memphis, Tennessee	190
Calumet Lubricants, Superior, Wisconsin	45
PADD 2 GRAND TOTAL	**3,966**

Source: EIA 2012a.

[a] bpsd = barrels per stream day. Defined as the quantity of oil product produced by a single refining unit during continuous operation for 24 hours.

Crude oil deliveries through the proposed Project to the Cushing tank farm would generally serve refineries in PADD 2, which includes 15 states in the Midwest from North Dakota to Oklahoma and east to Ohio. Crude oil refineries in those 15 states, including the crude oil capacity for each refinery, are presented in Table 4.15-17. In PADD 2, expansions and upgrades have been proposed or implemented in Oklahoma (Holly), Illinois (Wood River), Michigan (Marathon), and Indiana (Whiting). There is no indication that the availability of oil transported via the proposed Project would directly result in specific expansions of existing refineries and development of new refineries (none have been built in the United States in 30 years).

PADD 3 Refineries

The proposed Project would supply up to 830,000 bpd of crude oil to customers along the Gulf Coast in PADD 3, which covers six states from New Mexico to Alabama. Because up to 100,000 bpd of capacity is reserved for crude oil from the Williston Basin, and 155,000 bpd of capacity is available to pick up crude oil from domestic producers that deliver to Cushing, Oklahoma, the quantity of oil sands crudes is more likely to be closer to 600,000 bpd maximum for the next decade or two. There are 57 refineries in PADD 3 with a 2012 refining capacity of

approximately 9.2 million bpd (Table 4.15-18). Heavy crude oil accounted for approximately 2.15 million barrels per day (mmbpd) of the crude oil refined in PADD 3 in 2006.

As identified in Table 4.15-18, a total of 15 refineries in PADD 3 would be connected directly to the hubs to which the proposed Project connects. These 15 refineries are in the Gulf Coast area[8] and have a total crude oil capacity of almost 4.2 mmbpd, including over 1.4 mmbpd of heavy crude oil capacity (EIA 2012a). Oil transported via the proposed Project could be delivered to other refineries in PADD 3 through the existing pipeline network that extends throughout those general areas, or by tanker, barge, or rail. The other refineries in PADD 3 have a total crude oil refining capacity of almost 5 mmbpd. Thus, crude oil deliveries from the proposed Project could be processed at any of the refineries with direct or indirect access to the delivery points of the proposed Project.

The crude oil capacity for each refinery in PADD 3, including refineries with direct access to the proposed Project, without direct access to the proposed Project, and with possible pipeline connection to the proposed Project, are identified in Table 4.15-18.

Table 4.15-18 PADD 3 Refinery Crude Capacity: 2012

Refineries	Crude Oil Capacity (thousand bpsd)[a]
Gulf Coast Refineries with Direct Pipeline Access to the Proposed Project	
Motiva Enterprises LLC; Port Arthur, TX	300
Total Petrochemicals; Port Arthur, TX	140
Premcor Refining Group; Port Arthur, TX	415
Exxon Mobil; Beaumont, TX	359
Pasadena Refining; Pasadena, TX	107
Houston Refining; Houston, TX	302
Valero Energy Corp.; Houston, TX	90
Deer Park Refining; Deer Park, TX	340
Exxon Mobil; Baytown, TX	584
BP; Texas City, TX	475
Marathon Petroleum Co; Texas City, TX	84
Valero Energy Corp.; Texas City, TX	233
Calcasieu Refining; Lake Charles, LA	80
CITGO; Lake Charles, LA	440
ConocoPhillips; Lake Charles/Westlake, LA	252
Sub-Total Group I	**4,201**
Gulf Coast Refineries in PADD 3 Without Direct Pipeline Access to the Proposed Project	
Hunt Refining Co.; Tuscaloosa, AL	40
Shell Chemical; Saraland, AL ConocoPhillips; Belle Chasse, LA	85 260
Exxon Mobil; Baton Rouge, LA	523
Alon Refining Krotz Springs.; Krotz Springs, LA	83
Valero Energy Corp.; St. Charles/Norco, LA	210

[8] The Gulf Coast area refers to the region from Houston, Texas, to Lake Charles, Louisiana. Gulf Coast area refineries include 12 refineries on the Gulf Coast in Texas and three refineries in Lake Charles, Louisiana.

Refineries	Crude Oil Capacity (thousand bpsd)[a]
Marathon Petroleum; Garyville, LA	518
Chalmette Refining; Chalmette, LA	195
Valero Energy Corporation; Meraux, LA	140
Motiva Enterprises LLC; Norco, LA	250
Motiva Enterprises LLC; Convent, LA	255
Placid Refining; Port Allen, LA	59
Shell Chemical; Saint Rose, LA	56
ChevronTexaco; Pascagoula, MS	360
ConocoPhillips; Sweeny, TX	260
CITGO; Corpus Christi, TX	165
Valero Energy Corp.; Three Rivers, TX	95
Flint Hills Resources; Corpus Christi, TX	288
Valero Energy Corp.; Corpus Christi, TX	205
Sub-Total Group 2	**4,047**
Inland PADD 3 Refineries with Possible Pipeline Connection to the Proposed Project	
Navajo Refining; Artesia, NM	115
WRB Refining; Borger, TX	154
Valero Energy Corp.; Sunray/McKee, TX	160
AlonUSA; Big Spring, TX	70
Delek; Tyler, TX	65
Sub-Total Group 3	**564**
Inland PADD 3 Refineries without Pipeline Access to the Proposed Project	
Other Refineries without Access	382
Sub-Total Group 4	**382**
PADD 3 GRAND TOTAL	**9,194**

Source: EIA 2012a.

[a] bpsd = barrels per stream day. Defined as the quantity of oil product produced by a single refining unit during continuous operation for 24 hours.

Future Projections of Refinery Crude Oil Slates, Expansions and Investments in PADD 3

The existing refineries processing heavy crude oil in PADD 2 and PADD 3 are designed and permitted to refine heavy crude oil. Details about the PADD 3 refineries' imports of heavy crude oil are provided in Section 1.4.3.1, PADD Supply Characteristics. As a result, the processing of heavy crude oil transported via the proposed Project would occur within existing permit thresholds, including USEPA consent decrees with the refiners that place additional limits on the emissions of many of the potential refinery customers.[9]

Permitting of these facilities is under the authority of USEPA as the federal agency that implements and enforces the requirements of the Clean Air Act. State agencies with delegated authority to administer air quality programs and with approved State Implementation Plans

[9] In PADD 3, 91 percent of the refining capacity is subject to consent decrees with the USEPA (including all of the refineries in the Gulf Coast area except Lyondell in Houston), which requires the addition of better pollution control technologies and emissions monitoring systems.

include Texas and Louisiana. The permitting process is designed to avoid significant cumulative impacts to regional air quality associated with air emissions.

To address the potential that the proposed Project could induce changes in crude oil slates, or induce refinery expansions and capital investments, an independent analysis of various aspects of the proposed Project was commissioned by the U.S. Department of Energy (DOE) Office of Policy and International Affairs (EnSys 2010). This analysis incorporated projections of likely future PADD 3 refinery operations, including total refinery throughputs and potential refinery expansions and investments (i.e., adding downstream processing units to process a different crude slate) and the average crude slate quality (measured by average API gravity and sulfur content).

As explained in more detail in Section 3.13.3 of the Final EIS, the results of that EnSys modeling, which were done with model inputs from 2010, indicated that even with some differences in the total volume of Western Canadian Sedimentary Basin (WCSB) crude oil refined in PADD 3 across the different scenarios, the average API gravity and the average sulfur content of the crude oil slate would be essentially the same with or without the proposed Project. Additionally, these modeling results suggest that construction of the proposed Project would not be expected to alter market conditions in PADD 3 to induce construction of a new refinery, to induce expansion of existing refineries, to induce significant differences in investment levels in refinery down-stream processing units, or to induce significant differences in average crude-slate quality. Therefore there would be little, if any, difference in emissions associated with crude oil refining in PADD 3 with or without the proposed Project.

Although the EnSys modeling was based on inputs from market conditions in 2010, the market analysis in Section 1.4 indicates that the EnSys conclusions that even without the proposed Project significant amounts of oil sands crude are likely to be delivered to the Gulf Coast area remain likely. As noted in Section 1.4, there are other pipeline connections being made between PADD 2 and PADD 3 that will be able to deliver oil sands crude, and even if additional pipeline capacity remains constricted, it would be likely be economic to transport oil sands crude to the Gulf Coast area by rail under current and a range of future market conditions.

These results are consistent with certain known attributes of world crude oil markets described in more detail in Section 1.4, Market Analysis:

- Refiners in the United States primarily serve the U.S. market for finished transportation fuel (gasoline, diesel, etc.). Thus, total throughput at U.S. refineries is determined largely by the U.S. demand for transportation fuel derived from crude oil. But as noted in Section 1.4, Market Analysis, as U.S. demand for transportation fuel declines, the refiners in the Gulf Coast are expected to increase exports of refined products.
- Crude oil is a relatively freely exchangeable (fungible) commodity, with low marine-shipping costs, and with prices set within a world market that consumes over 80 mmbpd. Therefore shipping 830,000 bpd from a particular source of crude oil to a particular set of refineries would not necessarily have a large impact on the overall crude market or the competitive position of the PADD 3 refiners relative to that market.

- Refineries are optimized to process a particular crude slate into a particular set of refined products, and it is not easy or economically efficient in the short to medium term for a refinery to make significant changes in its crude slate quality. Thus, refineries (particularly large refineries in the Gulf Coast) typically obtain crude oil from a variety of sources, and blend those crude oils to achieve a consistent crude oil feedstock quality.
- Many of the refineries in PADD 3 and PADD 2 have already made significant capital investments in the downstream processing units necessary to refine a relatively heavier, more sulfurous crude oil blend. Having made those investments, to operate the refineries most efficiently, those refineries have significant incentive to seek out a heavier slate of crude oil, regardless of whether there is increased transport capacity to deliver WCSB oil sands-derived crude oils to PADD 3.

The Final EIS also included analysis indicating that because the emissions from refineries are dependent not just upon the quality of the crude oil slate input, and the quantity of crude oil processed in a refinery, but also on emissions control technologies employed by the refineries. The data described in the Final EIS indicated that at both the national level and the Gulf Coast level, refinery emissions were not correlated with fluctuations in crude slate quality.

In addition to this information, in the Final EIS, the Department provided a review of various refinery expansions and upgrades in PADD 2 associated with increasing the capacity of heavy crude oil processing. Specifically, the Department quantitatively reported on the change in emissions of criteria pollutants associated with proposed refinery expansions in Illinois, Indiana, and Michigan. Any refinery expansions or upgrades at refineries that could receive crude oil from the proposed Project would likely be required to adhere to similar regulatory standards. As a result of improvements in control technologies and the use of offsets, these refinery upgrades and expansions generally resulted in an overall increase in carbon monoxide, and a decrease in emissions of particulate matter, sulfur dioxide, and nitrogen dioxides. Volatile organic emissions tended to decrease slightly, but not consistently.

Cumulative air emissions in PADD 3 are likely to change over time as a result of ongoing and planned refinery expansions, whether or not the proposed Project is implemented. The largest permitted refinery expansion for processing heavy crude oil in recent years is for the Motiva refinery in Port Arthur, Texas. This expansion, officially completed in 2012, increased the heavy oil refining capacity of Motiva by 325,000 bpd (from the original capacity of 275,000 to 600,000 bpd). The Motiva refinery would have direct access to the proposed Project and would have the largest heavy oil refining capacity in PADD 3. This expansion would result in increases in most criteria pollutants, although there would be a reduction in VOCs (Table 4.15-19). The likely reasons that this expansion would result in net increases in most emissions include the overall size of the expansion and the fact that the existing refinery was already using relatively modern emission controls. Any modification to the existing refining processes would therefore not produce emission reductions in the same proportion as would occur for more outdated refineries. Specific emission estimates are unavailable for other refinery expansions under consideration in PADD 3.

Table 4.15-19 Net Emissions for the Motiva Refinery Expansion

NO_x (tons)	CO (tons)	VOC (tons)	SO_2 (tons)	PM (tons)	C_6H_6 (tons)	H_2SO_4 (tons)	H_2S (tons)	NH_3 (tons)	Cl_2 (tons)
592.74	1,489.53	-116.73	1679.73	464.37	-0.47	22.24	4.33	125.69	3.77

[a] NO_x = Oxides of nitrogen; CO = Carbon monoxide; VOC = Volatile organic compounds; SO_2 = Sulfur dioxide; PM = Particulate matter; C_6H_6 = Benzene; H_2SO_4 = Sulfuric acid; NH_3 = Ammonia; Cl_2 = Chlorine.

Cumulative air impacts along the proposed Project cumulative impact corridor could change if new refineries are constructed in the future, although EnSys (2010) indicates such potential refinery construction is not sensitive to whether the proposed Project is implemented or not. There are currently no new refineries planned within about 500 miles of any delivery point for the proposed Project, although one new refinery is proposed in the northern portion of PADD 2, the Hyperion Energy Center in South Dakota. While no new refinery has been permitted and built in the United States in the past 30 years, estimates of emissions used in the permitting process for the proposed Hyperion project can be used to allow quantification of potential emissions from upgraded PADD 3 refineries that would use modern technology to process heavy crude oil. In fact, the calculated emissions presented in the permitting process for the proposed Hyperion refinery are generally comparable to those calculated for the ongoing 325,000-bpd Motiva expansion. The calculated emissions resulting from processing up to 400,000 bpd for the proposed Hyperion refinery (SDDENR 2011) are:

- 687 tons of NO_X;
- 810 tons of CO;
- 183 tons of SO_2;
- 536 tons of VOCs; and
- 1,035 tons of PM.

It is expected that most of the oil transported by the proposed Project would replace historic crude oil supplies or supplant supplies from less stable or more costly sources for the following reasons:

- The maximum volume of oil that would be transported by the proposed Project (830,000 bpd) represents approximately 6 percent of the overall crude oil refining capacity of PADD 2 and PADD 3 (over 13 million bpd);
- The current supply of heavy crude oil delivered to PADD 3 from current overseas sources is either declining or at risk for political reasons; and
- There is a well-developed existing regional infrastructure to facilitate distribution of crude oil transported by the proposed Project among existing PADD 2 and PADD 3 refineries.

Although the EnSys (2010) results, and economic analysis in Section 1.4, Market Analysis, indicate that the construction of the proposed Project is not likely to impact imported amounts of WCSB crude oil or refinery emissions, the following hypothetical emissions estimate is presented for illustrative purposes. A conservative hypothetical maximum emissions estimate could be developed by assuming that the entire crude oil volume transported by the proposed Project would be heavy crude oil and that it would be refined at upgraded refineries. Using the emissions estimates discussed above for the Motiva refinery upgrade and the proposed Hyperion refinery project, this hypothetical maximum emissions estimate can be calculated by multiplying

the maximum proposed Project throughput (830,000 bpd) by the emission rates per barrel reported for Motiva or Hyperion since these refineries are assumed to be typical for recently upgraded refineries implementing BACT. Hypothetical maximum annual emissions of NO_x would range between about 1,514 and 1,604 tons, CO emissions would range between about 3,804 and 4,148 tons; SO_2 emissions would range between about 1,791 and 4,290 tons, particulate matter emissions would range between 1,186 and 2,170 tons, and VOC emissions would be about 1,718 tons. However, since the crude oil transported by the proposed Project would be replacing or displacing crude oil from other sources, the majority of the emissions generated from refining crude oil transported by the proposed Project would not result in incremental increases to refinery emissions in either PADD 2 or PADD 3. Additionally, it is expected that approximately one-third of the volume transported by the proposed Project would not be heavy crude oil, particularly in light of the proposed Bakken Marketlink and Cushing Marketlink connected actions.

End Use

Some commenters on the Draft and Supplemental Draft EIS expressed concerns relative to indirect contributions to cumulative air quality impacts related to the combustion or other use of petroleum products refined from the crude oil that would be transported to PADD 2 by the proposed Project. The end use of refined petroleum products could include combustion (e.g., vehicles, power generation, or other industrial facilities) or non-combustion uses (e.g., asphalt, petroleum coke, liquefied refinery gases, and lubricants). The ultimate use of refined product originating from crude oil transported by the proposed Project would not produce different end use emissions. Criteria pollutant emissions from consumer and manufacturing use of refined petroleum products are regulated under permits for some uses (e.g., mass transportation vehicles and petrochemical processing) and not for others (e.g., private vehicles) beyond standard quality rules designed to reduce pollutants (e.g., oxygenated fuels, low-sulfur diesel, Corporate Average Fuel Economy standards).

Indirect Cumulative Impacts and Life-Cycle Greenhouse Gas Emissions

Overview and Summary

The Supplemental EIS evaluates the relationship between climate change and the proposed Project in several ways:

- First, the potential contributions of the proposed Project to greenhouse gas emissions are addressed in the air quality analyses found in Section 3.12 and Section 4.12, Air Quality and Noise.
- Second, the potential impact of future predicted climate change effects (such as temperature and precipitation changes in the proposed Project area) on the construction and operation of the proposed Project itself is described in Section 4.14, Climate Change Impacts on the Proposed Project.
- Finally, this section presents information and analysis regarding indirect cumulative impacts and life-cycle greenhouse gas emissions including the potential impact of further development of the Western Canadian Sedimentary Basin (WCSB) oil sands on climate change.

This discussion on GHG life-cycle emissions associated with oil sands is provided in response to comments received during the Final EIS process and scoping for the Supplemental EIS and to assess recent and updated studies undertaken by others that were referred to in this analysis. The comments received included requests for analysis of the potential climate impacts of increasing development of the WCSB oil sands associated with the proposed Project. While such a broad review is typically beyond the scope of NEPA, this Supplemental EIS nonetheless presents information and analysis related to the proposed Project's potential life-cycle climate impacts. The market analysis presented in Section 1.4 is a critical input to the analysis in terms of how the proposed Project is expected to impact further development of the WCSB oil sands compared to the No Action Alternative in which the proposed Project is denied.

The key findings from this analysis of the indirect cumulative impacts and life-cycle GHG emissions are:

- This Supplemental EIS examined the potential for growth-induced impacts that could be associated with the proposed Project in Section 1.4, and it is unlikely that the proposed Project construction would have a substantial impact on the rate of WCSB oil sands development. As described in Section 1.4, even when considering the incremental cost of non-pipeline transport options, should the proposed Project be denied, a 0.4 to 0.6 percent reduction in WCSB production could occur by 2030, and should both the proposed Project and all other proposed pipeline projects not be built, a 2 to 4 percent decrease in WCSB oil sands production could occur by 2030.[10]
- Based upon the market analysis in Section 1.4, the incremental life-cycle emissions associated with the proposed Project are estimated in the range of 0.07 to 0.83 million metric tons carbon dioxide equivalent ($MMTCO_2e$) annually if the proposed Project were not built, and in the range of 0.35 to 5.3 $MMTCO_2e$ annually if all pipeline projects were denied, based on the following: [11]
  - The full range of incremental GHG emissions associated with the more carbon-intensive WCSB oil sands that would be transported through the proposed Project across the analyzed reference crudes (which could be displaced at the Gulf Coast refineries) is estimated in the range of 3.3 to 20.8 $MMTCO_2e$ annually[12] (the methodology used to derive this range is explained further in this section).

[10] The International Energy Outlook extends to 2035. In 2035, the production change would be 120,000 bpd, which would be 2.4 percent of the total International Energy Outlook forecasted production for the oil sands.

[11] As discussed in 1.4.6.3, Rail Potential to Transport WCSB Crude, if it is assumed that the difference in the cost of transport by rail were $7.50 rather than $5.00 per barrel, then the reduction in production would be 50 percent more. Under such an assumption, this change in production would represent a 50 percent reduction in GHG emissions above those indicated in the text above. This would equate to 0.1 to 1.3 $MMTCO_2e$ should the proposed Project be denied, and 0.5 to 8.0 $MMTCO_2e$ should both the proposed Project and all other proposed pipeline projects not be built.

[12] As noted elsewhere in the Supplemental EIS, the near-term initial throughput of the proposed Project is projected to be 830,000 barrels of crude per day with 100,000 bpd supplied by Bakken crude production and the remaining 730,000 bpd supplied by the WCSB oil sands. However, the GHG emission estimates assume that the full 830,000 bpd pipeline capacity is used to transport only WCSB crude.

  - If the proposed Project was not built, analysis demonstrates that WCSB oil sands would likely be developed, but there is potentially a 0.4 to 0.6 percent reduction in production, and if all other proposed pipeline projects were not built, there would potentially be a 2 to 4 percent reduction in WCSB oil sands production.
  - The range of GHG emissions represents the incremental GHG emissions for displacement of the analyzed reference crudes for the stated scenarios.[13]

- The largest share, or approximately 70 to 80 percent, of WTW GHG[14] emissions from the fuel life-cycle occurs during fuel combustion itself, regardless of the study design and input assumptions.
- A large source of variance in fuel life-cycle GHG studies is the treatment of lower-value products such as petroleum coke, electricity exports from cogeneration, and secondary carbon effects such as land-use change and capital equipment. While the issue of petroleum coke is an important consideration to GHG lifecycle analyses, it is important when comparing WCSB oil sands and the reference crudes that the full life-cycle be evaluated, not just the upstream or refining stage. The issue of petroleum coke is not a standalone issue for the WCSB oil sands; it is also a LCA consideration for the heavy conventional crudes. The petroleum coke-associated GHG emissions from oil sands should fundamentally be similar to some heavy reference crudes.
- Producing a barrel of premium fuels (i.e., gasoline, diesel, and kerosene/jet fuel) from bitumen produces roughly the same amount of petroleum coke as a barrel of premium fuels refined from heavy crudes, such as Venezuelan Bachaquero or Mexican Maya. The actual net GHG emissions from petroleum coke, however, depend on the final end use of the petroleum coke (i.e., whether it is stockpiled or combusted) and how its end use affects demand for other fuels such as coal. Since a portion of the petroleum coke produced from upgrading WCSB oil sands bitumen is currently stockpiled and not combusted, whereas the petroleum coke produced from refining reference crudes at Gulf Coast refineries is combusted. As a result, GHG emissions from petroleum coke produced from WCSB oil sands crudes are slightly lower than petroleum coke GHG emissions from other heavy reference crudes.
- The relative GHG-intensity of both reference crudes and oil sands-derived crudes will change differently over time. Conventional (deep) crude reservoirs require higher energy intensive secondary and tertiary production techniques as the reservoirs deplete and as water cut of the produced reservoir fluids increases. Oil sands surface mining is expected to have a relatively constant energy intensity long into the future.

Further details of the indirect cumulative impacts and life-cycle GHG emissions analysis are provided in the following sections.

[13] Note that these estimates do not consider differences in transportation or refining GHG emissions for WCSB oil sands crude sent to non-U.S. Gulf Coast refineries and is based on average GHG emission estimates from near-term WCSB oil sands production.

[14] Reference to the various stages in the life cycle from crude extraction from the reservoir, to refining, and to combustion of the refined fuel products is typically referred to as a “well-to-wheels” (WTW) analysis.

Introduction to Indirect Life-Cycle GHG Emissions

To assist in providing information regarding the carbon intensity of WCSB oil sands crudes compared to other crude oils, the Final EIS included a key studies review in the existing literature that address life-cycle GHG emissions of petroleum products, including petroleum products derived from WCSB oil sands, and a comparison of life-cycle GHG emissions reported in the literature for WCSB oil sands-derived crude oil and refined products with those of reference crude oils. A summary of the analysis is presented in the following sections and the full report is presented in Appendix W, Life-Cycle Greenhouse Gas Emissions of Petroleum Products from WCSB Oil Sands Crudes Compared with Reference Crudes. Project-level GHG emissions are presented in Sections 3.12, Air Quality and Noise (Affected Environment); 4.12, Air Quality and Noise (Environmental Consequences); and 4.15.3, Cumulative Impacts by Resource, which provide a discussion of climate change-related risks on the proposed Project. The Department is providing this information as a matter of policy, although the proposed Project would not substantively influence the rate or magnitude of oil extraction activities in Canada, or the overall volume of crude oil transported to the U.S. or refined in the U.S. (see Section 1.4, Market Analysis).

Thus, while this section provides an assessment of the differences between the life-cycle GHG emissions associated with WCSB oil sands-derived crudes that may be refined in the United States versus reference crudes, it also specifically compares results from other literature against the National Energy Technology Laboratory (NETL) studies' base case. A more detailed description of the ICF review is provided in Appendix W, Life-Cycle Greenhouse Gas Emissions.

This analysis reflects recent updates to previous life-cycle assessments (LCAs) of GHG emissions from oil sands-derived crudes, such as the updated report by Jacobs (2012), which offers new analysis and correlates the results with data reported to and audited by the Canadian government. Findings based on these new data have been included in this assessment. This analysis also includes a discussion of the GHG emissions associated with the production and combustion of petroleum coke produced by refining crude oils.

Life-Cycle Carbon Overview

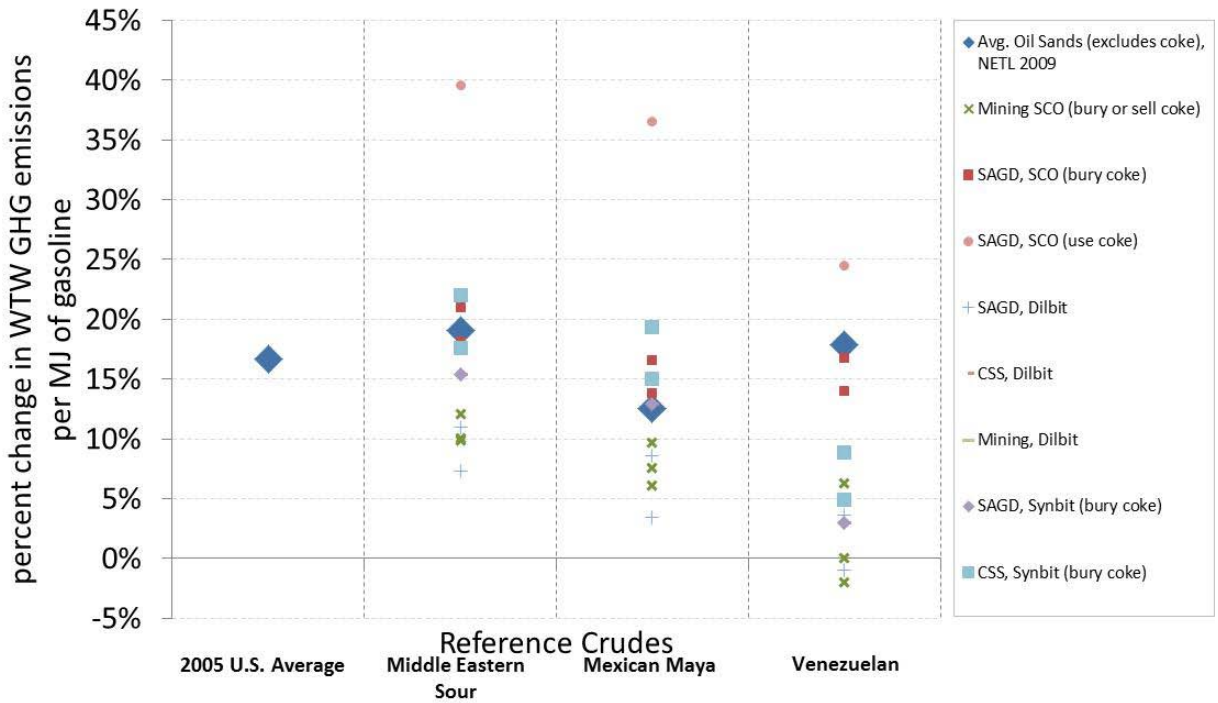
Evaluating life-cycle emissions provides a method to assess the relative GHG emissions between various sources of crude oil. The LCA methodology attempts to identify, quantify, and track carbon emissions arising from the development and use of a hydrocarbon resource. It is helpful to characterize carbon emissions into what can be considered primary and secondary flows. The primary carbon emissions are associated with the various stages in the life-cycle from the extraction of the crude from the reservoir to refining to combustion of the refined fuel products (typically referred to as a well-to-wheels analysis). The secondary carbon emissions are associated with activities (e.g., land use impacts) not directly related to conversion of the hydrocarbon resource into useful product fuels.

Most of the GHG emissions from hydrocarbon resource development result in three primary steps in the LCA: production of the crude oil, refining of the crude oil, and combustion of the refined products. Transportation of the crude oil to the refinery and transportation of the products to market also contribute to GHG emissions (discussions of these emissions for the proposed Project are presented in Sections 3.12 and 4.12, Air Quality and Noise), although these pieces of the life-cycle tend to be significantly smaller than the production, refining, and combustion stages referred to above.

The primary objective of refining crude oil is to produce three premium refined products: gasoline, diesel, and kerosene/jet fuel (i.e., gasoline and distillates). In addition to the primary emissions arising from the production, transportation, refining, and combustion steps of the LCA, a range of secondary carbon emissions should be considered. For example, extracting crude can influence secondary GHG emissions, such as changes in biological or soil carbon stocks resulting from land-use change during mining. In addition to premium fuels, typically 5 to 10 percent of the carbon in the petroleum resource ends up in co-products, such as petroleum coke, that are often (but not always) combusted and therefore emit carbon dioxide (CO_2). As discussed in greater detail below, these secondary flows are treated differently across the LCA literature and estimates of specific process inputs and emission factors vary according to the underlying methods and data sources used in each LCA.

The GHG emission factors modeled by NETL are based on a well-to-wheels (WTW) LCA. WTW assessments for petroleum-based fuels focus on the GHG emissions associated with extraction of the crude oil from reservoirs, transportation of crude oils to refineries, refining of the crude oil, distribution of refined product (e.g., gasoline, diesel, and jet fuel) to retail markets, and combustion of these fuels in vehicles or planes. For some WCSB oil sands crude oils, the assessment also addresses upgrading of the extracted crude oil (i.e., partial refining of some oil sands crude oils to produce synthetic crude oil). Other analyses (e.g., well-to-tank [WTT] analyses) establish different life-cycle boundaries and evaluate only the emissions associated with the processes prior to combustion of the refined products.

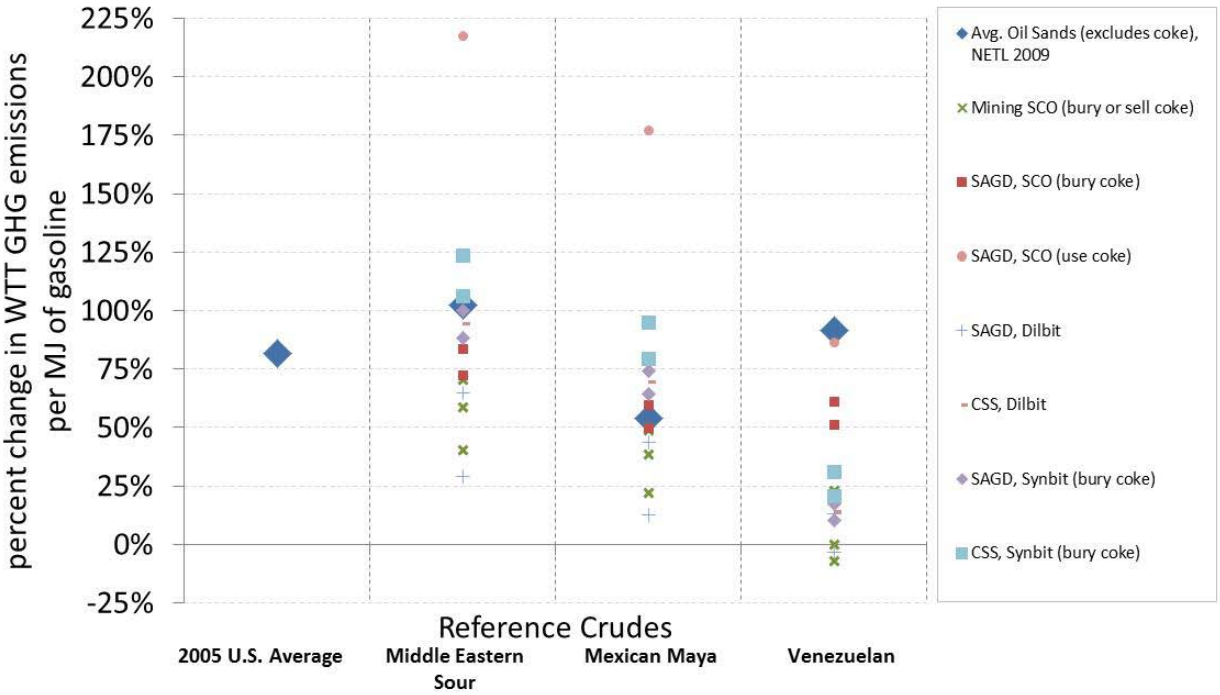
Inclusion of the combustion phase allows for a more complete picture of crude oil contribution to GHG emissions because this phase represents between approximately 70 to 80 percent (depending on crude source) of the WTW emissions (IHS CERA 2010, 2011). As a result, a WTW analysis reduces the percent differential in total GHG emissions between different crude oil sources. Because a WTT analysis focuses on pre-combustion processes, it highlights the differences in upstream life-cycle GHG emissions associated with the extraction, transportation, and refining of crude oils from different sources, as illustrated in a comparison of Figure 4.15.3-3 and Figure 4.15.3-4.



Sources: Data from NETL 2009, Jacobs 2009, TIAX 2009.

Notes: The percent differentials are calculated using the oil sands results relative to the corresponding study's reference crude. Only NETL (2008, 2009) provided a value for the 2005 U.S. average reference crude. A positive percentage indicates the oil sands' WTW is greater than the X-axis reference crude.
In this chart, all emissions are given per megajoule (MJ) of reformulated gasoline with the exception of NETL 2009, which is given per MJ of conventional gasoline.
"Venezuela Conventional" is used as the NETL reference crude for Venezuela Bachaquero in this analysis; this is a medium crude, not a heavy crude; thus, the NETL values are compared against a lighter Venezuelan reference crude than other studies.
Dilbit fuels do not include emissions associated with recirculating diluents back to Alberta. TIAX (2009) did not consider recirculation of diluent back to Alberta. Jacobs (2009) evaluated a scenario where diluent is recirculated to Alberta, which increased WTW emissions by 7 grams (g) CO_2/MJ (lower heating value [LHV]), or 7 percent, for reformulated gasoline relative to the case where diluent is not recirculated. This scenario has not been included in this figure because diluent would not be recirculated by the proposed Project.
SCO = synthetic crude oil; SAGD = steam-assisted gravity drainage; CSS = cyclic steam stimulation.

Figure 4.15.3-3 Comparison of the Percent Differential for WTW GHGs from Gasoline Produced from Various WCSB Oil Sands Relative to Reference Crudes



Sources: Data from NETL 2009, Jacobs 2009, TIAX 2009.

Notes: The percent differentials are calculated using the oil sands results relative to the corresponding study's reference crude. Only NETL (2008, 2009) provided a value for the 2005 U.S. average reference crude. A positive percentage indicates the oil sands' WTT is greater than the X-axis reference crude.
In this chart, all emissions are given per MJ of reformulated gasoline with the exception of NETL 2009, which is given per MJ of conventional gasoline.
"Venezuela Conventional" is used as the NETL reference crude for Venezuela Bachaquero in this analysis; this is a medium crude, not a heavy crude; thus, the NETL values are compared against a lighter Venezuelan reference crude than other studies.
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SCO = synthetic crude oil; SAGD = steam-assisted gravity drainage; CSS = cyclic steam stimulation.

Figure 4.15.3-4 Comparison of the Percent Differential for WTT GHGs from Gasoline Produced from Various WCSB Oil Sands Relative to Reference Crudes

Scope of Review of Life-Cycle Studies

A list of the reports reviewed for this assessment is presented in Table 4.15-20. The primary studies and additional supplemental reports for the assessment were selected on the following basis:

- The reports evaluate WCSB oil sands crude oils in comparison to crude oils from other sources;
- The reports focus on GHG impacts throughout the life-cycle of crude oils and their related products;

- The reports were published within the last 10 years (with one exception), and most were published within the last 5 years; and
- The reports represent the perspectives of various stakeholders, including industry, governmental organizations, and non-governmental organizations.

Table 4.15-20 Primary and Additional Studies Evaluated[a]

Primary Studies Analyzed	Type
NETL. 2008. Development of Baseline Data and Analysis of Life-cycle Greenhouse Gas Emissions of Petroleum-Based Fuels.	Individual LCA
NETL 2009. An Evaluation of the Extraction, Transport and Refining of Imported Crude Oils and the Impact of Life-cycle Greenhouse Gas Emissions.	Individual LCA
International Energy Agency (IEA). 2010. World Energy Outlook.	Meta-analysis
IHS CERA. 2010. Oil Sands, Greenhouse Gases, and U.S. Oil Supply: Getting the Numbers Right.	Meta-analysis
IHS CERA. 2011. Oil Sands, Greenhouse Gases, and European Oil Supply: Getting the Numbers Right.	Meta-analysis
Natural Resources Defense Council (NRDC). 2010. GHG Emission Factors for High Carbon Intensity Crude Oils ver. 2.	Meta-analysis
Energy-Redefined LLC for ICCT. 2010. Carbon Intensity of Crude Oil in Europe Crude.	Individual LCA
AERI/Jacobs Consultancy. 2009. Life-cycle Assessment Comparison of North American and Imported Crudes.	Individual LCA
Jacobs. 2012. EU Pathway Study: Life-cycle Assessment of Crude Oils in a European Context	Individual LCA
AERI/TIAX LLC. 2009. Comparison of North American and Imported Crude Oil Lifecycle GHG Emissions.	Individual LCA
Charpentier, et al. 2009. Understanding the Canadian Oil Sands Industry's Greenhouse Gas Emissions.	Meta-analysis
Brandt, A. 2011. Upstream greenhouse gas (GHG) emissions from Canadian oil sands as a feedstock for European refineries.	Meta-analysis
Additional Studies/Models Analyzed	**Type**
RAND Corporation. 2008. Unconventional Fossil-Based Fuels: Economic and Environmental Trade-Offs.	Individual LCA
Pembina. 2005. Oil Sands Fever: The Environmental Implications of Canada's Oil Sands Rush.	Partial LCA
Pembina. 2006. Carbon Neutral 2020: A Leadership Opportunity in Canada's Oil Sands. Oil sands issue paper 2.	Partial LCA
McCann and Associates. 2001. Typical Heavy Crude and Bitumen Derivative Greenhouse Gas Life-cycles.	Individual LCA
Pembina. 2011. Life-cycle assessments of oil sands greenhouse gas emissions: A checklist for robust analysis.	White Paper
GHGenius. 2010. GHGenius Model, Version 3.19. Natural Resources Canada.	Model
GREET. 2010. Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation Model, Version 1.8d.1. Argonne National Laboratory.	Model
Rooney et al. 2012. Oil Sands Mining and Reclamation Cause Massive Loss of Peatland and Stored Carbon.	Land use change journal article
Yeh et al. 2010. Land Use Greenhouse Gas Emissions from Conventional Oil Production and Oil Sands.	Land use change journal article

[a] See Appendix W, Life-Cycle Greenhouse Gas Emissions, for more information on each study.

Evaluation of the results from the primary and additional studies included in this assessment must take into account the treatment of co-products in each study. In a refinery, gasoline, diesel, and jet fuel are all co-products; other co-products produced from upgrading and refining crude oil can include petroleum coke, liquefied petroleum gas (LPG), sulfur, and surplus cogenerated electricity. Three different approaches are used for handling co-products in LCAs: all co-products can be included within the LCA boundary (also known as system expansion); a process can be split or separated into two or more subprocesses that each describe an individual product; or, when neither of the previous options are possible, the allocation process can be used to attribute a portion of GHG emissions to each co-product.

Allocation allows LCA practitioners to exclude other co-products from the LCA system boundary and only consider the GHG emissions associated with making and consuming the co-product of interest. Some studies apply a substitution credit for the fuels that are offset in other markets by the use of co-products, such as petroleum coke. Although individual studies may be internally consistent in how they treat allocation and co-products, the different approaches to accounting for co-products can have a significant impact on life-cycle emissions,[15] and can result in apples-to-oranges comparisons across the studies. Therefore, this assessment has avoided direct comparisons between studies that use different methods to account for co-products. The first two columns in Table 4.15-21 show the variation in allocation and substitution approaches used in the various studies, particularly with regard to the treatment of petroleum coke and the electricity cogeneration. Several studies do not explicitly state how they have dealt with these issues.

The primary and additional studies list reflects recent updates to previous LCAs of GHG emissions from oil sands-derived crudes and information on GHG emissions associated with land use. Jacobs (2012) and IHS CERA (2011) both examined life-cycle GHG emissions from producing gasoline and diesel from WCSB oil sands derived crudes for European markets. Jacobs (2012) developed carbon intensities for Alberta crudes based on first order engineering principles and models and calculation methods used in the GREET (2010) model. Jacobs (2012) also correlated the results with data reported to and audited by the Canadian government.

Regulatory authorities in Alberta require extensive information on bitumen production ranging from fugitive and flaring data to the energy consumption and GHG emissions from bitumen production both from in situ mining and from mining-upgrading. Jacob's GHG emissions for producing the heavy Alberta crude oils by steam-assisted gravity drainage are based on engineering estimates using energy consumption that has a close correlation with data reported to the Alberta government (Jacobs 2012, p.5-41). Jacobs' evaluation of the carbon intensity of mining and upgrading is based on data from audited industry and government reports, and engineering estimates based on estimated parameters governing crude oil production.

Engineering models to estimate energy consumption and GHG emissions from bitumen production correlated well with energy use and GHG emissions reported to the Government of Alberta. Jacobs (2012) used a similar set of engineering models and industry literature as the previous Jacobs (2009) study, but correlated the results with data reported to and audited by the Canadian government. IHS CERA (2011) does not contain any changes in emission estimates

[15] For instance, IHS CERA (2010) found that including petroleum coke combustion would increase WTW GHG emissions for a barrel of refined products by 8 to 10 percent, depending on crude type.

from IHS CERA (2010) except for the combustion emissions from end use of refined products.[16] For WCSB oil sands crude oils, the assessment focused on those that could be transported through the proposed Project. Based on this criterion, the solid, raw bitumen from oil sands was eliminated except to the extent that it is included within averaged results (e.g., NETL provides a single WCSB oil sands estimate that represents a weighted average of 43 percent crude bitumen from in situ production and 57 percent synthetic crude oil [SCO] from mining).

This assessment addresses three types of WCSB oil sands crude oils that are extracted either by mining or the in situ thermal processes. Conventional strip-mining methods are used to extract oil sands deposits that are less than about 75 meters below the surface.[17] To recover deeper deposits of oil sands, in situ methods are used. In situ recovery methods typically involve injecting steam into an oil sands reservoir to heat—and thus decrease the viscosity of—the bitumen, enabling it to flow out of the reservoir sand matrix to collection wells. Steam is injected using cyclic steam stimulation (CSS), where the same well cycles between periods of steam injection and bitumen production, or by steam-assisted gravity drainage (SAGD), where a pair of horizontal wells is drilled. The top well is used for steam injection, and the bottom well for bitumen production. Due to the high energy demands for steam production, steam injection in situ methods are generally more GHG-intensive than mining operations. The WCSB crude oil types assessed in this study are described briefly below:

- Synthetic crude oil—SCO is produced from bitumen via a refinery conversion of heavy hydrocarbons to lighter hydrocarbons. While SCO can be sour, it is usually a light, sweet crude oil without heavy fractions.
- Dilbit (diluted bitumen)—Dilbit is bitumen blended with a diluent, usually a natural gas liquid such as condensate, to create a "lighter" product and to reduce viscosity so the dilbit can be transported via pipeline. Dilbit feedstock processing requires more heavy oil conversion capacity than most crude oils.
- Synthetic bitumen (synbit) —Synbit is usually a combination of bitumen and SCO. The properties of synbit blends vary greatly, but blending lighter SCO with heavier bitumen results in a product more similar to conventional crude oil than SCO or dilbit alone.

The reference crudes evaluated in the literature reflect a range of sources and GHG emissions:

- The average U.S. barrel consumed in 2005 (NETL 2008). This reference was selected because it provides a baseline for fuels produced from the average crude consumed in the United States.
- Venezuela Bachaquero and Mexico Maya, which are representative of heavy crudes currently refined in PADD 3 refineries. It is assumed that these crude oils would be displaced or replaced by the WCSB oil sands crude oil that would be transported by the proposed Project, although it is likely that they would find markets elsewhere and would still be produced.

[16] IHS CERA (2010) provides a value of 384 kilograms (kg) CO_2e per barrel of refined product; IHS CERA (2011) provides a value of 402 kg CO_2e per barrel of refined product. It is not clear from the 2010 report what refined product blend was used to estimate the combustion emissions value. However, it is clear that the refined product blend used in the 2011 study is different from the one used in the 2010 study. Combustion emissions from end use of refined products are assumed to be the same across all crudes examined in each study.

[17] Mining accounts for roughly 48 percent of total bitumen capacity in the WCSB oil sands as of mid-2010 (IEA 2010, p. 152).

- Saudi Light (i.e., Middle Eastern Sour), which is considered the balancing grade for world crude oil supplies. This crude may ultimately be backed out of the world market if additional supply of WCSB oil sands crudes is produced.

Evaluation of Key Factors Influencing the GHG Results

There are many differences in the study design factors and input assumptions for life-cycle GHG analyses of WCSB oil sands crude oils relative to the four reference crude oils.

Study Design Factors

Study design factors relate to how the GHG comparison is structured within each study. These factors include the overall purpose and goal of the study, the types of crudes and refined products that are compared to each other, the timeframe over which the results of the study are applicable, the life-cycle boundaries established to make the comparison, the functional units or the basis used for comparing the life-cycle GHGs for crudes or fuels to each other (e.g., expressing GHG emissions per unit of crude, SCO, all refined products, or specific refined products such as gasoline or diesel, in terms of volume, energy, or distance units), and the treatment of co-products other than gasoline, diesel, and jet fuels (e.g., asphalt, petroleum coke, liquefied refinery gases, and lubricants). Some studies allocate a fraction of the GHG emissions from refining to these co-products and exclude these emissions from the life-cycle boundary (i.e., they are not included within the studies' LCA results). Other studies include these emissions but assign credits for GHG emissions from other sources that are offset by combustion of the co-products (e.g., electricity exported from a refinery replaces natural gas-fired power generation, and petroleum coke from a refinery replaces coal).

Key design factors across the studies identified through this assessment are summarized in Table 4.15-21. In general, the studies reviewed are consistent in their treatment of some factors (e.g., generally excluding emissions associated with land-use changes) but, as noted above, vary in their treatment of other factors (e.g., emissions from petroleum coke and electricity cogeneration). Emissions arising from the construction of capital infrastructure are also generally excluded.

Most studies exclude land-use change, although recent studies have sought to characterize land-use carbon flows to examine the implications for GHG emissions and carbon sequestration (Rooney et al. 2012; Yeh et al. 2010). Comparing only those portions of the two papers that focus on peatland soil carbon loss, the results were within a similar range (384 to 1,600 metric tons of carbon per hectare for Rooney compared to 778 to 1,067 metric tons of carbon per hectare for Yeh). These Rooney and Yeh estimates are equivalent to the annual GHG emissions from fuels combustion in approximately 293 to 1,222 and 594 to 815 passenger vehicles, respectively.[18] The range in Rooney et al. (2012) is larger because the authors gave a wide range for the value of peatland soil carbon storage whereas Yeh et al. (2010) explicitly included estimates of aboveground carbon sequestration in addition to soil carbon sequestration.

[18] Equivalencies based on USEPA's GHG Equivalency Calculator (USEPA 2012c).

Table 4.15-21 Summary of Key Study Design Features that Influence GHG Results

Estimated Relative WTW Impact [a]:		High					Medium				Low
Source	**Data Reference Year(s)**	**Petroleum coke combustion[b]**	**Cogeneration credit[c]**	**Upstream production of fuels included[d]**	**Flaring/venting GHG emissions included**	**Capital equipment included[e]**	**Methane emissions from tailing ponds included**	**Fugitive leaks included**	**Local and indirect land use change included**	**Refinery emissions account for upgrading[f]**	**Methane emissions from mine face**
NETL 2008	2005	No	NS	Yes	Yes	No	NS	Yes	No	No	NS
NETL 2009	2005	No	NS	Yes	Yes	No	NS	NS	No	No	NS
IEA 2010	2005-2009	NS	NS	Yes	NS	NS	Yes	NS	No	NA	NS
IHS CERA 2010	~2005-2030	V	V	No	NS	NS	V	NS	No	NA	V
IHS CERA 2011	~2005-2030	V	V	No	NS	NS	V	NS	No	NA	V
NRDC 2010	2006-2010	NS[g]	NS[g]	P	NS	NS	NS	NS	No	NA	NS
ICCT 2010	2009	NS	No	P	Yes	No	NS	Yes	No	No	NS
AERI/Jacobs 2009	2000s	Yes	Yes	Yes	Yes	No	No	No	No	Yes	No
Jacobs 2012	2000s	Yes	No[h]	Yes	Yes	No	Yes	Yes	Yes	Yes	Yes
AERI/TIAX 2009	2007-2009	P	P	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Charpentier et al. 2009	1999-2008	NS[7]	NS[7]	V	NS	V	NS	NS	No	NA	NS
Brandt 2011	V	V	V	NS[7]	V	NS[7]	V	V	V	V	V
RAND 2008	2000s	NS	NS	NS	Yes	No	Yes	Yes	No	No	Yes
Pembina Institute 2005	2000, 2004	NS	NS	NS	P	No	NS	P	No	No	NS
Pembina Institute 2006	2002-2005	NS	NS	No	P	No	Yes	Yes	No	No	Yes
McCann 2001	2007	P	NS	Yes	NS	No	NS	NS	No	NS	NS
GHGenius 2010	Current	Yes	No	Yes	Yes	No	Yes	Yes	Local	NS	Yes
GREET 2010	Current	NS	NS	Yes	Yes	No	NS	Yes	No	NS	NS
Rooney et al. 2012	1990s, 2000s	NA	NA	NA	NA	NA	No	NA	Local	NA	NA
Yeh et al. 2010	2000s	NA	NA	NA	NA	NA	Yes	NA	Local	NA	NA

Notes: Yes = included in life-cycle boundary; No = not included; P = partially included; NS = not stated; NA = not applicable; V = varies by study addressed in meta-study.

[a] High impact = greater than 3 percent change in WTW emissions. Medium impact = 1 to 3 percent change in WTW emissions. Low impact = less than 1 percent change in WTW emissions.

[b] "Yes" indicates that GHG results for products such as gasoline, diesel, and jet fuel do include petroleum coke production and combustion. "No" indicates that GHG emissions from petroleum coke production and combustion were not included in the system boundary for gasoline, diesel, or jet fuel. The effect of including petroleum coke depends on how much is assumed to be stored at oil sands facilities versus sold or combusted, and whether a credit is included for coke that offsets coal combustion.

[c] "Yes" indicates that the study applied a credit for electricity exported from cogeneration facilities at oil sands operations that offsets electricity produced by other power generation facilities. "No" indicates a credit was not applied. Including a credit for oil sands would reduce the GHG emissions from oil sands crudes relative to reference crudes.

[d] Indicates whether studies included GHG emissions from the production of fuels that are purchased and combusted on-site for process heat and electricity (e.g., natural gas).

[e] Indicates whether the study included GHG emissions from the construction and decommissioning of capital equipment such as buildings, equipment, pipelines, rolling stock.
[f] Indicates whether refinery emissions account for the fuel properties of SCO relative to reference crudes. Since SCO is upgraded before refining, it requires less energy and GHG emissions to refine into gasoline, diesel, and jet fuel products.
[g] Not discussed in the meta-study; may vary by individual studies analyzed.
[h] Jacobs (2012) did not apply a credit for export of excess electricity generated at SAGD or upgrading facilities. Where facilities do produce excess electricity, however, the study calculated the amount of natural gas that would be used to produce the excess electricity and subtracted this from total natural gas consumption.

Given the slight differences in the two approaches, the results are reasonably consistent with each other. Rooney et al. (2012) estimated GHG emissions and reduced carbon sequestration capacity from landscape changes due to currently approved mines. In absolute terms, Rooney et al. (2012) found that land use changes for approved oil-sands development could release 11.4 to 47.3 million metric tons (or 68 to 283 metric tons of carbon per hectare) of stored carbon and reduce future sequestration by 5,734 to 7,241 metric tons of carbon per year (or 34 to 43 kg of carbon per hectare), but the authors did not relate these effects to life-cycle GHG emissions associated with extraction, upgrading, transportation, refining, and combustion of refined products from oil sands-derived crudes. The primary driver for the release of stored carbon from land use change in Alberta is the replacement of carbon-rich peatland (containing 530 to 1,650 metric tons of carbon per hectare) with relatively low carbon post-mining soils (containing 50 to 146 metric tons of carbon per hectare). In three of the mines examined in Rooney et al. (2012), 67 percent of the peatlands were reclaimed; this land conversion proportion was then scaled by the total area permitted for oil sands mining to estimate the peatland loss for the entire region studied. The uncertainty in the carbon release estimate is derived from the wide range of carbon storage values for both the peatland and the post-mining soil.

The land disturbance emissions impact estimated by Yeh et al. (2010) was between 260 and 1,691 metric tons of carbon per hectare for surface mining production and between 6 and 135 metric tons of carbon per hectare for in situ.[19] The authors found that land use contributes to <0.4 percent of WTW life-cycle GHGs from in situ oil sands production, and between 0.9 to 2.5 percent of surface mining production over a 150-year modeling period. The larger contribution to surface mining life-cycle GHG emissions is due to the larger land use change impacts of these operations and that reclamation efforts may replace much of the disturbed peatland environment with upland forests that have lower stocks of carbon and do not provide long-term carbon sequestration benefits (Yeh et al. 2010).

Importantly, only a few studies modeled the effect that upgrading SCO has on downstream GHG emissions at the refinery. Several (but not all) studies include the following:

- Upstream production of purchased fuels and electricity used to power machinery in the oil fields and at refineries;
- Flaring and venting;
- Fugitive emissions; and
- Methane emissions from oil sands mining and tailings ponds.

Input Assumptions

Impact LCA results and assumptions are input at each life-cycle stage. Due to limited data availability and the complexity of and variation in the practices used to extract, process, refine, and transport crude oil, studies often use simplified assumptions to model GHG emissions. For example, for both WCSB oil sands crude oils and reference crude oils, assumptions about how much petroleum coke is produced, stored, and combusted at the upgrader or refinery, and how much is sold to other users, are key drivers of GHG emission estimates. Transportation

[19] The energy yields estimated by Yeh et al. for oil sands mining and in situ extraction were 0.92 petajoules per hectare and 3.3 petajoules per hectare, respectively.

assumptions have a more limited effect, but vary across the studies. The following are key input assumptions for WCSB oil sands-derived crude oils:

- Type of extraction process (i.e., mining or in situ production);
- Steam-oil ratio assumed for in situ operations;
- Efficiency of steam generation, and thus its energy consumption; and
- Upgrading processes modeled for SCO and whether or not estimated refinery GHG emissions account for upgrading.

For the reference crudes, key input assumptions include the oil-water and gas-oil ratios used to estimate reinjection and venting or flaring assumptions (e.g., stranded gas versus recovered gas, control levels on venting sources, the allocation of venting/flaring emissions to crude versus produced natural gas), and whether and what type of artificial lift (e.g., gas lift, water, steam, CO_2 flood) is considered for extracting crude oil. Life-cycle GHG emissions for gasoline produced from WCSB oil sands crude oils relative to other reference crude oils consumed in the United States, as reported by NETL (2009) are summarized in Table 4.15-22. The results are subject to several input assumptions that influence the results of the analysis. These assumptions and their estimated scale of impact on the WTW results are summarized in the last two columns of Table 4.15-22.

Table 4.15-22 GHG Emissions for Producing Gasoline from Different Crude Sources from NETL 2009 and Estimates of the Impact of Key Assumptions on the Oil Sands-U.S. Average Differential

	GHG Emissions (g CO_2e/MJ LHV gasoline)[a]					Findings on Key Assumptions Influencing Results	
Life-Cycle Stage	**2005 U.S. Average**	**Canadian Oil Sands**	**Venezuela Conventional**	**Mexico**	**Saudi Arabia**	**Description**	**Estimated Reference Crude WTW Impact**
Crude Oil Extraction	6.9	20.4[c]	4.5	7.0	2.5	Oil sands estimate assumes a weighted average of 43% crude bitumen (not accounting for blending with diluent to form dilbit) from CSS in situ production and 57% SCO from mining, based on data from 2005 and 2006	NA
Upgrading	NA	IE	NA	NA	NA		
Crude Oil Transport	1.4	0.9	1.2	1.1	2.8	Relative distances vary by study	Low increase or decrease
Refining	9.3	11.5d	11.0	12.9	10.4	Did not evaluate impact of upgrading SCO prior to refinery; only affects oil sands crudes	Medium decrease
Finished Fuel Transport	1.0	0.9	0.9	0.9	0.9	Transportation excluded co-product distribution	Low increase
Total WTT	**18.6**	**33.7**	**17.6**	**22.0**	**16.7**		

Life-Cycle Stage	GHG Emissions (g CO_2e/MJ LHV gasoline)[a]					Findings on Key Assumptions Influencing Results	
	2005 U.S. Average	Canadian Oil Sands	Venezuela Conventional	Mexico	Saudi Arabia	Description	Estimated Reference Crude WTW Impact
Fuel Combustion	72.6	72.6	72.6	72.6	72.6		
Total WTW	**91.2**	**106.3**	**90.2**	**94.6**	**89.3**	**All crudes other than SCO when petroleum coke is accounted in Gulf Coast refineries**	**High increase**
Difference from 2005 U.S. Average	**0%**	**17%**	**-1%**	**4%**	**-2%**		

Notes: IE = included elsewhere; NA = not applicable. LHV = lower heating value. WTT = well-to-tank; WTW = well-to-wheels.
[a] NETL 2009 values converted from kilograms (kg) CO_2e/MMBtu using conversion factors of 1,055 MJ/MMBtu and 1000 g/kg.
[b] Estimated impact on the WTW GHG emissions for reference crudes, except where noted (i.e., refining assumption affects oil sands crudes), as result of addressing the key assumptions/ missing emission sources. High = greater than approximated 3 percentage points change, Medium = approximated 1-3 percentage points change, and Low = less than approximated 1 percentage point change in WTW emissions.
[c] Included within extraction and processing emissions.
[d] Calculated by subtracting other process numbers from WTT total; report missing this data point.
[e] The effect that including petroleum coke manufacture, transportation and combustion has on WTW results depends upon assumptions about the replacement of petroleum coke supply from Gulf Coast refineries in its market by coal or fuel oil.

For example, NETL (2009) developed its weighted-average GHG emission estimate for oil sands extraction (including upgrading) from data on mining and cyclic steam stimulation (CCS) in situ operations in 2005 and 2006. The estimate that the NETL study used for mining oil sands was based on a 2005 industry report that estimates higher values than more recent estimates of surface mining GHG emissions (TIAX 2009; Jacobs 2009, 2012). The in situ GHG estimate is based on a CSS operation which, while CSS operations tend to be more GHG intensive than SAGD processes, is generally in the range of in situ estimates in other studies (e.g., TIAX 2009; Jacobs 2009). The NETL study, however, did not account for the fact that natural gas condensate is blended with crude bitumen to form dilbit, which is transported via pipeline to the United States. Since condensate has a lower GHG intensity than crude bitumen, per-barrel GHG emissions from dilbit are less than per-barrel emissions from crude bitumen.

The NETL study only considered combustion emissions from gasoline, diesel, and kerosene-type jet fuel and allocated the refinery emissions from co-products other than gasoline, diesel, and jet fuel to the co-products themselves. This approach removes the GHG emissions associated with producing and combusting co-products from the study's life-cycle boundary. This approach is consistent with DOE/NETL's objective of estimating the contribution of crude oil sources to the 2005 baseline GHG emissions profile for three transportation fuels (gasoline, diesel, and kerosene-type jet fuel). The treatment of co-products, in particular petroleum coke, can have an important effect on comparisons of the results of life-cycle assessments. Petroleum coke, discussed in further detail below, is produced by thermal decomposition of vacuum residuum into lighter hydrocarbons during bitumen upgrading and crude oil refining. It is approximately 95 percent carbon by weight. Heavier crudes would produce a larger fraction of coke than lighter fuels. Venezuela Bachaquero, Mexican Maya, and dilbit produce about 50 percent more coke than average U.S. 2005 crude or Saudi light crude (TIAX 2009). SCO has had all the vacuum residuum removed in the upgrader before it reaches the refinery, and thereby has no petroleum

coke manufacture in downstream refineries or petroleum coke transportation and combustion as do the average U.S. barrel, Mexican, Venezuelan, or Saudi reference crude oils.

The fates of petroleum coke are influenced by market effects, and differ depending on whether petroleum coke is produced at WCSB oil sands facilities in Alberta or at U.S. refineries in the Gulf Coast. In Alberta, petroleum coke produced from partial refining (upgrading) of oil sands crudes is either stockpiled or combusted for process heat and electricity. If stockpiled, the carbon contained in the coke is temporarily sequestered. Data from planned and operational upgraders in Alberta show that gasification of petroleum coke and other heavy ends at these facilities substantially increases GHG emissions ((S&T)2 Consultants 2008); however, the extent of consumption of petroleum coke at WCSB oil sands facilities may be influenced by the availability of low-cost natural gas to these facilities (Brandt 2011).

At U.S. refineries in the Gulf Coast, petroleum coke is shipped to overseas markets, primarily China where it is ultimately combusted as a fuel in industrial or electric power applications. Transporting raw or diluted bitumen to refineries in the Gulf Coast that sell coke to other markets may therefore cause a greater share of the coke to be consumed rather than stockpiled. As explained in more detail in Appendix W, Life-Cycle Greenhouse Gas Emissions, on GHG emissions, petroleum coke produced at the upgrader and not the Gulf Coast refineries may be offset by additional coal or fuel oil combustion in the market currently filled with Gulf Coast refinery petroleum coke; however, the net emissions from coke production and combustion at the upgrader would be much smaller (Appendix W, Life-Cycle Greenhouse Gas Emissions).

As a result, the effect of including petroleum coke combustion depends upon study assumptions about the end use of petroleum coke at both the refinery and upgrader, and whether petroleum coke use offsets other fuels, such as coal or fuel oil. These factors, in turn, depend on market interactions involving the supply of petroleum coke relative to the availability of other competing fuel substitutes. These dynamic market effects are difficult to characterize and are generally not explicitly modeled in existing LCAs (Brandt 2011, Jacobs 2012). These issues are discussed further in the Petroleum Coke Characteristics, GHG Emissions, and Market Effects section below.

Additionally, the NETL study used linear relationships to relate GHG emissions from refining operations to specific crudes based on API gravity and sulfur content. The study notes that these relationships do not account for the fact that bitumen blends (dilbits and synbits) and SCO in particular would produce different fractions of residuum and light ends than full-range crudes. Accounting for the variable properties of these crude oil types and resulting refinery GHG emissions would change the differences between WTW GHG emissions for premium fuels refined from WCSB oil sands derived crude oils relative to reference crude oils.

Petroleum Coke Characteristics, GHG Emissions, and Market Effects

The Final EIS, released in August 2011, found that the treatment of petroleum coke in LCA studies was an important factor that influences the life-cycle GHG emission results. It is important when comparing oil sands and the reference crudes that the full life-cycle is evaluated, not just the upstream or refining stage. The issue of petroleum coke is not a standalone issue for oil sands crudes; it is also an LCA consideration for the heavy conventional crudes. If the GHG emissions for the production and combustion of petroleum coke and other co-products are included within life-cycle boundaries for one type of crude, it must be done for the other crudes for an even comparison.

Producing a barrel of premium fuels (i.e., gasoline, diesel, and kerosene/jet fuel) from bitumen produces roughly the same amount of petroleum coke as a barrel of premium fuels refined from heavy crudes, such as Venezuelan Bachaquero or Mexican Maya. The actual net GHG emissions from petroleum coke, however, depend on the final end use of the petroleum coke (i.e., whether it is stockpiled or combusted) and how its end use affects demand for other fuels such as coal. Since a portion of the petroleum coke produced from upgrading WCSB oil sands bitumen is currently stockpiled and not combusted, whereas the petroleum coke produced from refining reference crudes at Gulf Coast refineries is combusted, GHG emissions from petroleum coke produced from WCSB oil sands crudes are slightly lower than petroleum coke GHG emissions from other heavy reference crudes.

Recent reports published since the Final EIS (Oil Change International 2013, Gordon 2012) have also recognized petroleum coke as an important source of GHG emissions in the crude oil life-cycle. To better understand the importance of petroleum coke in the life-cycle of both oil-sands-derived and reference crudes, this section describes:

- Petroleum coke characteristics relative to coal, for which it serves as a substitute in the electric power sector;
- The effect of including petroleum coke production and combustion in life-cycle GHG emission estimates of oil sands and other reference crudes; and,
- Market effects related to changes in the petroleum coke production, how these effects have been captured in existing LCA studies, likely markets for petroleum coke, and potential effects on the demand for other fuels.

Physical characteristics of petroleum coke are provided in Table 4.15-23, including heating value (on a higher heating value basis),[20] carbon content, and CO_2 emissions per unit energy. For comparison purposes, these characteristics are also provided for bituminous, sub-bituminous, lignite, and anthracite types of coal. The change in CO_2-intensity for these coals is provided relative to petroleum coke on an energy basis. Table 4.15-23 shows that bituminous, sub-bituminous, and lignite coal are between about 4 and 9 percent less CO_2-intensive than petroleum coke on an energy basis, while anthracite coal is approximately 2 percent more CO_2-intensive.

Recent reports (Oil Change International 2013, Gordon 2012) have critiqued existing LCA studies for allocating GHG emissions from producing and combusting petroleum coke outside the study boundaries, or for assuming that petroleum coke combustion substitutes or offsets coal combustion. Defined pathways for individual products are the cornerstone of LCA, and must be appropriate to the study's goal and scope. For example, NETL excluded GHG emissions from petroleum coke production and combustion because they are outside the boundary of premium fuel products (i.e., gasoline, diesel, and kerosene/jet fuel) (NETL 2008, 2009). This approach is consistent with the study's goal of estimating the contribution of crude oil sources to the 2005 baseline emissions profile for premium fuels.

[20] The heating value is the amount of heat released during the combustion of a specified amount of a substance, and the higher heating value is determined by bringing all the products of combustion back to the original pre-combustion temperature.

Table 4.15-23 Petroleum Coke and Coal Heating Values, Carbon Contents, and CO_2 Emissions per Unit Energy from USEPA (2012b)

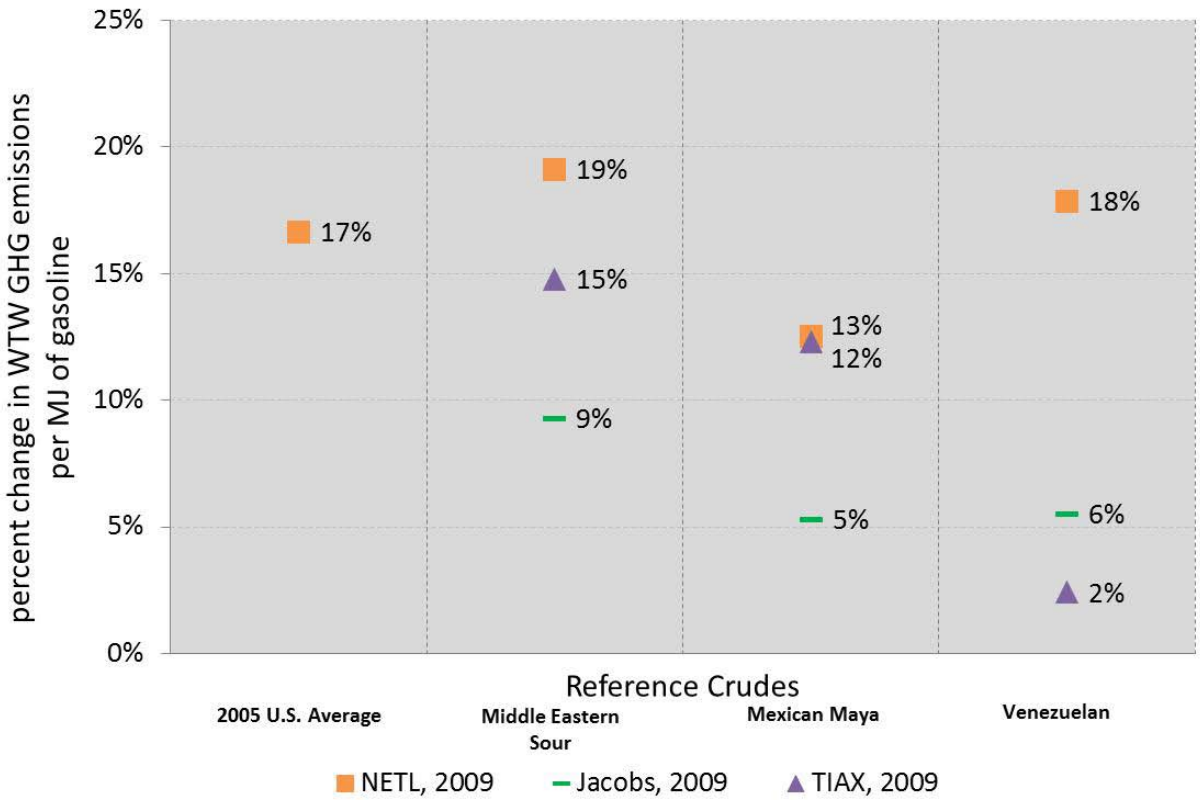
Characteristic	Units	Petroleum Coke	Bituminous Coal	Sub-bituminous Coal	Lignite Coal	Anthracite Coal
Heating value[a]	million Btu/ short ton	30.12[b]	23.89[c]	17.14[c]	12.87[c]	22.57[c]
Carbon content[d]	% carbon, by weight	92%	67%	50%	38%	70%
CO_2 emissions per unit energy	$kgCO_2$/ million Btu	102.10[e]	93.27[f]	97.17[f]	97.67[f]	103.67[f]
	grams CO_2/MJ	96.77	88.40	92.10	92.57	98.26
Change in emissions-intensity relative to petroleum coke	**% change**	**--**	**-9%**	**-5%**	**-4%**	**2%**

Notes: Data in table reflects national characteristics provided by USEPA (2012b) U.S. Inventory of Greenhouse Gas Emissions: 1990-2010. Original sources cited in USEPA (2012b) are provided below.
[a] On a higher heating value basis.
[b] EIA (2010). Annual Energy Review 2009. U.S. Energy Information Administration.
[c] EIA (1993). State Energy Report 1992. U.S. Energy Information Administration.
[c] Calculated from heating value and CO_2 emissions per unit energy.
[e] Based on data sourced from EIA (1994), EIA (2009), USEPA (2009) and USEPA (2010a)
[f] Calculated from USGS (1998) and PSU (2010); data presented in USEPA (2010b)

Other LCA studies do not exclude the GHG emissions from the production and combustion of petroleum coke and other co-products that leave the system boundary. Instead, these studies typically apply a substitution credit for the fuels that are offset in other markets by the use of petroleum coke and other co-products. To calculate the credit, studies generally assume one-to-one substitution on an energy basis (i.e., one Btu of coal is offset by one Btu of petroleum coke). Although some studies have assumed that the net GHG emissions from offsetting coal for coke are negligible (IHS CERA 2012), other studies have accounted for the fact that petroleum coke has a higher CO_2 intensity on an energy basis when compared to bituminous and sub-bituminous coal. For example, Jacobs found this net difference to be approximately 8 g CO_2/MJ (plus a small, unspecified adjustment to account for transportation of coke versus coal) (Jacobs 2009 p. 8-3); the most recent Jacobs report assumed that offsetting the combustion of coal with petroleum coke results in a small incremental net increase of approximately 2 g CO_2/MJ (Jacobs 2012, p. 9-12).

Since the treatment of petroleum coke and other co-products has a large effect on WTW GHG emissions, it is important to ensure that consistent system boundaries are applied when comparing GHG emissions from WCSB oil sands crudes to other reference crudes. For example, the GHG emissions from oil sands extraction and upgrading have been estimated as 3.2 to 4.5 times higher than conventional oil production (Oil Change International 2013; Huot 2011), but this comparison does not describe entirely equivalent crude oil types. The upstream LCA stage for some oil sands includes the process of upgrading, which removes the heavy coke bottom of the crude barrel. For conventional crudes, the extraction stage does not contain the equivalent process of upgrading or coking; instead, for conventional crudes the coking process occurs within the refining stage.

Since the boundaries across different LCA studies differs depending on the goal and scope of a particular study, the change in WTW emissions from oil sands crudes relative to other reference crudes is compared on an internally-consistent basis (i.e., by comparing the relative change within studies, not across different studies) in Figures 4.15.3-3, 4.15.3-4, and 4.15.3-5, and in the incremental assessment of GHG emissions in this section.



Source: NETL 2009; Jacobs 2009; TIAX 2009.

Notes: In this chart, all emissions are per MJ of reformulated gasoline with the exception of NETL 2009, which is per MJ of conventional gasoline. Venezuela Conventional is used as the NETL reference crude for Venezuela Bachaquero in this analysis. This is a medium crude, not a heavy crude; thus, the NETL values are compared against a lighter Venezuelan reference crude than other studies. The percent differentials refer to results for scenarios from the various studies and are calculated using the oil sands results relative to the corresponding study's reference crude. A positive percentage indicates the oil sands' near-term WTW weighted average is greater than the X-axis reference crude.

Figure 4.15.3-5 Percent Change in Near-Term WTW Weighted-Average GHG Emissions from the Mix of WCSB Oil Sands Crudes that may be Transported in the Proposed Project Relative to Reference Crudes

Virtually all crude oils, light, medium and heavy, including bitumen, contain a fraction of the raw oil out of the ground that does not boil even under full vacuum conditions. This fraction, called vacuum residuum, will thermally destruct into lower molecular weight hydrocarbon compounds and elemental carbon when heated above about 800°F. This fraction is commonly used for three products: asphalt, residual fuel oil (called No. 6 fuel oil or bunker fuel), and petroleum coke. The coking process takes advantage of the thermal destruction nature of vacuum residuum by heating the oil above the thermal destruction temperature and quickly discharging

the hot oil into a drum where the hydrocarbons exit the top as vapors and the elemental carbon settles to the bottom as petroleum coke.

Canadian oil sands bitumen contains about 40 percent vacuum residuum fraction. When this bitumen is blended with 30 percent diluent, creating what is referred to as dilbit, the dilbit contains about 30 percent vacuum residuum fraction. Venezuelan Bachaquero crude contains about 40 percent vacuum residuum, and Arab Light crude contains about 20 percent vacuum residuum. So the vacuum residuum of Canadian oil sands bitumen is within the range of crude oils commonly refined in the Gulf Coast area, which is the proposed destination of Canadian oil sands crudes transported by the proposed Project.

Domestic consumption of petroleum coke in the United States is unlikely to significantly increase, so petroleum coke exports are likely to continue, with China remaining a large importer of U.S. petroleum coke to meet its domestic energy demands. Since the USEPA specified sulfur limits on No. 6 fuel oil (which are very hard and expensive to achieve in anything but low sulfur crude oils), the U.S. electrical power industry largely abandoned use of No. 6 fuel oil for electricity generation. This limitation of sulfur in fuel oil did not solve the acid rain air pollution problem in the northeastern United States, so the USEPA specified SOx emissions controls on coal-fired power plants. Flue gas stack scrubbers remove the SOx, and hence, the acid rain problem is largely resolved today. Nevertheless, No. 6 fuel oil has not re-entered the power generation market because refineries have installed coking units to convert oil into petroleum coke. While coke can be used as a supplement to coal in electrical power plants, with declining reliance on coal and long term contracts with coal suppliers, petroleum coke has not significantly penetrated the U.S. power plant industry. For example, in 2011 petroleum coke consumption was equivalent to 0.5 percent of coal consumption for electricity generation across all sectors (EIA 2012b). Most of the Gulf Coast coke is exported to markets in China, Japan, and Mexico, which accounted for 35 percent of all exports in 2011 (EIA 2012c). China was the single largest importer of U.S. petroleum coke, accounting for approximately 14 percent of U.S. exports (EIA 2012c).

The sulfur content of petroleum coke in the United States is a consideration for coal-fired power plants as they must control SOx emissions with flue gas scrubbers. Consideration is also given to the sulfur content of No. 6 fuel oil, but the power industry is converting to plentiful and inexpensive natural gas, and the coking assets are in place to process virtually all vacuum residuum not destined for the asphalt market.

The proposed Project will transport a mix of SCO and dilbit.[21] Petroleum coke from the bitumen upgraded into SCO is produced at Canadian upgraders. A significant fraction of this petroleum coke—approximately 50 to 75 percent (ERCB 2010; Oil Change International 2013, citing Alberta ERCB)—is currently stockpiled because it faces the same barriers to penetrate the Canadian coal-fired power plant market as does petroleum coke in the United States and it cannot be economically transported by rail for export to overseas markets at current market prices.

[21] For the purposes of this GHG Section, a 50/50 mix of SCO and dilbit is assumed, representing a conservative approach to life-cycle GHG considerations. As described in Section 1.4, Market Analysis, there is a significant difference in the projected percentages (between the 2008 and 2012 CAPP forecasts) of the crude oil that would go to market as upgraded synthetic crude oil, the projections being 47% percent and 28% percent respectively.

The dilbit transported by the proposed Project would be transported to Gulf Coast refineries where it would produce approximately the same quantities of petroleum coke as other heavy reference crudes such as Venezuelan Bachaquero and Mexican Maya. So of the total WCSB oil sands throughput of the proposed Project, slightly more than half of the petroleum coke is produced in Canada, where approximately 50 to 75 percent of it is currently stockpiled and the rest used as a substitute for other fuels in the production and upgrader process. The remainder of the petroleum coke (all that is produced from the dilbit fraction and none in the SCO) is produced at Gulf Coast refineries where it is used as a fuel in domestic or overseas markets.

Petroleum refineries attempt to maximize the use of all assets. Therefore, Gulf Coast area refineries will choose blends of Canadian oil sands crudes (dilbit, SCO, synbit) with other domestic and imported crudes to fill out the refinery assets including the coker units. Hence, approximately the same quantity of petroleum coke would be produced from a mix of crudes that backs out imported crude oils such as Mexican Maya, Venezuelan Bachequero, and Saudi Arabian Light crudes. The coke produced from Canadian oil sands crudes would be marketed the same as current coke; most of it would be exported with China being a large importer of U.S. petroleum coke.

The petroleum coke-associated GHG emissions from oil sands would be fundamentally similar to some heavy reference crudes given the following:

- Accounting for the non-combustion for approximately half of the upgrader petroleum coke manufacture;
- The combustion of coke manufactured from reference crude oils (including transportation to the China market);
- The lower refining emissions of SCO (because all the residuum processing was done at the upgrader); and
- The likely transportation of displaced reference crudes to alternative markets (e.g., Mexican Maya transported 10,000 miles to China rather than 700 miles to the Gulf Coast.

The oil sands petroleum coke-associated GHG emissions would likely be higher than the U.S. average barrel, especially with rapidly expanding shale oil production in North America.

While certain LCA studies developed detailed data models of oil sands production, processing, transport, and refining processes, including petroleum coke, they do not have access to the detailed data of the processes used to produce other reference crudes. For example, all conventional crudes, such as Saudi Arab Light and most U.S. production prior to the shale oil boom, are in various stages of declining production requiring enhanced production techniques with larger energy intensities per barrel of oil produced. As a result, the conventional crude production carbon intensity can be expected to trend upward, whereas the WCSB oil sands carbon intensity can be expected to be relatively flat since the deposits are shallow, they can be extracted using mining or near-surface in situ methods, and new production methods could potentially reduce the energy intensity. Even Saudi Arab Light crude from the giant Ghawar field in Saudi Arabia, which is produced with a 10 million barrel per day water flood pumped from the Arabian Gulf, is rapidly increasing in water cut, such that it is possible in 10 years oil sands could be less energy intensive, well-to-wheels, than Saudi Arab Light delivered to the same Gulf Coast destination.

A large share of Gulf Coast petroleum coke is shipped to China for the following reasons:

- It is less expensive, including the shipping, than China's coal; and
- China is challenged to keep pace with its rapidly growing economy with equally rapid coal production growth.

Coal accounted for nearly half the increase in global energy use over the past decade, and China was responsible for nearly half the global coal use in 2009 (IEA 2011). China, alongside India, is expected to lead in energy consumption growth in non-OECD[22] Asian regions, which is projected to rise by 91 percent from 2010 to 2035 (EIA 2012d).

At the same time, Mexico, Venezuela, and other large petroleum producers depend heavily on their crude oil exports to support their national economies. Just as the Market Analysis (see Section 1.4, Market Analysis) found it unlikely that the proposed Project construction would have a substantial impact on the rate of the oil sands development, these other petroleum producers are unlikely to forego crude oil sales if the U.S. substitutes Canadian oil sands crudes for Mexican and Venezuelan crudes. They can be expected to sell their crudes for whatever price the market will bear, and that is probably to China. Similarly, all the production and transportation assets are in place for Saudi Arabia to supply the crude oil displaced from the U.S. market to any country in the world who will buy it.

Expanding electrical power generation in China is easier and more cost-effective with No. 6 fuel oil than coal. Both No. 6 fuel oil and coal have high sulfur contents, and China has significant air pollution problems primarily from coal power plants. Thus, when China chooses to invest in a solution to air pollution, installing power plant flue gas scrubbers is a leading option. That will make No. 6 fuel oil equally suitable for power generation, but more economical in new power plants than coal. Therefore, worldwide crude oils displaced from the Gulf Coast refineries with Canadian oil sands crudes would more likely find their way to China, along with roughly the same amount of petroleum coke from the Gulf Coast, both displacing coal production in China.

Supplementing the worldwide crude oil market, Canadian oil sand crude will more likely substitute for expanded coal production in China rather than expand the use of solid carbon fuels (coal and coke) used in power generation in North America or China. With the discovery of economic production of light, sweet crude oils from hydraulic fracturing shale, the combination of expanded light U.S. crude and heavy Canadian oil sands production would likely not alter petroleum refining assets in the Gulf Coast area with regard to coking capacity. Refineries designed to run primarily heavy crudes may have to add facilities to pre-distill light ends from light shale oil crudes, but the remaining secondary units of the refineries (vacuum distillation unit, gas oil cracking, coking, and hydrotreating distillate products) can be expected to be protected like any asset in place.

GHG Intensity of WCSB Crudes

The wide variation in design and input assumptions within the various studies leads to a wide divergence in calculated GHG emissions. Based on an extensive review of information provided in the studies reviewed, the WTW and WTT GHG emission estimates of gasoline produced from WCSB oil sands-derived crude oils were compared to similar emission estimates from four reference crude oils (see Figures 4.15.3-3 and 4.15.3-4). Additional information on the data

[22] Organization for Economic Cooperation and Development.

sources and assessment is available in Appendix W, Life-Cycle Greenhouse Gas Emissions. As shown in Figure 4.15.3-3, the NETL WTW GHG emission estimates from gasoline produced from WCSB oil sands derived crude oils are 17 percent higher than the GHG emission estimates for gasoline produced from the average mix of crude oils consumed in the United States in 2005, and are approximately 19, 13, and 16 percent higher than GHG emission estimates for Middle East Sour, Mexican Heavy (i.e., Mexican Maya), and Venezuelan[23] crude oils, respectively (NETL 2009). The WTW emission estimates for gasoline produced from SCO via in situ methods of oil sands extraction (i.e., SAGD and CSS) in general are higher than the GHG emission estimates for mining extraction methods (Figure 4.15.3-3). This difference is primarily attributable to the energy requirements of producing steam as part of the in situ extraction process.

Gasoline produced from dilbit generally has lower estimated GHG life-cycle emissions than gasoline produced from SCO extracted by mining and in situ methods. This is a result of blending raw bitumen with a diluent (e.g., gas condensate) for transport via pipeline. Diluent produces fewer GHG emissions than bitumen, so blending the two together results in lower WTW GHG emissions. This assessment evaluates the refining of both bitumen and diluent at the refinery, since diluent would not be separated from the dilbit blend and recirculated by the proposed Project. Wheel-to-wheel GHG emission estimates from gasoline produced from synbit, a blend of SCO and bitumen, are similar to WTW GHG emission estimates for gasoline produced from SCOs produced from bitumen extracted by either mining or in situ methods.

Similar trends were evident in the WTT GHG analyses (see Figure 4.15.3-4). The percentage increase in WTT GHG emission estimates for gasoline produced from WCSB oil sands-derived crude oils as compared to gasoline produced from reference crudes (Figure 4.15.3-4) is much larger than the percent increases for WTW GHG emission estimates (Figure 4.15.3-3). Most of the gasoline life-cycle WTW GHG emissions occur during the combustion stage irrespective of the feedstock (i.e., reference crude or oil sands). Because WTT GHG emission estimates do not include the combustion phase, the differences in GHG life-cycle emissions associated with crude oil extraction and refining are emphasized; when expressing the comparison in terms of percentage increases, the same incremental differences in the numerator are divided by a smaller denominator.

The GHG emissions associated with different oil sands extraction, processing, and transportation methods vary by roughly 25 percent on a WTW basis. Life-cycle GHG emission estimates for fuels produced from WCSB oil sands crude oils are higher than emission estimates for fuels produced from lighter crude oils, such as Middle Eastern Sour crudes and the 2005 U.S. average mix. Compared to heavier crude oils from Mexico and Venezuela, WTW emission estimates associated with fuels derived from WCSB oil sand-derived crude oils are 37 percent higher than for SAGD SCO (petroleum coke burned at the upgrader) and 2 percent lower for mining-derived SCO (including storing or selling the petroleum coke).

Estimates from recent LCA studies are within these ranges. A recent study by IHS CERA found that transportation fuels produced from oil sands result in average WTW GHG emissions that are 14 percent higher than the average crude refined in the United States (results range from 5 to 23 percent higher) (IHS CERA 2012). In addition, Jacobs found that WTW GHG intensities of

[23] NETL uses Venezuelan Conventional as a reference crude rather than Venezuelan Bachaquero.

transportation fuels produced from oil sands are within 7 to 12 percent of the upper range of the conventional crudes WTW intensity (Jacobs 2012).

Incremental GHG Emissions from Oil Sands Crudes Potentially Transported by the Proposed Project Compared to Reference Crudes

As noted earlier in this section, and in Section 1.4, Market Analysis, under most scenarios the proposed Project would be unlikely to substantially influence the rate or magnitude of oil extraction activities in Canada, or the overall volume of crude oil transported to the United States or refined in the United States. Although there have been developments in the North American crude market since that analysis was completed, those developments do not alter the conclusion reached (see Section 1.4, Market Analysis). Thus, from a global perspective, the decision whether or not to build the proposed Project would be unlikely to substantially affect the rate of extraction and combustion of WCSB oil sands crude and its impact on the global market. On a life-cycle basis and compared with reference crudes refined in the United States, the reliance on oil sands crudes for transportation fuels would likely result in an increase in incremental GHG emissions.[24]

Although an LCA is not strictly necessary for evaluating the potential environmental impacts attributable to the proposed Project under NEPA, it is relevant and informative for policy makers to consider in a variety of contexts. For illustrative purposes, this section provides information on the incremental life-cycle GHG emissions (in terms of the U.S. carbon footprint) from WCSB oil sands crudes that would likely be transported by the proposed Project (or any transboundary crude oil pipeline). The incremental emissions are a function of:

- Throughput of the pipeline
- Mix of oil sands crudes imported
- GHG intensity of the crudes in the pipeline compared to the crudes they displace

Acknowledging the methodological differences in GHG-intensity estimates among the studies, the weighted-average GHG emissions for selected studies were calculated to estimate the incremental GHG emissions from WCSB oil sands relative to displacing an equivalent volume of reference crudes in U.S. refineries.

Jacobs (2009), TIAX (2009), and NETL (2009) formed the subset of studies used to develop weighted averages for the carbon footprint analysis. These studies are independent analyses of WTW GHG emissions from oil sands and reference crudes that use consistent functional units for comparison with each other. The other studies included in this assessment either did not look at the full WTW fuel life cycle, did not evaluate emissions on a consistent functional unit basis for comparison, or are meta-analyses that include the results of the Jacobs and TIAX studies. Despite the underlying differences in study assumptions, the comparisons illustrated below are internally consistent and make comparisons between crudes from the same study. For illustrative purposes, Figure 4.15.3-5 shows the percent change in weighted-average GHG emissions from

[24] Note that a substantial share of these emissions would occur outside the United States. Also note that the U.S. National Inventory Report, like other national inventories, only characterizes emissions within the national border, rather than using a life-cycle approach. If the United States used a life-cycle approach, upstream emissions from other imported crudes would be attributed to the United States.

the mix of WCSB oil sands crude oil that may be transported in the proposed Project relative to each of the four reference crudes on a gasoline basis.

The change in GHG emissions is calculated for the Jacobs (2009) and TIAX (2009) values by weighting the WTW GHG intensity of individual oil sands crudes by the composition of oil sands crudes that could be transported in the proposed Project. For this GHG life-cycle assessment, 50 percent of pipeline throughput is assumed to be SCO, and 50 percent would be dilbit.[25] All WCSB dilbit is currently produced using in situ production and 12 percent of SCO is produced via in situ methods (Alberta Energy Resources Conservation Board [ERCB] 2010), yielding a final mix of 50 percent in situ-produced dilbit, 44 percent mining-produced SCO, and 6 percent in situ-produced SCO.[26] The results are representative of near-term expected WCSB oil sands composition and GHG intensities.

The Canadian oil sands average from NETL (2009) is also plotted on Figure 4.15.3-5 for comparison with Jacobs (2009) and TIAX (2009), although the NETL result assumes a mix of 43 percent crude bitumen and 57 percent SCO. The NETL study did not account for the fact that condensate is blended with crude bitumen to form dilbit, which is transported via pipeline to U.S. refineries. Since condensate has a lower GHG intensity than crude bitumen, per-barrel GHG emissions from dilbit are less than per-barrel emissions from crude bitumen. The results show a 2 to 19 percent increase in WTW GHG emissions from gasoline produced from the weighted-average mix of oil sands crudes that may be transported in the proposed Project relative to the reference crudes in the near term. Heavier crudes generally take more energy to produce and emit more GHGs than lighter crudes, and in particular, the weighted-average WCSB oil sands crude is currently more energy- and carbon-intensive than lighter crudes like Middle Eastern Sour.

For illustrative purposes, Table 4.15-24 shows the incremental annual WTW GHG emissions associated with displacement of 100,000 barrels of each reference crude per day with WCSB oil sands crude oil using the weighted-average estimate for the mix of WCSB oil sands crudes that may be transported in the proposed Project.

[25] As described in Section 1.4, there is a significant difference in the projected percentage of that crude oil that would go to market as upgraded synthetic crude oil, 47 percent in the 2008 CAPP forecast, dropping to 28 percent in the 2012 CAPP forecast.

[26] Of in situ WCSB oil sands production from SAGD and CSS facilities, CSS accounts for 47 percent of production, and SAGD accounts for 53 percent. This ratio was used to calculate an average for in situ-produced dilbit for TIAX, which provided separate estimates for CSS and SAGD dilbit. Primary in situ production of WCSB bitumen (i.e., using conventional oil production techniques) was not included since estimates were not provided in the studies included in the scope of this assessment. Primary production currently accounts for 32.9 thousand cubic meters per day, or 14 percent of total oil sands production (ERCB 2010).

Table 4.15-24 Incremental Annual GHG Emissions of Displacing 100,000 Barrels per Day of Each Reference Crude with WCSB Oil Sands ($MMTCO_2e$[a]) by Study

Reference Crude	Jacobs 2009	TIAX 2009[b]	NETL 2009[a]
Middle Eastern Sour	1.3	2.0	2.5
Mexican Maya	0.5	1.6	1.7
Venezuelan[c]	0.4	0.5	2.4
U.S. Average (2005)	NA	NA	2.3

Note: The incremental annual GHG emissions presented here are calculated using internally consistent comparisons for each reference crude and the weighted average WCSB oil sands crude using information from each respective study. The incremental annual GHG emissions estimates for displacing the U.S. average (2005) reference crude is only provided for NETL (2009) because only NETL included a U.S. average reference. NA = Not Applicable.
[a] $MMTCO_2e$ = million metric tons of CO_2 equivalent.
[b] The NETL and TIAX studies allocate a portion of GHG emission to co-products other than gasoline, diesel, and jet fuel products, which are not accounted for in these estimates. As a result, incremental GHG emissions are underestimated for those studies.
[c] Venezuelan conventional crude values for NETL refer to a medium crude, not the heavy crude Venezuelan Bachaquero.

The incremental GHG emissions were calculated by first multiplying the WTW GHG emission intensities per barrel of gasoline and distillates (i.e., gasoline, diesel, and kerosene/jet fuel) for WCSB and reference crudes from each study by the volume of premium fuel products produced by 100,000 barrels of WCSB oil sands crude. WTW GHG emissions from each reference crude were then subtracted from the WTW GHG emissions from the equivalent volume of WCSB oil sands crude to estimate incremental GHG emissions. The 100,000 barrels of crude were converted to an equivalent volume of gasoline and distillate products using yield data provided in each respective study. As previously noted, these incremental GHG estimates provide an example of the potential effect, on a life-cycle basis, resulting from displacement of reference crude oils in PADD 3 refineries; on a global scale, the decision whether or not to build the proposed Project would not affect the extraction and combustion of WCSB oil sands crude on the global market (see Section 1.4, Market Analysis).

The incremental GHG emissions in Table 4.15-24 are compared against four different reference crude oils. To the extent that Middle Eastern Sour is the world balancing crude (i.e., the crude oil that would most likely be replaced by WCSB crude and backed out of the global market), it may ultimately be the crude that is backed out of the world market by WCSB oil sands crudes. From another perspective, if the proposed Project is built and the PADD 3 refineries continue using about the same input mix of heavy crudes as they currently use, Venezuelan Bachaquero or Mexican Mayan are likely to be displaced by WCSB oil sand crudes. Finally, NETL (2009) estimated the GHG emissions intensity of the average barrel of crude oil refined in the United States in 2005. The Jacobs and TIAX studies are not compared to this reference crude because they did not include a U.S. average estimate.

The three studies referenced in Table 4.15-24 used different methods to allocate GHG emissions between premium fuels (e.g., gasoline, diesel, and jet fuel) and other co-products (e.g., light and heavy ends, petroleum coke, sulfur). Jacobs (2009) attributes all GHG emissions associated with extracting, refining, and distributing other co-products to premium fuels;[27] thus, the incremental

[27] Jacobs (2009) also applies a substitution credit for offsetting other products that are replaced by each of the co-products. For example, the production and use of petroleum coke is assumed to offset GHG emissions from coal-fired electricity production.

GHG emissions shown for Jacobs (2009) in Table 4.15-24 take into account the production and use of these co-products.

As noted elsewhere in the Supplemental EIS, the near-term initial throughput of the proposed Project is projected to be 830,000 barrels of crude per day with 100,000 bpd supplied by Bakken crude production and the remaining 730,000 bpd supplied by the WCSB oil sands. However, assuming that the full 830,000 bpd capacity of the pipeline is used to transport only WCSB crude, and based on the results in the Jacobs (2009) study, incremental GHG emissions from the proposed Project would be 11.1 $MMTCO_2e$ if the oil sands crude oil transported by the proposed Project offset an equivalent amount of Middle Eastern Sour crude oil. Incremental emissions would be 4.4 $MMTCO_2e$ annually if oil sands crude oil offset Mexican Maya crude oil and 3.3 $MMTCO_2e$ annually if Venezuela Bachaquero crude oil were offset.

Unlike the Jacobs study, the TIAX and NETL studies allocate a portion of GHG emissions to co-products other than gasoline, diesel, and jet fuel products, and these emissions are not included in the studies' WTW GHG results. As a result, the incremental GHG emissions estimates for TIAX and NETL in Table 4.15-24 may underestimate total incremental GHG emissions.[28]

TIAX (2009) found that the change in refinery energy use associated with an incremental barrel output of co-products other than gasoline, diesel, and jet fuel contributed to less than one percent of energy use and GHG emissions per barrel of refined product at the refinery, so any error introduced by the underestimate of GHG emissions attributed to co-products is negligible. According to the results of the TIAX study, incremental GHG emissions from the portion of WCSB oil sands crudes transported by the proposed Project would be 16.7 $MMTCO_2e$ if oil sands crude oil offset an equivalent amount of Middle Eastern Sour crude oil. Incremental emissions would be 13.4 $MMTCO_2e$ and 4.0 $MMTCO_2e$ annually if oil sands crudes offset Mexican Maya and Venezuelan Bachaquero crude oil, respectively.

Based on the results of NETL (2009), incremental emissions from the portion of WCSB oil sands crudes transported by the proposed Project would be 20.8 $MMTCO_2e$ annually if oil sands crude oil offset an equivalent amount of Middle Eastern Sour crude oil. Incremental emissions would be 13.8 $MMTCO_2e$ and 19.5 $MMTCO_2e$ annually if oil sands crudes offset Mexican Maya and Venezuelan Bachaquero crude oil, respectively. Compared to the average barrel of crude refined in the United States in 2005, incremental emissions from oil sands crudes would be 18.7 $MMTCO_2e$ annually.

The effect of allocating a portion of the life-cycle GHG emissions of refining crude oils to other, non-premium co-products was larger in the NETL study than in either of the studies by Jacobs (which did not allocate any emissions to other co-products) or TIAX (which allocated less than 1 percent of GHG emissions at the refinery to other co-products). To estimate the magnitude of this effect, the NETL results for WCSB oil sands and the 2005 U.S. average crude oils were adjusted to include other product emissions modeled in NETL's analysis. The lead NETL study author was contacted to vet the approach used to make this adjustment in order to ensure that it

[28] Adjusting the TIAX and NETL GHG emission estimates to include co-products other than gasoline, diesel, and kerosene/jet fuel would require two pieces of information: 1) the GHG intensity of the other products, for both WCSB crudes and reference crudes, and 2) the yield of the other products, for both WCSB crudes and reference crudes. TIAX (2009) and NETL (2008) do not provide explicit emissions intensity factors or product yields in a format that enables separate emissions estimates to be developed for these products. These products largely comprise the remaining fractions of the input crude that cannot be converted into premium products.

was made consistently with the NETL study framework (Personal communication, Timothy Skone 2011). Adjusting the NETL results to include other product emissions could increase the differential in incremental emissions from WCSB oil sands compared to the 2005 U.S. average crude oils by roughly 30 percent.

The full range of incremental GHG emissions associated with the displacement of the reference crudes by the WCSB oil sands crude estimated from the quoted subset of studies is 3.3 to 20.8 $MMTCO_2e$ annually. This is equivalent to annual GHG emissions from fuels combustion in approximately 770,800 to 4,312,500 passenger vehicles or the CO_2 emissions from combusting fuels used to provide the energy consumed by approximately 190,400 to 1,065,400 homes for one year.[29]

Section 1.4, Market Analysis, concludes construction of the proposed Project is unlikely to have a substantial impact on the development rate of the WCSB oil sands, and that even when considering the incremental cost of non-pipeline transport options, should the proposed Project be denied, a 0.4 to 0.6 percent reduction in WCSB production could occur by 2030, and in the scenario of all pipeline projects not being built, a 2 to 4 percent decrease in WCSB oil sands production could occur. This infers that of the 3.3 to 20.8 $MMTCO_2e$ annual incremental GHG emissions, the proposed Project would be responsible for incremental GHG emissions in the range of 0.07 to 0.83 $MMTCO_2e$ annually, and in the scenario where all pipelines were not constructed, the incremental GHG emissions would be 0.35 to 5.3 $MMTCO_2e$ annually.[30] The differentials presented here are based on life-cycle emission estimates for current or near-term conditions in the world oil market, as can be seen from the reference years used in each report. Over time, however, the GHG emission estimates for fuels derived from both WCSB oil sands crude oils and the reference crude oils are likely to change.

GHG emissions from the production phase for reference crude oils may become more energy-intensive over time due to the need to extract oil from deeper reservoirs by using more energy-intensive secondary and tertiary recovery techniques, such as CO_2 flood. Many of the reference crude oil reservoirs are 1 to 2 miles (or more) underground or under the ocean floor and exploration efforts for new deep oil reservoirs would continue as known reservoirs continue to deplete.

In contrast, the extent of the WCSB oil sands deposits is well understood and defined, where the deposits are much shallower and can be extracted using either surface mining or near-surface in situ methods. In the future, in situ extraction methods are projected to represent a larger share of the overall oil sands production, increasing from about 45 percent of 2009 oil sands production to an estimated 53 percent by 2030 (ERCB 2010). In particular, the share of SAGD in situ extraction methods are projected to rise from roughly 18 percent in 2009 to 40 percent of oil sands production in 2030 (IHS CERA 2011).[31] The GHG profile of this more energy-intensive oil sands extraction method may be reduced by new technologies and innovations to reuse steam

[29] Equivalencies based on USEPA's GHG Equivalency calculator (USEPA 2012c).

[30] In 2010, U.S. GHG emissions totaled 6,821.8 $MMTCO_2e$ (excluding emissions/removals from Land use, land-use change, and forestry) (USEPA 2012b). In 2010, global CO_2 emissions from fuel combustion were 30,326 $MMCO_2e$ (IEA 2012).

[31] Although the balance of mining and in situ extraction would change in the future, there are incentives for producers to keep GHG intensity as low as possible. For example, Alberta's climate policy requires that oil sands producers and other large industrial GHG emitters reduce their emissions intensity by 12 percent from an established baseline.

onsite and/or improve thermal recovery. However, surface mining is projected to remain a significant extraction method for WCSB crude oils for the next 20 years (IHS CERA 2010, 2011). Considering these factors, GHG intensity for future reference crude oils may trend upward while the GHG intensity for WCSB oil sands-derived crude oils may be relatively constant to slightly upward. If this is the case, the differential in life-cycle GHG emissions for fuels refined from these crude oils may decrease.

Conclusions

The studies show conclusively that combustion (i.e., tank-to-wheels) phase of the fuel life-cycle dominates the total GHG life-cycle emissions under all scenarios. Overall, it is clear that comparisons of GHG life-cycle emission estimates for fuels derived from different sources are sensitive to the choice of boundaries, consistent application of boundary conditions within studies, and to key input parameters. In particular, the results depend on assumptions regarding the uses of petroleum coke at oil sands facilities and at U.S. refineries, and upon the weighted-average mix of WCSB oil sands crude transported to the United States by the proposed Project or some other transboundary pipeline. SAGD and CSS in situ production methods are generally more GHG-intensive than mining, and while SCO requires upgrading prior to pipeline transport, bitumen blends such as dilbit and synbit require additional refining emissions and do not produce an equivalent amount of premium fuel products per barrel input.

Despite the differences in study design and input assumptions, it is clear that WCSB crudes, as would likely be transported through the proposed Project, are on average somewhat more GHG-intensive than the crudes they would displace in the U.S. refineries. As discussed in Section 1.4, Market Analysis, there would be no substantive change in global GHG emissions and, as explained in Section 4.15.3, Cumulative Impacts by Resource, there would likely be no substantial change in WCSB imports to PADD 3 with or without the proposed Project in the medium to long-term, the life-cycle GHG emissions associated with transportation fuels produced in U.S. refineries would increase if WCSB crude oils replace existing heavy crude oil sources for PADD 3.

It is also noted that the GHG intensity of reference crudes may increase in the future as more of the world crude supply requires extraction by increasingly energy intensive tertiary and enhanced oil recovery techniques,[32] although the latter can be in part act as a sequestration method. The energy intensity of surface-mined Canadian crudes would likely be relatively constant while higher energy intensive in situ production may increase somewhat; the proportion of in situ extraction is forecast to increase relative to the less energy-intensive surface mining. Although there is some uncertainty in the trends for both reference crudes and oil sands derived crude oils, on balance the gap in GHG intensity is likely to decrease over time.

[32] As with the producers of oil sands, however, in some cases producers of reference crudes are likely to face regulatory pressures or other incentives to lower the GHG intensity of their production process. Such a dynamic would counter the trend toward higher GHG intensities.

GHG Mitigation

The Government of Alberta has worked to mitigate and reduce the GHG emissions associated with oil sands production. In 2008, the Government of Alberta revised its Climate Change Strategy which aims to reduce 200 $MMTCO_2e$ of GHG emissions by 2050.[33] The strategy focuses three main policy initiatives as follows:

- First, the Climate Change and Emissions Management Act, enacted in 2003, establishes mandatory annual GHG intensity reduction targets for large industrial GHG emitters. Those emitters that fall short can either purchase credits from other companies that have reduced their emissions, or pay $15 for every metric ton of CO_2e above their target into a government-run clean energy technology fund (Government of Alberta 2010a).
- Second, the Government of Alberta has dedicated $1.55 billion to fund three large-scale CCS projects. Of these three projects, one involves oil sands producers. This project is expected to reduce 15.2 million metric tons of CO_2e per year (Government of Alberta 2012).
- Third, the funds collected as part of the Climate Change and Emissions Management Act are placed in the Climate Change and Emissions Management Fund, which is dedicated to investing in clean energy projects (Government of Alberta 2011a). In 2011 companies paid $55.4 million into the fund (Government of Alberta 2011b). Several projects selected for funding in 2011 focus on energy efficiency improvements and cleaner energy production at oil sands production facilities (Climate Change and Emissions Management Corporation 2010). CCS is expected to contribute 70 percent of the reductions, conservation and efficient energy use would contribute to 12 percent reduction, and greening energy production would contribute 18 percent (Government of Alberta 2008). Other GHG mitigation policy proposals could establish some form of broad fiscal or regulatory national GHG reduction policy that would incentivize or regulate lower GHG emissions from oil sands operations and other sectors of the economy. Canada is committed to meeting its emission reduction target under the Cancun Agreements of 17 percent below 2005 levels by 2020 using various approaches including provincial carbon taxes, cap and trade, feed-in tariffs, and regulatory approach by sector. Federal oil and gas sector GHG regulations are under development and draft regulations are expected in 2013. Additionally the Government of Canada is working with Alberta on a Joint Canada-Alberta implementation plan for oil sands monitoring which commits both governments to implement scientifically rigorous and comprehensive environmental monitoring programs (United Nations [UNFCC] 2012).

4.15.3.13 Potential Releases

The potential for cumulative impacts associated with the unintended operational releases from the proposed Project are addressed qualitatively because effects are heavily dependent upon how large the spills would be and where they might occur. Small to medium spills (up to 1,000 barrels), would more likely occur on construction sites or at operations and maintenance facilities, where in general, surface spreading is contained and infiltration into the ground

[33] In addition to mitigation initiatives, it is also worth noting that in September 2012 the Environmental ministers for Canada and Alberta together announced a joint environmental monitoring system of oil sands production that would include, among others, increased frequency of monitoring in the oil sands region, a doubling of the number of monitoring stations, and making data publicly available.

reduced by responders that are at these locations. For medium to large spills (greater than 1,000 barrels), the response time between the spill event and arrival of the response contractors would influence potential magnitude of impacts to environmental resources. Once the responders are at the spill scene, the efficiency, effectiveness, and environmental sensitivity of the response actions (e.g., containment and cleanup of oil, protection of resources from further oiling) would substantively influence the type and magnitude of potential additional environmental impacts.

Oil and hazardous materials spills as well as any inadvertent releases are a concern for fisheries habitats along the pipeline. Fish and aquatic invertebrates could experience toxic impacts of spilled oil, and the potential impacts would generally be greater in standing water habitats (e.g., wetlands, lakes, and ponds) than in flowing rivers and creeks. Also, in general, the impacts would be lower in larger rivers and lakes and much lower under flood conditions since the toxic hydrocarbon concentrations would likely be relatively rapidly diluted. Even when major fish kills have occurred as a result of oil spills, population recovery has been observed and long-term changes in fish abundance have not been reported (Kubach 2011); therefore, impacts of oil spills on fisheries resources is not expected to contribute significantly to cumulative effects.

Despite the uncertainty associated with the prediction of potential impacts from spills, historical pipeline incident data on existing crude oil pipelines indicate that impacts are typically localized, with short- and long-term effects to resources. If multiple spills occurred concurrently (geographically and temporally) in a region with a high density of oil pipeline routes and associated facilities, cumulative effects could occur to shallow groundwater and surface water resources, aquatic and/or terrestrial habitats, and wildlife. As shown in Figure 4.15.2-2 and 4.15.2-3, the southeastern region of Montana and the Steele City, Nebraska, area are candidate areas for cumulative impacts associated with concurrent spills. Larger spills could cause both local and regional disruption of human uses, as well as local and regional impacts to biological populations and communities. However, the effects would still be expected to diminish over time, and would not be expected to have permanent effects to resources, ecosystems, and human communities. Furthermore, the combined implementation of industry standards and practices, combined with design standards and the addition of the Special Conditions developed by the PHMSA and agreed to by Keystone, aid in reducing the potential for spill incidents associated with the proposed Project.

4.15.4 Extraterritorial Concerns

While the proposed Project analyzed in this Supplemental EIS begins at the international boundary where the pipeline would exit Saskatchewan, Canada, and enter the United States through Montana, the origination point of the pipeline system would be in Alberta, Canada. Neither NEPA nor Department regulations (22 CFR 161.12) nor Executive Orders 13337 and 12114 (Environmental Effects Abroad of Major Federal Actions) legally require that this Supplemental EIS include an analysis of the environment or activities outside of the United States. As a matter of policy, and in response to concerns that the proposed Project would contribute to certain continental scale environmental impacts, the Department has included a summary of information regarding environmental analyses and regulations related to the Canadian portion of the proposed Keystone XL Project and WCSB oil sands production. This section addresses 1) the Canadian National Energy Board (NEB) environmental analysis of the Keystone XL Project in Canada, 2) the potential influence of the proposed Project on oil sands development in Canada, 3) a summary of environmental impacts of oil sands development in

Alberta, and 4) protections for Canadian and U.S.-shared Migratory Bird and Threatened and Endangered Species resources.

4.15.4.1 Canadian National Energy Board Environmental Analysis of the Proposed Project

The analysis of the environmental effects of the overall proposed Project has been in progress on both sides of the international border under appropriate regulatory authorities (Appendix X, Canadian Environmental Assessment Act). In Canada, the NEB conducted that analysis, held public hearings in September 2009, and issued its findings in March 2010. The NEB identified the nine key issues listed below relative to the proposed Keystone XL Project:

- The need for the proposed facilities;
- The economic feasibility of the proposed facilities;
- The potential commercial impacts of the proposed project;
- The potential environmental and socioeconomic effects of the proposed facilities, including those to be considered under the Canadian Environmental Assessment Act (Appendix W, Canadian Environmental Assessment Act);
- The appropriateness of the general route of the pipeline;
- The method of toll and tariff regulation;
- The suitability of the design of the proposed facilities;
- The terms and conditions to be included in any approval the NEB may issue; and
- Potential impacts of the project on aboriginal interests.

Relative to impacts to aboriginal or indigenous peoples, the NEB granted intervener status to the following aboriginal groups in Canada:

- Moosomin First Nation;
- Neekaneet First Nation No. 380;
- Red Pheasant Band No. 108; and
- Sweetgrass First Nation.

In the March 2010 finding, the NEB determined that the proposed Keystone XL Project is required in Canada to meet the present and future public convenience and necessity, provided that the NEB terms and conditions presented in the project certificate are met, including all commitments made by Keystone during the hearing process. Pertinent NEB documents are provided in Appendix X, Canadian Environmental Assessment Act.

4.15.4.2 Influence of the Proposed Project on Oil Sands Development in Canada

As stated in Section 1.4, Market Analysis, approval or denial of any one crude oil transport project, including the proposed Project, remains unlikely to significantly impact the rate of extraction in the oil sands, or the continued demand for heavy crude oil at refineries in the U.S. Limitations on pipeline transport would force more crude oil to be transported via other modes of transportation, such as rail, which would probably (but not certainly) be more expensive. Longer term limitations also depend upon whether pipeline projects that are located exclusively in

Canada proceed (such as the proposed Northern Gateway, the Trans Mountain expansion, and the TransCanada proposal to ship crude oil east to Ontario on a converted natural gas pipeline).

If all such pipeline capacity were restricted in the medium-to-long-term, the incremental increase in cost of the non-pipeline transport options could result in a decrease in production from the oil sands, perhaps 110,000 to 220,000 barrels per day (bpd) (approximately 2 to 4 percent) by 2030. If the proposed Project were denied but other proposed new and expanded pipelines go forward, the incremental decrease in production could be approximately 17,000 to 30,000 bpd (from 0.4 to 0.5 percent of total WCSB production) by 2030.

In addition to the existing transport capacity into the United States, there would likely be market demand to put in place pipeline capacity into the United States similar to that of the proposed Project, including pipeline capacity to PADD 3. Also Canadian producers are actively seeking to develop alternative crude oil markets worldwide, including efforts to develop necessary transportation facilities to allow shipment of WCSB crude oil to British Columbia and onward to Asia, or eastward to Atlantic coast ports for marine shipment would continue. Other countries that would likely represent markets for WCSB crude oil are primarily located in Asia; those nations are experiencing increased demand for crude oil and are currently heavily dependent on OPEC for their supplies. In recent years, Chinese investment in WCSB crude oil production has greatly accelerated. Various pipeline projects have been proposed to transport crude oil from Alberta to the Canadian west coast, although they currently face significant opposition in the regulatory process (see Section 1.4, Market Analysis).

4.15.4.3 Environmental Effects of Oil Sands Development in Alberta

Many commenters on the Draft EIS and Supplemental Draft EIS documents prepared for the previously proposed project expressed concerns about impacts in western Canada related to the extraction of crude oil from oil sand deposits in the provinces of Alberta and Saskatchewan, Canada. Additionally, there has been much controversy over environmental impacts to wildlife, boreal forests, threatened and endangered species, and water resources related to oil sands production. Evaluation of impacts from extraction of crude oil from the oil sands is outside of the scope of analysis legally required under NEPA. Further, it is not expected that the proposed Project would have any impact on the rate of development of extraction in Canada. However, in response to comments and as a policy decision, a summary of general regulatory oversight and environmental impacts in Canada related to oil sands production has been included.

Government regulators of oil sands activities in Canada are working to manage and provide regional standards for air quality, land impact, and water quality and consumption based on a cumulative effects approach. Oil sands environmental regulations are administered by federal and provincial governments including the Ministry of the Environment, the Canadian Environmental Assessment Agency (which administers the Canadian Environmental Assessment Act), the Alberta Department of Environment, and the Alberta Department of Sustainable Resource Development. Oil sands deposits are located primarily in Alberta, but also extend into Saskatchewan. The Canadian Government and the Government of Alberta have a cooperative agreement to minimize regulatory overlap (the Canada-Alberta Agreement for Environmental Assessment Cooperation). Oil Sands development projects undergo an environmental review under Alberta's Environmental Protection and Enhancement Act and the Water Act, as well as the CEA and the Species at Risk Act (SARA). Other federal and provincial agencies may participate in the review as Responsible Authorities or as Federal Authorities with specialist advice.

In early April 2011, the Government of Alberta announced that it had prepared a draft development plan for the Lower Athabascan oil sands region. The plan would require cancellation of about 10 oil sands leases, set aside nearly 20,000 square kilometers (7,700 square miles) for conservation, and set new environmental standards for the region in an effort to protect sensitive habitat, wildlife, and forest land. On August 22, 2012, the Government of Alberta approved the Lower Athabasca Regional Plan. It became effective on September 1, 2012.

Bitumen, a heavy oil extract, is recovered from oil sands by either in situ (in place) recovery or surface mining. Most (80 percent) bitumen is recovered using in situ techniques that use SAGD to pump steam underground through a horizontal well to liquefy the bitumen, which is recovered by an extraction well. In situ recovery is less disturbing to the land surface than surface mining and does not require tailings ponds. Oil sands underlie 140,200 square kilometers ($km^{2)}$ (54,132 square miles [mi^2]) in three areas of northeast Alberta of which 602 km^2 (232 mi^2) has been disturbed by surface mining activity. Surface mining requires an open pit, similar to many coal, iron ore, copper, and diamond mines. Mined oil sands are then transported to a cleaning facility where they are mixed with hot water to separate the oil from the sand. There were 100 active oil sands projects in Alberta as of November 2011. Of these, six mining projects have been approved; five of these projects are currently producing bitumen (Government of Alberta—Energy 2012b).

The human footprint within Alberta's boreal forest natural region includes: 12 percent agriculture, 3 percent forestry, 2 percent energy, and 1 percent transportation infrastructure, leaving 82 percent of the region with no human footprint (Alberta Biodiversity Monitoring Institute [ABMI] 2009). The human footprint within the Alberta-Pacific Forest Industries Forest Management Agreement Area (Al-Pac FMA), a 57,331 km^2 (22,136 mi^2) area centered on the Athabasca oil sand deposit, includes: 4 percent forestry, 2 percent energy, and 1 percent transportation infrastructure, leaving 93 percent with no footprint (ABMI 2009). Cumulative impacts from oil sands development include GHG emissions and land surface alteration. Land surface alteration includes mine sites, tailings ponds, well sites, industrial roads, pipelines, power lines, seismic cut lines, and facilities. Biodiversity indicators evaluate ecosystem intactness or the proportion of human disturbance by assessing when common species become rare or disappear and when weedy or invasive species become common. Intactness indices for the Al-Pac FMA indicate:

- Intactness for 12 old-forest birds ranged from 96 to 100 percent with 7 of 12 old-forest birds less abundant than expected;
- Intactness for 11 winter-active mammals ranged from 89 to 100 percent with 3 of 11 winter-active mammals less abundant than expected;
- Percent occurrence of 16 non-native weeds ranged from 2 to 28 percent with non-native weeds detected across 39 percent of the Al-Pac FMA;
- For 4 of 17 species at risk that were evaluated, intactness was 97 or 98 percent, and 3 of the 4 species were less abundant than expected (the monitoring system is not designed to evaluate the other 13 species at risk);
- Intactness for four old-forest habitats ranged from 91 to 95 percent and for all old-forest habitats was 92 percent; and
- Intactness for live trees was 97 percent, for snags (standing deadwood) was 95 percent, and for downed deadwood was 98 percent (AMBI 2009).

The following cumulative statistics related to environmental effects from oil sands development in Alberta are derived from the records of the province of Alberta (Government of Alberta 2010b):

- Alberta's oil sands account for about 5 percent of Canada's overall GHG emissions and Canada is responsible for about 2 percent of global emissions;
- Oil sands mining projects have reduced GHG emissions intensity by an average of 39 percent between 1990 and 2008 and are working toward further reductions;
- All existing and approved oil sands projects may withdraw no more than 3 percent of the average annual flow of the Athabasca River (2008 usage was 0.7 percent of the long-term average annual flow);
- Water use by oil sands mining operations continues to decrease, despite significant increases in production;
- Many in situ projects recycle up to 90 percent of the water used in their operations, and use deep-well saline water as an alternative to freshwater wherever possible;
- Long-term air quality monitoring since 1995 shows improved or no change in CO, ozone, fine particulate matter, and SO_2, and an increasing trend in NO_2;
- Air quality in the oil sands region is rated good 95 percent of the time;
- Tailings (water, fine silts, left-over bitumen, salts and soluble organic compounds) ponds are constructed with groundwater seepage-capture facilities, and are closely monitored;
- Tailings settling ponds are designed and located after environmental review and bird deterrents are used to prevent birds from landing on tailings ponds;
- Currently, processing 1 tonne (1.1 tons) of oil sand produces about 94 liters (25 gallons) of tailings;
- About 602 km^2 (232 mi^2) have been disturbed by oil sands mining activity of which 67 km^2 (26 mi^2) has been or is in the process of reclamation (mine operators must provide a reclamation security bond);
- Alberta's boreal forest covers 381,000 km^2 (147,100 mi^2) of which the maximum area available for oil sands mining is 4,800 km^2 (1,854 mi^2) or about 1.25 percent of Alberta's boreal forest area;
- Alberta has committed to a cumulative effects approach that looks at potential impacts of all projects within a region; and
- The Alberta Land Stewardship Act supports the Land-use Framework, which includes province-wide strategies for establishing monitoring systems, promoting efficient use of lands, reducing impact of human activities and including aboriginal people in land-use planning.

With respect to potential impacts of oil sands development in Alberta on freshwater ecosystems, a joint study by the Queen's University in Kingston, Ontario and Environment Canada was published online in early January 2013 in the Proceedings of the National Academy of Sciences of the United States of America (PNAS) Early Edition that examined the effect of Athabasca Oil Sands development on lake ecosystems. The study found evidence of local industrial

contributions of Polycyclic Aromatic Hydrocarbons (PAHs) in aquatic ecosystems in the Athabasca oil sands region and concluded that atmospheric deposition of PAHs from upgrader emissions and unweathered bitumen dust from surface mining areas are likely major sources of PAHs entering regional aquatic ecosystems. The study concluded that the ecological consequences of increased PAH loadings to lakes in the region are unknown and require further assessment. In addition, the primary ecological changes noted in the lakes, increased primary production and shifts in targeted zooplankton assemblages, were attributed to 20th century climate change, and the study noted that increased PAH loadings have not yet resulted in decreases in the relative abundance of the targeted zooplankton evaluated in this study.

4.15.4.4 Protected Bird Species in Canada

Oil sands projects and oil transportation pipelines are evaluated and permitted by Canadian federal and provincial Canadian governments. Canada's version of the Migratory Bird Treaty Act is called the Migratory Bird Convention Act (MBCA). Both the U.S. and Canadian acts are based on the Migratory Birds Convention treaty signed in 1916 by the United States and the United Kingdom (on behalf of Canada). The Canadian Wildlife Service handles wildlife matters that are the responsibility of the Canadian federal government. Canadian regulations supporting the MBCA are available at http://laws.justice.gc.ca/en/M-7.01/C.R.C.-c.1036/. In addition, Canada's rare and endangered migratory birds are protected under the SARA (see http://www.sararegistry.gc.ca/default_e.cfm). Canadian protections for migratory birds are parallel to U.S. migratory bird protections. Canada also provides for protection of migratory bird habitat within government-recognized sanctuaries. Recent losses of migratory birds at WCSB oil sands tailings ponds have been cited as violations of the MBCA and have been prosecuted by the Canadian government.

Bird resources (waterfowl, waterbirds, shorebirds, and landbirds) are shared on a continental scale. The Tri-National North American Bird Conservation Initiative Committee was established to increase cooperation and effectiveness of bird conservation efforts among Canada, the United States, and Mexico. Partnership-based bird conservation initiatives have produced national and international conservation plans for birds that include species status assessments, population goals, habitat conservation threats, issues and objectives, and monitoring needs. Multi-national North American bird conservation plans include the North American Waterfowl Management Plan, North American Landbird Conservation Plan, United States and Canadian Shorebird Conservation Plans, Waterbird Conservation for the Americas, North American Grouse Management Strategy, and Northern Bobwhite Conservation Initiative. At the request of the Department, Keystone provided a synopsis of the TransCanada Corporation's participation in North American migratory bird conservation efforts.

The Partners in Flight conservation assessment concluded that nearly half of native landbirds in Canada, Mexico, and the United States depend on habitats in at least two of the countries and more than 200 species (more than 80 percent of all individual landbirds) use habitats in all three countries in at least one season (Berlanga et al. 2010). The landbird assessment identified 148 bird species in need of immediate conservation attention because of highly threatened and declining populations. The most imperiled species include 44 species with very limited distribution, mostly in Mexico, that are at greatest risk of extinction; 80 tropical residents dependent on deciduous, highland, and evergreen forests in Mexico; and 24 species that breed in temperate-zone forests, grasslands, and arid land habitats (Berlanga et al. 2010). Steep declines in 42 common bird species have occurred over the past 40 years with the majority of steeply

declining species breeding in the northern United States and southern Canada, and wintering in the southern United States and Mexico (Berlanga et al. 2010). Declining bird populations face a diversity of threats on breeding grounds from land-use policies and practices related to agriculture, livestock grazing, urbanization, energy development, and logging (Berlanga et al. 2010). Migratory species are threatened on their wintering grounds by loss of grasslands in northern Mexico and tropical forests in southern Mexico (Berlanga et al. 2010).

Oil sands development alters habitats through land surface alteration including: mine sites, tailings ponds, well sites, industrial roads, pipelines, power lines, seismic cut lines, and facilities. These land alterations reduce both the amount and the suitability of adjacent habitat available for migratory birds. Project components such as roads and power lines increase migratory bird collision mortality. Tailings ponds contain residual bitumen and are an exposure risk especially for migratory waterbirds. Alberta's oil sands lease areas cover about 21 percent of the 418,325 mi^2 Boreal Taiga Plains Bird Conservation Region (Government of Alberta—Energy 2010, U.S. NABCI Committee 2000). One hundred seventy migratory birds (49 waterbirds, 121 landbirds) have been recorded on 19 breeding bird survey routes concentrated within the southern portions of the leased area (Sauer et al. 2011, Government of Alberta—Energy 2010). Population trends for 9 of these 49 waterbirds and 29 of these 121 landbirds experienced significant declines within the Boreal Taiga Plains Region from 1999 to 2009; while nearly 70 percent of these birds showed no significant population trends (Sauer et al. 2010). Waterbirds and landbirds of moderate to high conservation concern present in the oil sands lease area based on the breeding bird survey data are listed in Table 4.15-25 (Kushlan et al. 2002, Berlanga et al. 2010, Brown et al. 2001, Sauer et al. 2011).

Table 4.15-25 Waterbirds and Landbirds of Conservation Concern Present in Alberta's Oil Sands Lease Areas

Common Name	Species Name	1999-2009 Trend	Relative Abundance	Average Birds/Route
Waterbirds				
Eared grebe	*Podiceps nigricollis*	NS +	4.0	0.93
Western/Clark's Grebe	*Aechmophorus spp.*	NS +	0.2	1.42
American White Pelican	*Pelecanus erythrorhynchos*	NS +	6.4	1.88
Brack-crowned Night-heron	*Nycticorax nycticorax*	UK	UK	0.17
Killdeer	*Charadrius vociferus*	-3.3	5.0	2.95
American Avocet	*Recurvirostra americana*	NS +	0.4	0.44
Greater Yellowlegs	*Tringa melanoleuca*	NS -	0.1	0.45
Lesser Yellowlegs	*Tringa flavipes*	-5.4	1.1	0.84
Solitary Sandpiper	*Tringa solitaria*	NS +	0.1	1.10
Willet	*Catoptrophorus semipalmatu*	NS -	0.2	0.91
Upland Sandpiper	*Bartramia longicauda*	NS +	0.1	0.17
Marbled Godwit	*Limosa fedoa*	NS +	0.5	0.81
Common Snipe	*Gallinago gallinago*	NS +	15.3	4.86
Wilson's Phalarope	*Phalaropus tricolor*	NS -	0.3	0.70

Common Name	Species Name	1999-2009 Trend	Relative Abundance	Average Birds/Route
Franklin's Gull	*Larus pipixcan*	-6.0	UK	34.51
California Gull	*Larus californicus*	NS -	11.7	1.77
Forster's Tern	*Sterna forteri*	NS +	0.3	0.25
Black Tern	*Chlidonias niger*	-1.6	11.1	8.16
Landbirds				
Olive-sided Flycatcher	*Contopus cooperi*	-2.8	0.9	0.53
Sprague's Pipit	*Anthus spragueii*	NS +	0.9	0.59
Canada Warbler	*Wilsonia canadensis*	NS +	0.5	3.93
Chestnut-collared Longspur	*Calcarius ornatus*	UK	UK	0.07

Source: Government of Alberta - Energy 2010, Sauer et al. 2011, Kushlan et al. 2002, Berlanga et al. 2010, Brown et al. 2001

Notes: 1999-2009 Population Trends in the Boreal Taiga Plains Bird Conservation Region: NS + = non-significant positive, NS - = non-significant negative, UK = unknown, numeric values are significant trends.
Numeric scale rating for relative abundance within the Boreal Taiga Plains 0 = least abundant
Average number of birds recorded for the 19 routes within the lease area

Oil sand operations are required to have plans to minimize their effects on wildlife and biodiversity, and Alberta's government monitors and verifies that industry adheres to these plans. Alberta's Biodiversity Monitoring Institute collects data and reports on thousands of species, habitats, and human footprint activities for evaluating changes to achieve responsible environmental management in the oil sands area. Techniques used to minimize impacts to migratory birds include: restricting industrial activity during nesting; maintaining the integrity of large river corridors for migration staging; restoring land in key habitat areas; deterring birds from industrial areas; reducing industrial footprints and use of low impact technology for seismic exploration; and constructing nesting sites to replace lost natural sites (Government of Alberta 2011c).

Neither Section 7 of the ESA nor the Section 7 consultation and analysis process under ESA implementing regulations address species outside the borders of the United States, and nothing in the language of Section 7 indicate that it would apply extraterritorially. Shared species currently covered by both the ESA and the Canadian SARA that could potentially occur within the U.S. and Canadian portions of the proposed Project are listed in Table 4.15-26.

Table 4.15-26 Federally Protected Bird Species of the Proposed Project

Common Name	Scientific Name	Status U.S./Status Canada	Preliminary Findings (U.S.)	Evaluation (Canada)
Piping Plover	*Charadrius melodus*	Threatened/Endangered	NLAA	NS
Whooping Crane	*Grus americana*	Endangered/Endangered	NLAA	Not Evaluated
Greater Sage Grouse	*Centrocercus urophasianus*	Candidate/Endangered	NLAA	NS
Sprague's Pipit	*Antus spragueii*	Candidate/Threatened	NLAA	NS

NLAA = may affect, not likely to adversely affect species
NS = effects not significant

Conservation measures developed to reduce impacts to these species for the proposed Project are described in Section 4.8, Threatened and Endangered Species and Species of Conservation Concern, and the 2012 BA, provided in Appendix H. Two U.S. federal candidate species (Greater sage-grouse [*Centrocercus urophasianus*] and the Sprague's pipit [*Antus spragueii*]) occurring in Montana and South Dakota are not yet eligible for protection under the ESA but are protected under Canada's SARA (Table 4.15-26). Required mitigation, including seasonal restrictions, to minimize impacts of the proposed Project to SARA-protected species is available in Appendix X, Canadian Environmental Assessment Act.

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