

4.1 GEOLOGY

4.1.1 Introduction

This section describes potential impacts to geological resources associated with the construction and operation of the proposed Project and connected actions and discusses potential mitigation measures that would avoid or minimize the potential impacts. The information, data, methods, and/or analyses used in this discussion are based on information provided in the 2011 Final Environmental Impact Statement (Final EIS) as well as new circumstances or information relevant to environmental concerns that have become available since the publication of the Final EIS, including the proposed reroute in Nebraska. The information that is provided here builds on the information provided in the Final EIS, and in many instances replicates that information with relatively minor changes and updates. Other information is entirely new or substantially altered from that presented in the Final EIS. Specifically, the following items have been substantially updated from the 2011 document related to impacts to geological resources:

- A new section, Section 4.1.2, Impact Assessment Methodology, was added to explain the assessment methodology used to evaluate potential geologic impacts associated with the proposed Project;
- Impacts to paleontological resources have changed due to the availability of results from additional field surveys that were conducted in 2011 and 2012 in Montana and South Dakota;
- The discussion of procedures to minimize and mitigate adverse effects of pipeline construction activities on significant paleontological materials has been expanded;
- The number of miles identified with the potential for rock ripping has been changed due to the proposed Nebraska reroute; and
- Additional discussion about the Bakken Marketlink connected action has been incorporated in the context of mineral and fossil fuel resources.

4.1.2 Impact Assessment Methodology

The impacts of the proposed Project on the geological resources are evaluated using a combination of quantitative and qualitative methods, including the following:

- Qualitative evaluation of the effects of the proposed Project on the surficial and bedrock geology;
- Calculation of areas along the proposed pipeline route that may require rock ripping for the construction of the proposed pipeline;
- Calculation of the distance of the proposed pipeline route to nearby fossil fuel and mineral resources and its direct effect to the resource or indirect effect to the accessibility to the resource;
- Evaluation of the effects of the proposed Project to fossil-bearing geologic formations and paleontological resources; and
- Evaluation of the risks that a geology hazards found along the proposed pipeline route may have to the proposed pipeline.

4.1.3 Potential Impacts

4.1.3.1 Geological Resources

Construction

Most of the proposed Project route passes through areas where bedrock is buried under unconsolidated sediments consisting of glacial till, alluvium, colluvium, loess, and/or aeolian deposits. In these areas, impacts to bedrock would be expected to be minimal and limited to areas where bedrock is within 8 feet of the surface, which reflects the typical maximum depth of trench excavation.

Rock ripping (the break up and removal of rock material with an excavator) could be necessary where dense material, paralithic bedrock, abrupt textural change, or strongly contrasting textural stratification is present within 8 feet of the ground surface. Approximately 202 miles of the proposed Project route would cross areas identified as potential ripping locations. Table 4.1-1 summarizes the approximate locations of expected ripping operations by state, county, and approximate milepost.

Table 4.1-1 Potential Ripping Locations for the Proposed Project^a

Milepost Range	State	County	Length (miles)
10.96–18.73	Montana	Phillips	1.23
25.82–57.59	Montana	Valley	3.31
90.26–156.74	Montana	McCone	19.30
156.74–197.13	Montana	Dawson	9.45
197.85–218.06	Montana	Prairie	6.40
218.54–282.67	Montana	Fallon	19.67
282.83–354.31	South Dakota	Harding	35.94
355.07–358.10	South Dakota	Butte	1.03
358.1–373.36	South Dakota	Perkins	13.94
373.36–424.61	South Dakota	Meade	30.86
426.26–426.28	South Dakota	Pennington	0.02
426.28–484.45	South Dakota	Haakon	17.76
485.29–523.42	South Dakota	Jones	25.50
530.94–536.83	South Dakota	Lyman	2.05
537.56–596.84	South Dakota	Tripp	15.26
871.49–871.53	Nebraska ^a	Jefferson	0.04
871.62–871.69	Nebraska ^a	Jefferson	0.07
872.11–872.22	Nebraska ^a	Jefferson	0.11
872.27–872.32	Nebraska ^a	Jefferson	0.05
Proposed Project Total			201.99

^a Shallow bedrock areas (<60 inches) taken from the SSURGO Soils Database (USDA 1932).

Additionally, at 14 major river crossings, horizontal directional drilling would be employed to install the proposed pipeline, requiring depths greater than 8 feet and thereby impacting additional bedrock. These major river crossings include four planned in Montana, five in South Dakota, and five in Nebraska. At other river and stream crossings, the proposed pipeline would be buried under at least 5 feet of cover for at least 15 feet on either side of the bank-full width. Rock ripping and the installation of the pipeline at some river crossings would involve some disturbance and modification of the surficial geology, but would not have substantive impacts to geology. For additional information on stream crossings, see Section 4.3, Water Resources.

Some areas within Montana, South Dakota, and Nebraska do not have sufficient temporary housing in the vicinity of the proposed pipeline route to house all construction personnel working in those areas. As such, temporary work camps would be constructed to meet the housing needs of the construction workforce in these remote locations. Potential impacts to geological resources during the construction of these camps would be negligible.

Operation and Maintenance

Routine pipeline operation and maintenance activities would not be expected to affect physiography or bedrock geology. The depth to the bottom of the pipeline is, on average, between 7 and 8 feet below ground surface, which is below the frost line along the proposed route. The frost line is not expected to impact the operation of the pipeline.

4.1.3.2 Paleontological Resources

Construction

Excavation activities, erosion of fossil beds exposed due to grading, and unauthorized collection can damage or destroy paleontological resources during construction. Because fossils might be discovered during trench excavation, a Paleontological Monitoring and Mitigation Plan would be prepared by TransCanada Keystone Pipeline, LP (Keystone) prior to construction on federal and certain state and local government lands. Fossils or other paleontological resources found on private land would only be recovered with approval of the landowner, and, therefore, may be unavailable for scientific study. In addition, appropriate regulatory agencies in each state would be consulted on the requirements for the Paleontological Monitoring and Mitigation Plan prior to excavation.

According to the guidelines provided in the Potential Fossil Yield Classification (PFYC) system, there are various mitigation measures that may be applied to geological units where the concern for paleontological resources is moderate to very high. These measures could include such actions as monitoring of excavations during construction to identify the presence of completely buried subsurface fossils, periodic spot-checking of impacts to significant fossils during construction activities, or avoidance of disturbance to the fossil-bearing unit of potential impact. Collaboration between land managers and knowledgeable researchers would be necessary to determine the appropriate action during construction of the proposed route.

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. This law requires the Secretaries of the Interior and Agriculture to manage and protect paleontological resources on lands under their jurisdiction using scientific principles and expertise. The Act affirms the authority for many of the policies the agencies already have in

place such as issuing permits for collecting paleontological resources, curation of paleontological resources, and confidentiality of locality data. The statute also establishes criminal and civil penalties for fossil theft and vandalism on federal lands.

Both Montana and South Dakota have enacted legislation to manage and protect paleontological resources on state-managed lands. In Montana, a certificate of compliance under the Major Facilities Siting Act would be required from Montana Department of Environmental Quality (MDEQ) prior to construction of the proposed pipeline. MDEQ has the authority to require mitigation actions when significant paleontological resources are inadvertently discovered on any lands (i.e., public and privately owned land). The requirements are set forth in the document entitled Conditional Requirements for the Treatment of Inadvertently Discovered Significant Paleontological Resources for the Keystone XL Pipeline. The requirements are designed to minimize and mitigate the adverse effects of pipeline construction activities on significant paleontological materials. The Montana Antiquities Act, as amended (1995), requires the Department of Natural Resources and Conservation and other state agencies to avoid or mitigate damage to important paleontological resources (when feasible) on state trust lands. The Montana Department of Fish, Wildlife and Parks has written rules for implementing the State Antiquities Act. The Montana State Historic Preservation Office also issues antiquities permits for the collection of paleontological resources on state-owned lands. The MDEQ has drafted a Memorandum of Understanding with Keystone in Montana for the identification, evaluation, and protection of paleontological resources. This Memorandum of Understanding has not yet been fully signed and executed.

South Dakota requires a permit from the South Dakota Commissioner of School and Public Lands to survey, excavate, or remove paleontological resources from state land and to determine the repository or curation facility for paleontological collections from state lands. Condition 44 of the proposed Project's permit from the South Dakota Public Utilities Commission specifies the need for surveys in accordance with the procedures described for the South Dakota paleontological field surveys. Condition 44 also mandates the following mitigation measures:

- “Following the completion of field surveys, Keystone shall prepare and file with the Commission a paleontological resource mitigation plan. The mitigation plan shall specify monitoring locations, and include Bureau of Land Management (BLM) permitted monitors¹ and proper employee and contractor training to identify any paleontological resources discovered during construction and the procedures to be followed following such discovery. Paleontological monitoring will take place in areas within the construction right-of-way (ROW) that are underlain by rock formations with high sensitivity (PFYC Class 4) and very high sensitivity (PFYC Class 5), and in areas underlain by rock formations with moderate sensitivity (PFYC Class 3) where significant fossils were identified during field surveys.
- If during construction, Keystone or its agents discover what may be a paleontological resource of economic or scientific significance, Keystone or its contractors or agents shall immediately cease work at that portion of the site and, if on private land, notify the affected landowner(s). Upon such a discovery, Keystone's paleontological monitor will evaluate whether the discovery is of economic or scientific significance. If an economically or

¹ The onsite monitor would be required to hold a valid Paleontological Resource Use Permit from the BLM, authorizing the monitor to survey and collect paleontological resources in anticipation or in conjunction with a land-use action.

scientifically significant paleontological resource is discovered on state land, Keystone will notify South Dakota Schools of Mines and Technology (SDSMT) and if on federal land, Keystone will notify the BLM or other federal agency. In no case shall Keystone return any excavated fossils to the trench. If a qualified and BLM-permitted paleontologist, in consultation with the landowner, BLM, or SDSMT determines that an economically or scientifically significant paleontological resource is present, Keystone shall develop a plan that is reasonably acceptable to the landowner(s), BLM, or SDSMT, as applicable, to accommodate the salvage or avoidance of the paleontological resource to protect or mitigate damage to the resource. The responsibility for conducting such measures and paying the costs associated with such measures, whether on private, state or federal land, shall be borne by Keystone to the same extent that such responsibility and costs would be required to be borne by Keystone on BLM managed lands pursuant to BLM regulations and guidelines, including the BLM Guidelines for Assessment and Mitigation of Potential Impacts to Paleontological Resources, except to the extent factually inappropriate to the situation in the case of private land (e.g., museum curation costs would not be paid by Keystone in situations where possession of the recovered fossil(s) was turned over to the landowner as opposed to curation for the public). If such a plan will require a materially different route than that approved by the Commission, Keystone shall obtain Commission approval for the new route before proceeding with any further construction. Keystone shall, upon discovery and salvage of paleontological resources either during pre-construction surveys or construction and monitoring on private land, return any fossils in its possession to the landowner of record of the land on which the fossil is found. If on state land, the fossils and all associated data and documentation will be transferred to the SDSMT; if on federal land, to the BLM. To the extent that Keystone or its contractors or agents have control over access to such information, Keystone shall, and shall require its contractors and agents to, treat the locations of sensitive and valuable resources as confidential and limit public access to this information.”

To comply with Major Facilities Siting Act conditions in Montana and South Dakota Public Utilities Commission conditions in South Dakota, a paleontological monitor would be provided for each construction spread that includes an area assigned moderate-to-high fossil-bearing potential (PFYC 3, 4, and 5) and in areas where scientifically significant fossils were identified during surface surveys. The paleontological monitor would need to meet the qualifications established by the BLM for paleontological monitoring on federal lands.

No specific regulations have been identified concerning paleontological resources that would apply to the proposed Project in Nebraska.

Operation and Maintenance

Routine pipeline operations and maintenance activities are not expected to affect paleontological resources. Collection of paleontological resources for scientific or other purposes, however, would not be allowed by Keystone within the permanent ROW during proposed Project operations.

4.1.3.3 Mineral and Fossil Fuel Resources

Although the proposed Project route would not cross any active surface mines or quarries, construction and operation of the proposed Project would limit access to sand, gravel, clay, and stone resources that are located within the permanent ROW. As summarized in Section 3.1.2.4,

Fossil Fuel and Mineral and Resources, the proposed Project route would cross deposits of sand, gravel, clay, and stone; however, the acreage of deposits covered by the proposed ROW is minimal when compared to the amounts available for extraction throughout the proposed Project route.

As summarized in Section 2.1.3, Borrow Material Requirements, approximately 415,588 cubic yards of gravel and other fill materials would be used for temporary sites such as storage sites, contractor yards, and temporary access roads. These materials would also be used to stabilize the land for permanent facilities including pump stations, mainline valves, permanent access roads, and the proposed pipeline trench bottom. Fill materials would be obtained from an existing, previously permitted commercial source located as close to the proposed pipeline or contractor yard as possible.

The proposed Project route would cross underlying coal-bearing formations in South Dakota. Although not currently planned, if surface mining was proposed for this area in the future, the proposed pipeline could limit access to these resources.

As mentioned in Section 3.1.2.4, Fossil Fuel and Mineral and Resources, the proposed Project route would span across the crude-oil-rich Williston Basin through a portion of Montana. The proposed pipeline would not have a significant impact on the currently existing oil and gas producing wells within the vicinity of the proposed ROW. The Bakken crude oil wells would be connected to the Cushing Oil Terminal at Cushing, Oklahoma through a connection with the Bakken Marketlink Project at Baker, Montana.

4.1.3.4 Geologic Hazards

Seismic

Based on the evaluation of potential seismic hazards along the proposed ROW, 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.

The proposed pipeline would be constructed to withstand probable seismic events within the seismic risk zones crossed by the proposed pipeline. The proposed pipeline would be constructed in accordance with U.S. Department of Transportation regulations 49 Code of Federal Regulation (CFR) Part 195, Transportation of Hazardous Liquids by Pipeline (49 CFR 195), and all other applicable federal and state regulations. These regulations are designed to prevent crude oil pipeline accidents and to ensure adequate protection for the public.

In accordance with federal regulations 49 CFR 195, internal inspection of the proposed pipeline would occur if an earthquake, landslide, or soil liquefaction event were suspected of causing abnormal pipeline movement or rupture. If damage to the proposed pipeline was evident, the proposed pipeline would be inspected and repaired as necessary.

Landslides

Construction activities, such as vegetation clearing and alteration of surface-drainage patterns, could increase landslide risk. Implementation of temporary erosion control structures would reduce the likelihood of construction-triggered landslides. Potential erosion control measures would include trench breakers, slope breakers or water bars, erosion control matting, and

mulching. In addition, areas disturbed by construction along the pipeline ROW would be revegetated consistent with the Construction, Mitigation, and Reclamation Plan (CMRP) (see Appendix G) and specific landowner or land manager requirements.

Revegetation would also help reduce the risk of landslides during the operational phase of the proposed Project. The proposed pipeline would be designed and constructed in accordance with 49 CFR Parts 192 and 193. These specifications 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. Proposed pipeline installation techniques, especially padding and use of rock-free backfill, are designed to effectively insulate the proposed pipeline from minor earth movements.

To reduce landslide risk during operations, erosion and sediment control and reclamation procedures would be employed as described in Section 4.11 of the CMRP (Appendix G). These procedures are expected to limit erosion and maintain slope stability after the construction phase. Additionally, landslide activity would be monitored during the proposed pipeline's operation through aerial and ground patrols and through landowner awareness programs designed to encourage reporting. Keystone's company-wide Integrated Public Awareness plan would be implemented. This plan is consistent with the recommendations of American Petroleum Institute RP-1162 (Public Awareness Programs for Pipeline Operators). The plan includes educational materials designed to inform landowners of potential threats associated with the proposed pipeline and teach landowners to identify threats to the proposed pipeline including the potential for landslides. Landowners would be provided a toll-free telephone number to report potential threats to the proposed pipeline and other emergencies.

Subsidence

Because there are no appreciable limestone areas in Nebraska (or in other states along the proposed route), the risk of subsidence from karst features along the proposed pipeline route are negligible.

Floods

There is a risk of pipeline exposure due to lateral or vertical scour at water crossings due to floods. To mitigate the potential risk of pipeline exposure to lateral and vertical scours, the pipeline has been designed to be buried below the calculated scour depth at active stream crossings. In addition, at some stream crossings the pipeline would be installed using the horizontal directional drilling method deep below the stream bed where it would not be affected by scouring events. Additional protection measures related to proposed pipeline stream crossing procedures can be found in Section 4.3, Water Resources.

4.1.4 Recommended Additional Mitigation

No additional potential mitigation measures are recommended.

4.1.5 Connected Actions

4.1.5.1 Bakken Marketlink Project

Construction and operation of the Bakken Marketlink Project would include metering systems, three new storage tanks near Baker, Montana, and two new storage tanks within the boundaries of the proposed Cushing tank farm. The property proposed for the Bakken Marketlink facilities near Pump Station 14 is currently used as pastureland and hayfields and that a survey of the property indicated that there were no waterbodies or wetlands on the property. As a result, the potential impacts associated with expansion of the proposed pump station site to include the Bakken Marketlink facilities would likely be similar to those described above for the proposed pipeline ROW in that area.

4.1.5.2 Big Bend to Witten 230-kV Transmission Line

The proposed Big Bend to Witten electrical lines would be a 230-kilovolt (kV) single circuit transmission line strung to a single-pole structure. The poles would typically about 110 feet high steel poles with wire span distances averaging 800 feet. The poles would be directly embedded into excavated holes to a depth of about 20 feet. All substation and switchyard work installation activities, including the placement of concrete foundations, erecting support structures, construction of control buildings, and the installation of electrical equipment would involve surficial land clearance and landscape leveling. Excess fill material would be spread throughout undeveloped areas within the substation sites. Since the construction and operation of electrical distribution lines and substations would require minor disturbances to the landscape of the area, the impacts to the geological resources are expected to be negligible.

4.1.5.3 Electrical Distribution Lines and Substations

The proposed Project would require electrical service from local power providers for pump stations and other aboveground facilities in Montana, South Dakota, and Nebraska. Most of the proposed new electrical lines to service pump stations would be 115-kV lines stung a single-pole and/or H-frame wood poles. The poles would be typically about 60 to 80 feet high with wire span distance of about 250 to 400 feet. The power line poles and associated structures would be delivered on flatbed trucks. Radial arm diggers would typically be used to excavate the required holes. Poles would be either wood or steel and would be directly embedded into the excavated holes using a mobile crane or picker truck where appropriate. Anchors may be required at angles and dead ends. Since the construction and operation of electrical lines and associated structures would require minor disturbances to the landscape of the area, the impacts to the geological resources are expected to be negligible.

4.1.6 References

Burns and McDonnell, 2011, Clay Center 115 kV Transmission Project in Clay County, Kansas, Westar Energy, Project No. 62783.

USDA. See United States Department of Agriculture.

United States Department of Agriculture (USDA). 1932. Natural Resources Conservation Service Web Soil Survey. Retrieved August 5, 2008:
<http://websoilsurvey.nrcs.usda.gov/app>.