6.0 SOILS

6.1 GENERAL SOIL COMPOSITION

The Project will cross the following Major Land Resource Areas ("MLRA"): Red River Valley of the North; Northern Minnesota Gray Drift; Rolling Till Prairie; Northern Minnesota Glacial Lake Basins; Superior Lake Plain; Central Minnesota Sandy Outwash; and Wisconsin and Minnesota Thin Loess and Till, Northern part.

The Red River Valley of the North MLRA consists of a nearly level glacial lake plain that is bordered on the east by outwash plains, gravelly beaches, and dunes. The dominant soil types in this area are Mollisols and Vertisols.

The Northern Minnesota Gray Drift MLRA consists of a complex pattern of moraines, outwash plains, drumlins, lake plains, and drainages. The dominant soil types in this area are Alfisols, Entisols, and Histosols, with some Mollisols in the westernmost part of the area.

The Rolling Till Prairie MLRA consists of stagnation moraines, end moraines, glacial outwash plains, terraces, and flood plains, and is mostly dominated by till-covered moraines. The dominant soil type in this area is Mollisols.

The Northern Minnesota Glacial Lake Basin MLRA consists of glacial lake plains with remnants of gravelly beaches, strandlines, deltas, and sandbars. The dominant soil types in this area are Alfisols, Entisols, and Histosols.

The Superior Lake Plain MLRA consists of till plains mixed with lake plains, lake terraces, beaches, flood plains, swamps, and marshes. This MLRA is also characterized by some rocky knobs, hills, and low mountains. The dominant soil types in this area are Alfisols, Spodosols, Inceptisols, and Entisols.

The Central Minnesota Sandy Outwash MLRA consists of mostly large outwash plains and stream terraces. The dominant soil types in this area are Mollisols and Histosols.

The Wisconsin and Minnesota Thin Loess and Till MLRA consists of landscapes dominated by gently undulating to rolling, loess-mantled till plains, drumlin fields, and end moraines mixed with outwash plains associated with major glacial drainage ways, swamps, and bogs. The dominant soil types in this area are Alfisols, Entisols, Histosols, and Spodosols.

The above-mentioned MLRAs generally range from somewhat poorly drained soils with sandy to clayey textures to well or excessively drained soils, and have a frigid temperature regime; an aquic or udic soil moisture regime; and mixed, smectic, or isotic mineralogy (USDA Natural Resources Conservation Service ["NRCS"], 2006).

6.2 IDENTIFICATION OF SOIL CONDITIONS

6.2.1 Background and Methodology

Detailed soil characteristics along the majority of the preferred route were identified and assessed using SSURGO database (USDA NRCS, 2013a). The SSURGO database is a digital version of the original county soil surveys developed by NRCS for use with GIS. It provides the most detailed level of soils information for natural resource planning and management. The majority of the details were gathered at a scale of 1:12,000. Soil maps are linked in the SSURGO database to information about the component soils and their properties (USDA NRCS, 2013b).

SSURGO data was unavailable for Crow Wing County; therefore NRCS STATSGO2 data was used instead. STATSGO2 was created by generalizing more detailed soil survey maps. Where more detailed soil survey maps were not available, information on geology, topography, vegetation, and climate was assembled and related to satellite images. Soils of similar areas were studied and the probable classification and extent of the soils was determined (USDA NRCS, 2013c).

SSURGO and STATSGO2 attribute data consists of physical properties, chemical properties, and interpretive groupings. Attribute data applies to the whole soil (e.g., listed hydric, prime farmland soils, or slope class), as well as to layer data for soil horizons (e.g., texture or permeability). The soil attribute data can be used in conjunction with spatial data to describe the soils in a particular area.

6.2.2 Soil Characteristics and Assessments

NDPC digitized and overlaid the preferred route and additional temporary workspaces onto SSURGO/STATSGO2 database data to identify soil mapping units in the Project area. Based on that analysis, NDPC identified soil characteristics that could affect or be affected by pipeline construction. These characteristics include highly erodible soils, prime farmland and hydric soils, compaction-prone soils, presence of stones and shallow bedrock, droughty soils, depth of topsoil, and percent slope.

Tables 6.2.2-1 and 6.2.2-2 provide a summary of significant soil characteristics identified along the preferred route by county according to the SSURGO and STATSGO2 databases. Table 6.2.2-3 lists topsoil depths for prime farmland crossed by the preferred route. Individual soil characteristics are discussed separately in the following sections.

Table 6.2.2-1
Soil Characteristics in the Sandpiper Pipeline Project Area

County	Total Acres in County [a]	Prime Farmland	Hydric Soils	Compact. Prone	Highly Erodible		Reveg. Concerns	Stony/ Rocky	Shallow to Bedrock
					Water	Wind			
		Acres							
Polk	847.3	707.4	416.8	285.0	24.1	483.1	142.6	1.4	0.0
Red Lake	161.2	125.5	157.8	5.0	2.4	111.0	35.7	0.0	0.0
Clearwater	552.9	467.7	127.7	52.7	107.7	231.6	92.9	0.0	0.0
Hubbard	746.5	388.9	178.4	56.5	209.9	704.7	384.2	0.0	0.0
Cass	665.6	343.6	108.5	68.6	149.7	579.5	319.8	0.0	0.0
Crow Wing	70.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aitkin	674.1	303.3	393.0	283.9	46.0	555.2	315.1	0.0	0.0
Carlton	547.7	274.0	139.5	157.3	87.6	251.4	266.1	10.8	0.0 [b]
Total	**4,266.1**	**2,610.5**	**1,521.6**	**909.1**	**627.3**	**2,987.4**	**1,556.4**	**12.2**	**0.0**

N/A Data not available for Crow Wing County.
[a] Acreage is based on the construction right-of-way dimensions as discussed in Table 1.2-1 and additional temporary workspace.
[b] As stated in section 5.1, the preferred route will cross 2.5 miles of shallow bedrock in Carlton County based on regional digital data. This information was not reflected in NRCS soils data.

Table 6.2.2-2
Topsoil Depths and Slope Class in the Sandpiper Pipeline Project Area [a]

County	Total Acres in County [a]	Topsoil Depth (inches) in Acres				Slope Class (percent) in Acres				
		0-6	>6-12	>12-18	>18	0-5	>5-8	>8-15	>15-30	>30
Polk	847.3	814.7	28.7	3.5	0.0	822.7	7.8	9.8	6.6	0.0
Red Lake	161.2	141.8	19.4	0.0	0.0	161.2	0.0	0.0	0.0	0.0
Clearwater	552.9	528.2	25.2	0.1	0.0	445.8	14.8	77.6	15.2	0.0
Hubbard	746.5	720.5	11.1	5.9	8.9	536.7	82.0	83.8	40.9	3.1
Cass	665.6	629.4	11.5	22.0	2.7	515.9	0.0	90.1	59.6	0.0
Crow Wing	70.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aitkin	674.1	534.7	107.8	27.9	3.4	607.3	48.0	5.6	13.0	0.0
Carlton	547.7	456.1	49.2	0.0	42.2	314.9	173.0	0.0	57.3	2.3
Total	**4,266.1**	**3,825.4**	**252.9**	**59.4**	**57.3**	**3,404.5**	**325.7**	**266.9**	**192.6**	**5.4**

N/A Data not available for Crow Wing County.
[a] Acreage is based on the construction right-of-way dimensions as discussed in Table 1.2-1 and additional temporary workspace.

Table 6.2.2-3
Topsoil Depths on Prime Farmland in the Sandpiper Pipeline Project Area

County	Total Prime Farmland Acres in County [a]	Topsoil Depth in Acres			
		0-6 inches	>6-12 inches	>12-18 inches	>18 inches
Polk	707.4	686.1	21.3	0.0	0.0
Red Lake	125.5	121.9	3.7	0.0	0.0
Clearwater	467.7	467.7	0.0	0.0	0.0
Hubbard	388.9	388.96	0.0	0.0	0.0
Cass	343.6	343.2	0.4	0.0	0.0
Crow Wing	N/A	N/A	N/A	N/A	N/A
Aitkin	303.3	303.3	0.0	0.0	0.0
Carlton	274.0	274.0	0.0	0.0	0.0
Total	**2,610.5**	**2,585.1**	**25.4**	**0.0**	**0.0**

N/A Data not available for Crow Wing County.
[a] Acreage is based on the construction right-of-way dimensions as discussed in Table 1.2-1 and does not include access roads or additional temporary workspace. Includes land listed by the NRCS as potential prime farmland if a limiting factor is mitigated (e.g., artificial drainage).

6.3 GENERAL CONSTRUCTION AND OPERATION IMPACTS AND MITIGATION

Pipeline construction activities such as clearing, grading, trench excavation, and backfilling, as well as the movement of construction equipment along the right-of-way, may result in impacts on soil resources. Clearing removes protective cover and exposes soil to the effects of wind and precipitation, which may increase the potential for soil erosion and movement of sediments into sensitive environmental areas. Grading and equipment traffic may compact soil, reducing porosity and percolation rates, which could result in increased runoff potential. Trench excavation and backfilling could lead to a mixing of topsoil and subsoil and may introduce rocks to the soil surface from deeper soil horizons. Contamination from release of fuels, lubricants, and coolants from construction equipment could also impact soils. NDPC will minimize or avoid these impacts on soils by implementing the mitigation measures described in the EPP and APP (see Appendices A and C, respectively). NDPC will develop a Contaminated Soils Plan to address issues from prior contamination if encountered during construction.

6.3.1 Prime Farmland and Topsoil Segregation

Prime Farmland

The USDA defines prime farmland as land that has the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and that is available for these uses. It has the soil properties, growing season, and moisture supply

needed to produce sustained high yields of crops in an economic manner if it is treated and managed according to acceptable farming methods. In general, prime farmland has an adequate and dependable water supply from precipitation or irrigation, a favorable temperature and growing season, an acceptable level of acidity or alkalinity, an acceptable content of salt or sodium, few or no rocks, and is permeable to water and air. Prime farmland is not excessively eroded or saturated with water for long periods of time and it either does not flood frequently during the growing season or is protected from flooding (USDA, NRCS 2013d). Soils that do not meet the above criteria may be considered prime farmland if the limiting factor is mitigated (e.g., by controlling soil moisture conditions through artificial drainage). Approximately 19.6 percent of the preferred route will cross prime farmland soils with no limiting factor. An additional 16.8 percent of the soils crossed are considered prime farmland if limiting factors are mitigated, and 24.8 percent of the preferred route will cross soils on farmland of statewide importance.

Impacts on prime farmland from construction of the Project could include interference with agricultural drainage (if present), mixing of topsoil and subsoil, and compaction and rutting of soil. These impacts could result from right-of-way clearing, trench excavation and backfilling, and vehicular traffic within the construction right-of-way. However, with the mitigation measures specified in the APP (see Appendix C), these impacts will be temporary and will not result in a permanent decrease in soil productivity.

NDPC will implement the measures described in its APP to minimize impacts on prime farmland and promote the long-term productivity of the soil. These measures will include topsoil segregation, compaction alleviation, removal of excess rock, and restoration of agricultural drainage systems and existing erosion control structures.

Topsoil Segregation

Topsoil thickness is the result of factors such as wetness, topography, climate, and the predominant vegetation present when the soil was being formed. Other factors being equal, prairie soils have more topsoil than forest soils; and wet soils have more topsoil than dry soils. According to data presented in Tables 6.2.2-2 and 6.2.2-3, topsoil depths along the majority of the preferred route are generally less than 6 inches but are thicker in some areas.

To minimize topsoil disturbance and topsoil/subsoil mixing associated with pipeline construction, NDPC will remove and segregate topsoil in cropland, hay fields, pasture, residential areas, and other areas as requested by the landowner (see EPP typical drawings presented as Figures 1, 2, and 3 in Appendix A). Topsoil will be stripped to a maximum depth of 12 to 18 inches unless otherwise requested by the landowner. If less-than-specified maximum depths of topsoil are present, every effort will be made to segregate to the depth that is present. The segregated topsoil and subsoil will be stockpiled separately and replaced in the proper order during backfilling and final grading of the construction right-of-way.

NDPC consulted with the MDA in the development of its APP. MDA recommended that additional procedures be developed to minimize adverse impacts on crop yields that could occur when topsoil layers with markedly different soil properties are mixed. Implementation of proper topsoil segregation, as detailed in the APP, will minimize the loss of crop productivity, ensure successful post-construction revegetation, and minimize the potential for long-term erosion problems. In the event of a conflict between the PRP and the APP, the APP contains a process to determine the best course of action.

6.3.2 Soil Compaction and Rutting

Soil compaction modifies the structure and reduces the porosity and moisture-holding capacity of soils. Construction equipment traveling over wet soils could disrupt the soil structure, reduce pore space, increase runoff potential, and cause rutting. The degree of compaction depends on moisture content and soil texture. Fine-textured soils with poor internal drainage that are moist or saturated during construction are the most susceptible to compaction and rutting. Approximately 21.3 percent of the preferred route is underlain by soils that are prone to compaction. In addition, approximately 13.4 percent of the preferred route will cross soils with organic surface horizons. These horizons also may be susceptible to rutting during pipeline construction.

NDPC will minimize compaction and rutting impacts by implementing the measures described in its EPP and APP (see Appendices A and C, respectively). These measures may include temporarily suspending certain construction activities on susceptible soils during wet conditions, constructing from timber mats, or using low-ground-weight equipment in wetlands. On agricultural land, compaction impacts may be mitigated through the use of deep tillage operations during restoration activities. If subsequent construction and cleanup activities result in further compaction, additional measures will be undertaken to reduce soil compaction.

6.3.3 Erosion by Wind and Water

Erosion is a continuing natural process that can be accelerated by human activity. Factors that influence the degree of erosion include soil texture, soil structure, length and percent of slope, vegetative cover, and rainfall or wind intensity. Soils most susceptible to erosion by water are typified by bare or sparse vegetative cover, non-cohesive soil particles with low infiltration rates, and moderate to steep slopes. Wind erosion processes are less affected by slope length or steepness. Clearing, grading, and equipment movement could accelerate the erosion process and, without adequate protection, result in discharge of sediment to adjacent waterbodies and wetlands.

The majority of the preferred route (greater than 85 percent) is underlain by soils that are not likely to be susceptible to water erosion (see Table 6.2.2-1); these soils are generally found on terrain with slopes that are less than or equal to 5 percent. Approximately 70.0 percent of the soils along the pipeline route are considered susceptible to wind erosion.

NDPC will implement the erosion control measures described in the EPP (see Appendix A) to minimize erosion both during and after construction activities. These measures may include construction of silt fences, installation of slope breakers, temporary sediment barriers, and permanent trench breakers, as well as revegetation and mulching of the construction right-of-way. Erosion and sedimentation controls will be inspected and maintained as necessary until final stabilization is achieved. NDPC also will implement dust mitigation measures, including the use of water trucks to moisten the right-of-way, as needed, to reduce impacts from wind erosion.

6.3.4 Droughty Soils

Droughty, or dry, soils were identified on the basis of surface texture and drainage class. Well drained to excessively drained soils with a coarse surface texture (i.e., fine sand or coarser) may be difficult to revegetate. Drier soils contain less water to aid in the germination and eventual establishment of new vegetation. Coarser textured soils also have a lower water holding capacity, which could result in moisture deficiencies in the root zone, creating unfavorable conditions for many plants. Approximately 36.5 percent of the preferred route will cross soils classified as droughty soils.

NDPC will minimize the impacts of pipeline construction on droughty, non-cultivated soils by timely reseeding using species tolerant of dry conditions and by applying mulch to conserve soil moisture. NDPC has initiated consultation with appropriate soil conservation authorities and will continue to work with these authorities to develop seed mixes and seeding dates adapted to the Project area, including droughty soil areas.

6.3.5 Stony/Rocky Soils and Shallow Bedrock Soils

Trenching or grading can bring stones or rocks to the soil surface where they can damage farm equipment and interfere with planting. Similarly, backfilling shallow bedrock could redistribute rock to an overlying soil horizon, which may reduce soil moisture-holding capacity. Less than 1 percent of the preferred route would cross stony or rocky soils.

Based on the analysis of the SSURGO/STATSGO2 soils data, no soils crossed by the preferred route are indicated to contain shallow bedrock (i.e., bedrock within five feet of the surface). However, other sources of geological data presented in Section 5.1 suggest that there is an area of more or less continuous bedrock exposure from approximate MP 580.9 to MP 583.4. If bedrock is encountered within the trench, NDPC will only backfill with this rock to the depth of the original bedrock layer. During clean up, NDPC will use rock pickers or other rock removal equipment to remove rocks of a greater size and density on the right-of-way than undisturbed areas adjacent to the right-of-way.