3.3 Paleontological Resources

3.3.1 Regulatory Structure

The Paleontological Resources Preservation Act (PRPA) became law in 2009 with the passage of Public Law 111-011 (BLM 2011). The PRPA included specific provisions addressing management of these resources by the BLM, NPS, Bureau of Reclamation (BOR), USFWS, and USFS. It affirmed the authority for many policies that those agencies already had in place for the management of paleontological resources such as issuing permits for collecting paleontological resources, curation of paleontological resources, and confidentiality of locality data. The PRPA only applies to federal lands and does not affect private lands. It provides authority for the protection of paleontological resources on federal lands including criminal and civil penalties for fossil theft and vandalism. Consistent with policy up to the passage of the act, the PRPA also includes provisions allowing for casual or hobby collecting of common invertebrate and plant fossils without a permit on federal lands managed by the BLM, the BOR, and the USFS, under certain conditions. Casual collecting is not allowed within national parks or other lands managed by the NPS. The Act directed federal agencies to begin developing regulations, establishing public awareness and education programs, and inventorying and monitoring federal lands.

The BLM also manages paleontological resources (fossils) on federal lands under the following statutes and regulations (BLM 2011):

- Federal Land Policy and Management Act of 1976 (P.L. 94-579);
- NEPA (P.L. 91-190); and
- Various sections of BLM's regulations found in Title 43 CFR that address the collection of invertebrate fossils and, by administrative extension, fossil plants.

In addition to the statutes and regulations listed above, fossils on public lands are managed through the use of internal BLM guidance and manuals. These include the BLM Manual 8270 and the BLM Handbook H-8270-1 (BLM 2011). Various internal instructional memoranda have been issued to provide guidance to the BLM in implementing management and protection of fossil resources.

North Dakota has two laws (passed in 1989) that deal with the management of paleontological resources (North Dakota Geological Survey [NDGS] 2007). The North Dakota Paleontological Resource Protection Act (Section 54-17.3, N.D.C.C.), gives the NDIC, acting through the office of the State Geologist, the responsibility to protect paleontological resources located on state land. The second law gives the NDGS authority to operate and maintain a public repository for North Dakota fossils. In addition, the State of North Dakota has entered into Memorandums of Understanding with the BLM and USFS for cooperative management of paleontological resources within the state.

3.3.2 Potential Fossil Yield Classification System

Recently, the BLM has adopted the Potential Fossil Yield Classification (PFYC) system to identify and classify fossil resources on federal lands (BLM 2011). Paleontological resources are closely tied to the geologic units (i.e., formations, members, or beds) that contain them. The probability for finding paleontological resources can be broadly predicted from the geologic units present at or near the surface. Therefore, geologic mapping can be used for assessing the potential for the occurrence of paleontological resources.

The PFYC system is a way of classifying geologic units based on the relative abundance of vertebrate fossils or scientifically significant fossils (plants and invertebrates) and their sensitivity to adverse impacts. A higher class number indicates higher potential. The PFYC is not intended to be applied to specific paleontological localities or small areas within units. Although significant localities may occasionally occur in

a geologic unit, a few widely scattered important fossils or localities do not necessarily indicate a higher class; instead, the relative abundance of significant localities is intended to be the major determinant for the class assignment.

The PFYC system is meant to provide baseline guidance for predicting, assessing, and mitigating paleontological resources. The classification should be considered at an intermediate point in the analysis, and should be used to assist in determining the need for further mitigation assessment or actions. The BLM intends for the PFYC system to be used as a guideline as opposed to rigorous definitions. Descriptions of the potential fossil yield classes are summarized in **Table 3.3-1**.

Table 3.3-1 Potential Fossil Yield Classification

Class	Description	Basis	Comments
1	Igneous and metamorphic (tuffs are excluded from this category) geologic units or units representing heavily disturbed preservation environments that are not likely to contain recognizable fossil remains.	Fossils of any kind known not to occur except in the rarest of circumstances. Igneous or metamorphic origin. Landslides and glacial deposits.	The land manager's concern for paleontological resources on Class 1 acres is negligible. Ground disturbing activities would not require mitigation except in rare circumstances.
2	Sedimentary geologic units that are not likely to contain vertebrate fossils or scientifically important invertebrate fossils.	Vertebrate fossils known to occur very rarely or not at all. Age greater than Devonian. Age younger than 10,000 years before present. Deep marine origin. Aeolian origin. Diagenetic alteration.	The land manager's concern for paleontological resources on Class 2 acres is low. Ground disturbing activities are not likely to require mitigation.
3	Fossiliferous sedimentary geologic units where fossil content varies in significance, abundance, and predictable occurrence. Also sedimentary units of unknown fossil potential.	Units with sporadic known occurrences of vertebrate fossils. Vertebrate fossils and significant invertebrate fossils known to occur inconsistently; predictability known to be low. Poorly studied and/or poorly documented. Potential yield cannot be assigned without ground reconnaissance.	The land manager's concern for paleontological resources on Class 3 acres may extend across the entire range of management. Ground disturbing activities would require sufficient mitigation to determine whether significant paleontological resources occur in the area of a proposed action. Mitigation beyond initial findings would range from no further mitigation necessary to full and continuous monitoring of significant localities during the action.

Table 3.3-1 Potential Fossil Yield Classification

Class	Description	Basis	Comments
4	Class 4 geologic units are Class 5 units (see below) that have lowered risks of human-caused adverse impacts and/or lowered risk of natural degradation.	Significant soil/vegetative cover; outcrop is not likely to be impacted. Areas of any exposed outcrop are smaller than 2 contiguous acres. Outcrop forms cliffs of sufficient height and slope that most is out of reach by normal means. Other characteristics that lower the vulnerability of both known and unidentified fossil localities.	The land manager's concern for paleontological resources on Class 4 areas is toward management and away from unregulated access. Proposed ground disturbing activities would require assessment to determine whether significant paleontological resources occur in the area of a proposed action and whether the action would impact the paleontological resources. Mitigation beyond initial findings would range from no further mitigation necessary to full and continuous monitoring of significant localities during the action.
5	Highly fossiliferous geologic units that regularly and predictably produce invertebrate fossils and/or scientifically significant invertebrate fossils, and that are at risk of natural degradation and/or human-caused adverse impacts.	Vertebrate fossils and/or scientifically significant invertebrate fossils are known and documented to occur consistently, predictably, and/or abundantly. Unit is exposed; little or no soil/vegetative cover. Outcrop areas are extensive; discontinuous areas are larger than 2 contiguous acres. Outcrop erodes readily; may form badlands. Easy access to extensive outcrop in remote areas. Other characteristics that increase the sensitivity of both known and unidentified fossil localities.	The land manager's highest concern for paleontological resources should focus on Class 5 areas. Mitigation of ground disturbing activities is required and may be intense. Areas of special interest and concern should be designated and intensely managed.

Source: BLM 2008.

3.3.3 Fossil Resources in the Project Area

The Bullion Creek and Sentinel Butte formations are fossiliferous and, where they are well exposed in the badlands west of the Project area, numerous fossil localities have been identified (Hoganson 1997; Hoganson and Campbell 1997). Fossils common to both formations include invertebrates (freshwater mollusks), plants (petrified wood), and vertebrates (reptiles and mammals). In spite of the abundance of fossils in these formations, the Project route generally crosses areas where the bedrock is not well exposed or is covered by surficial materials, and the sensitivity of these formations along the route probably would

have a PFYC rating of 3. However, where the Bullion Formation would be exposed along the banks of Lake Sakakawea and where the Sentinel Butte Formation is exposed in badlands on the approaches to the Little Missouri River, the PFYC rating is recommended to be 4/5.

The Golden Valley Formation contains plants and invertebrates, but vertebrates are not common (Hickey 1972; Murphy 2009). On that basis a PFYC rating of 3 is recommended.

3.4 Soils

Information on Major Land Resource Areas and soil characteristics was obtained from U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) literature or databases, including the Land Resource Regions and Major Land Resource Areas (MLRAs) of the U.S., the Caribbean, and the Pacific Basin, USDA Handbook 296 (USDA 2006) and the Soil Survey Geographic Database (SSURGO). Soil baseline characterization for the Project area is based on SSURGO database review and analyses. SSURGO is the most detailed level of soil mapping completed by the NRCS. The SSURGO databases for Williams, McKenzie, and Billings counties, North Dakota (NRCS 2011), are the source for the soils data in this section. **Tables 3.4-1** and **3.4-2** provide a summary of the soil characteristics within the Project area generated from the SSURGO data. The various soil map units within the Project area were combined into generalized groups of soils to evaluate potential impacts and to determine effective erosion control measures, reclamation, and revegetation potential in the area.

Table 3.4-1 Summary of Soil Characteristics Along the Pipeline Routes (miles crossed)

	Droughty	Prime Farmland	Farmland of Statewide Importance	Hydric	Wind Erodible	Water Erodible	Shallow Depth to Bedrock	Compaction Prone
Proposed Action	32.25	0.27	28.86	34.76	5.21	15.03	13	57.62

Source: NRCS 2011.

Table 3.4-2 Soil Characteristics at Receipt Facilities

Receipt/ Delivery Facilities	Droughty	Compaction Prone	Farmland of Statewide Importance	Hydric	Wind Erodible	Water Erodible	Shallow Depth to Bedrock
Truck Receipt Points							
Belfield							
Dunn	X						
Watford City	X			X	X		
Arrow Midstream		X	X				
Keene		X					
Beaver Lodge			X	X			

Source: NRCS 2011.

The Project area is located within the following 3 MLRAs of soil resources (USDA 2006):

- MLRA 54 – Rolling Soft Shale Plain;
- MLRA 53B – Central Dark Brown Glaciated Plains; and
- MLRA 58C – Northern Rolling High Plains, Northeastern Part.

MLRA 54 is predominantly unglaciated, but the eastern and northern edges have been glaciated. The area is located on an old, moderately dissected, rolling plain with some local badlands, buttes, and isolated hills. Terraces are adjacent to broad floodplains along most of the major drainages. Elevation ranges from 1,650 feet amsl in the east with a gradual slope to about 3,600 feet amsl in the west. The soils generally formed in residuum and alluvium from sedimentary parent materials. They are shallow to very deep, generally somewhat excessively drained to moderately well drained, and loamy or clayey. The dominant soil orders in this MLRA are Mollisols and Entisols. Mollisols are fertile soils with high organic matter and a nutrient-enriched, thick surface. In contrast, Entisols are considered recent soils that lack soil development because erosion or deposition rates occur faster than the rate of soil development.

The nearly level to rolling till plains in MLRA 53B include kettle holes, kames, moraines, and small glacial lakes. Moderately steep and steep slopes are adjacent to the major stream valleys. Elevation ranges from 1,640 to 1,970 feet amsl increasing gradually from southeast to northwest. Almost all of this MLRA is covered by glacial till plains. Some glaciolacustrine deposits also occur. Kettle holes, kames, moraines, and small glacial lakes break up the nearly level terrain. Alluvial deposits are extensive along the Missouri River but occur in narrow and discontinuous strips along other streams and rivers. Low terraces occur along the major rivers. The dominant soil order in this MLRA is Mollisols. The soils generally are very deep, well drained to very poorly drained, and clayey or loamy.

MLRA 58C has some glacially modified topography, but it is very similar to the unglaciated parts. This MLRA is known as the Little Missouri Badlands, which were formed when the Little Missouri River was diverted along a steeper course by Pleistocene glaciers. The MLRA is an area of old plateaus and terraces that have been cut by the Little Missouri River and its tributaries. Much of the area consists of rolling hills with some badlands. Moderately steep and steep slopes occur along the Little Missouri River and its tributaries. Some isolated mountains, such as the Killdeer Mountains, are in the area. Elevation generally ranges from 1,970 to 3,280 feet amsl. The soils generally formed in tertiary marine sediments consisting of shale, siltstone, and sandstone. The dominant soil orders in this MLRA are Entisols, Inceptisols, and Mollisols. Inceptisols are weakly developed soils that formed in humid and subhumid regions. Inceptisols have altered horizons that have lost bases or iron and aluminum but retain some weatherable minerals. They are shallow to very deep, generally well drained, and loamy.

Soil characteristics such as susceptibility to erosion and the potential for revegetation are important to consider when planning for construction activities and stabilization of disturbed areas. These hazards or limitations for use are a function of many physical and chemical characteristics of each soil, in combination with the climate and vegetation. **Tables 3.4-1** and **3.4-2** summarize important soil characteristics to be considered when evaluating the effects of surface-disturbing activities.

Water erosion is the detachment and movement of soil by water. Natural erosion rates depend on inherent soil properties, slope, soil cover, and climate. Approximately 10 percent of the soils crossed by the Project route are highly erodible to water. Water erodible soils are illustrated in **Figure 3.4-1**. Wind erosion is the physical wearing of the earth's surface by wind. Wind erosion removes and redistributes soil. Small blowout areas may be associated with adjacent areas of deposition at the base of plants or behind obstacles, such as rocks, shrubs, fence rows, and roadbanks (Soil Quality Institute 2001). Wind erodible soils comprise approximately 4 percent of the soils crossed by the Project route. The occurrence of wind erodible soils is illustrated in **Figure 3.4-2**. Highly erodible soils typically require aggressive erosion control measures to minimize soil loss and offsite deposition if they are disturbed.

Prime farmland is land that has the best combination of physical and chemical characteristics for producing crops and is available for these uses. It has the combination of 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. These soils have the capability to be prime farmland, even if they have not yet been developed for agricultural uses. Farmland of statewide importance is land

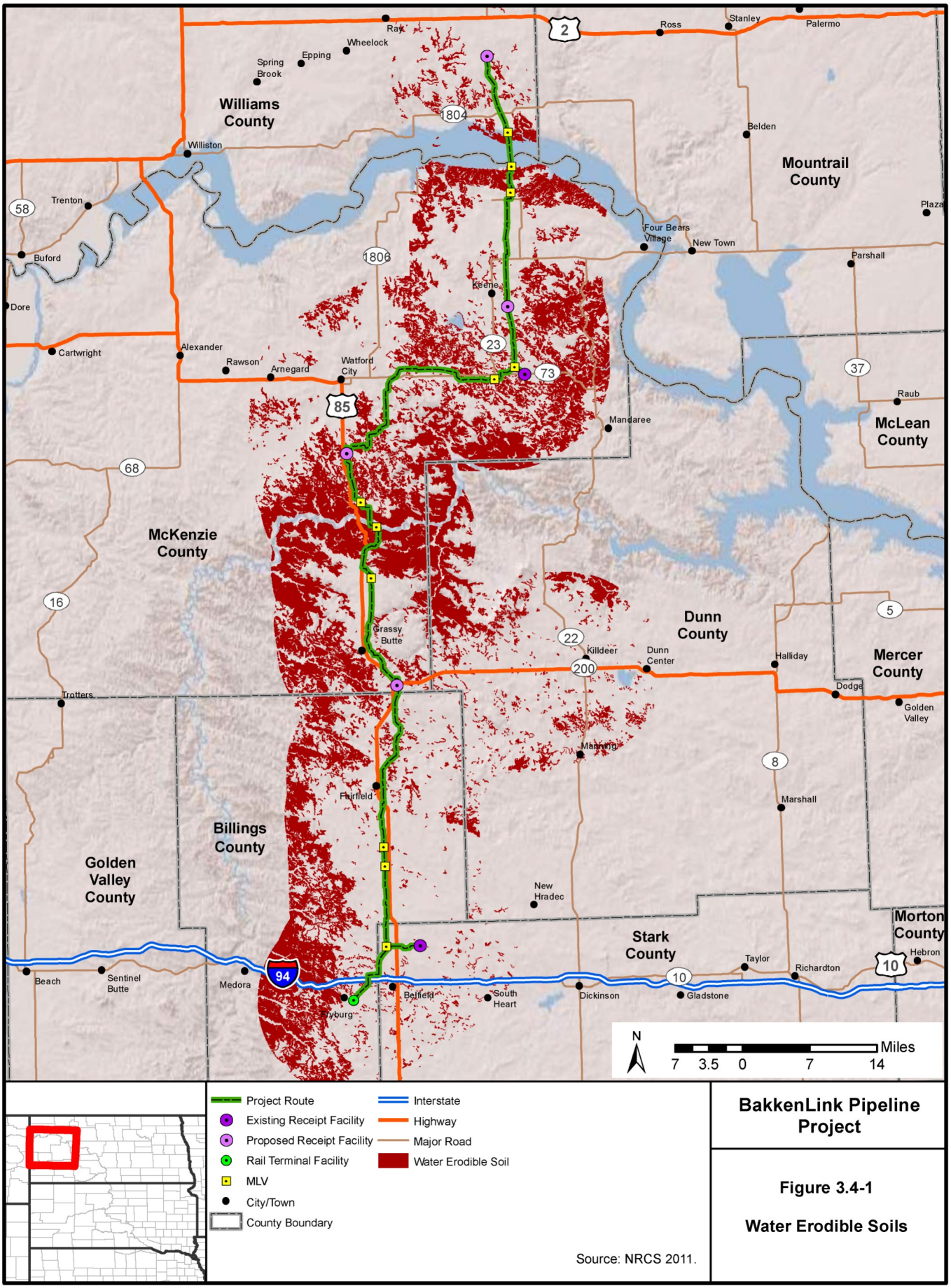
other than prime farmland that has a good combination of physical and chemical characteristics for the production of crops. It does not include publicly owned lands for which there is an adopted policy preventing agricultural use. The Farmland Protection Policy Act states that federal programs that contribute to the unnecessary and irreversible conversion of farmland to non-agricultural uses would be minimized and shall be administered in a manner that, as practicable, are compatible with state and local government and private programs and policies to protect farmland. Less than 1 percent of soils crossed by the Project route are prime farmland and 20 percent of soils crossed are farmland of statewide importance. The occurrence of prime farmland and farmland of statewide importance are illustrated on **Figure 3.4-3**.

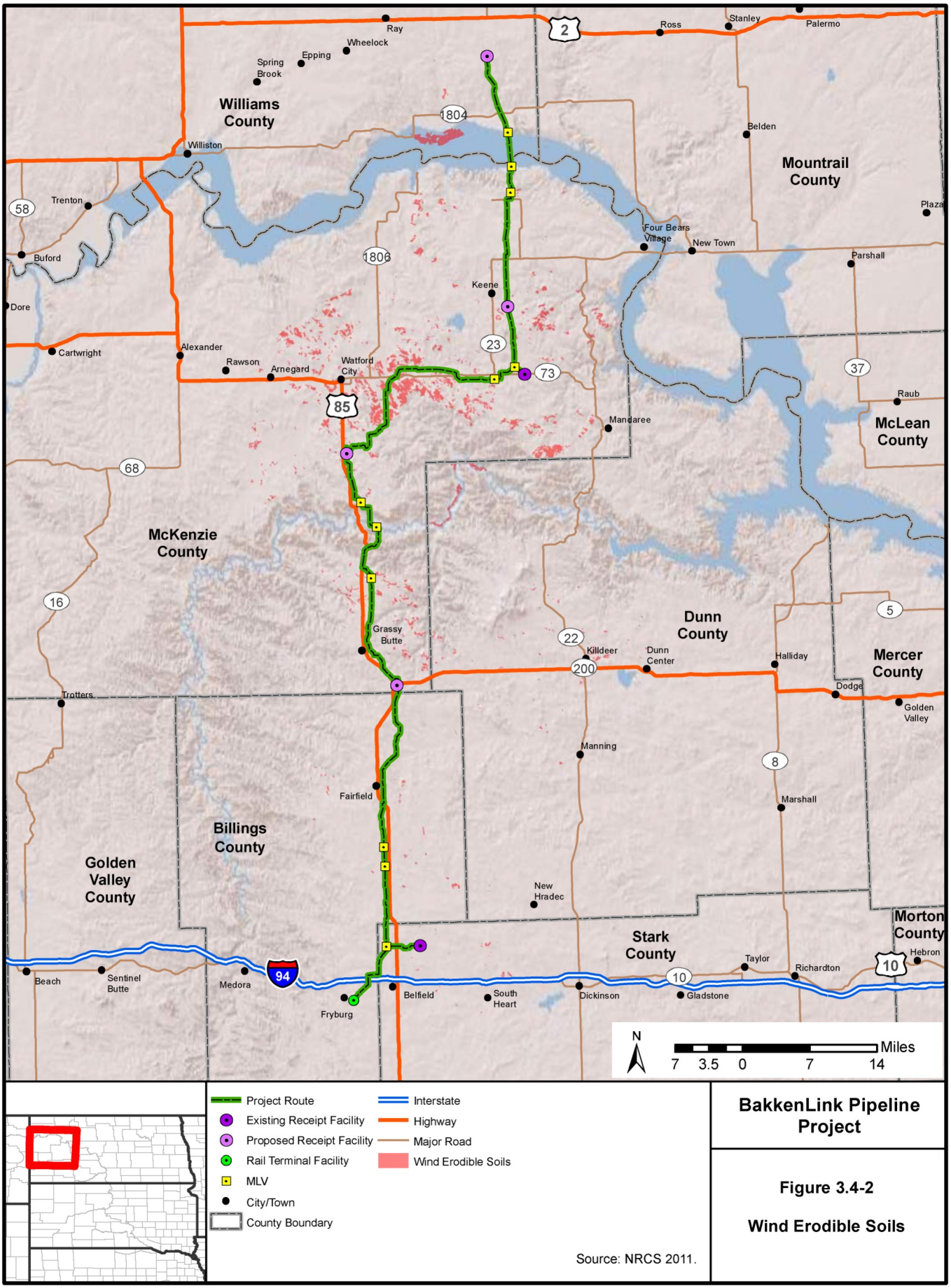
Soil compaction occurs when soil particles are pressed together and the pore spaces between them are reduced and bulk density is increased. Moist fine textured soils are most susceptible to severe compaction. Approximately 39 percent of the soils crossed by the Project route are compaction prone. The occurrence of compaction prone soils is illustrated on **Figure 3.4-4**.

Soils that are droughty have physical characteristics that may limit plant growth due to low water holding capacity. In addition, the success of stabilization and restoration efforts in these areas may be limited unless additional treatments and practices are employed to offset the adverse physical characteristics of the soils. Approximately 22 percent of the soils crossed by the Project route are considered droughty. The occurrence of droughty soils is illustrated on **Figure 3.4-5**.

Hydric soils are soils that formed under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part of the soil profile. These soils are commonly associated with floodplains, lake plains, basin plains, riparian areas, wetlands, springs, and seeps. Approximately 24 percent of the soils crossed by the Project route have at least one component of the map unit that is hydric. Smaller areas of hydric soils may exist but may not be captured due to the scale of mapping. The occurrence of hydric soils is illustrated on **Figure 3.4-6**.

Soils with a shallow depth to bedrock include soils that have lithic (hard) bedrock less than 60 inches from the soil surface. This can be an important consideration for trenching. Approximately 9 percent of the soils crossed by the Project route have a shallow depth to bedrock. The occurrence of soils with a shallow depth to bedrock is illustrated on **Figure 3.4-7**.


Williams County
Mountrail County
McLean County
McKenzie County
Dunn County
Mercer County
Billings County
Golden Valley County
Stark County
Morton County
Rax
Wheelock
Epping
Spring Brook
Ross
Stanley
Palermo
Williston
Belden
Trenton
Buford
Dore
Cartwright
Alexander
Rawson
Arnegard
Watford City
Four Bears Village
New Town
Parshall
Plaza
Keene
Raub
Mandaree
Grassy Butte
Killdeer
Dunn Center
Halliday
Dodge
Golden Valley
Trotters
Manning
Fairfield
Marshall
New Hradec
Beach
Sentinel Butte
Medora
Belfield
South Heart
Dickinson
Gladstone
Taylor
Richardton
Hebron
Tryburg
1804
1806
2
58
23
73
37
85
68
16
22
200
5
8
94
10
N
Miles
7 3.5 0 7 14
Project Route
Existing Receipt Facility
Proposed Receipt Facility
Rail Terminal Facility
MLV
City/Town
County Boundary
Interstate
Highway
Major Road
Water Erodible Soil
Source: NRCS 2011.
BakkenLink Pipeline Project
Figure 3.4-1
Water Erodible Soils

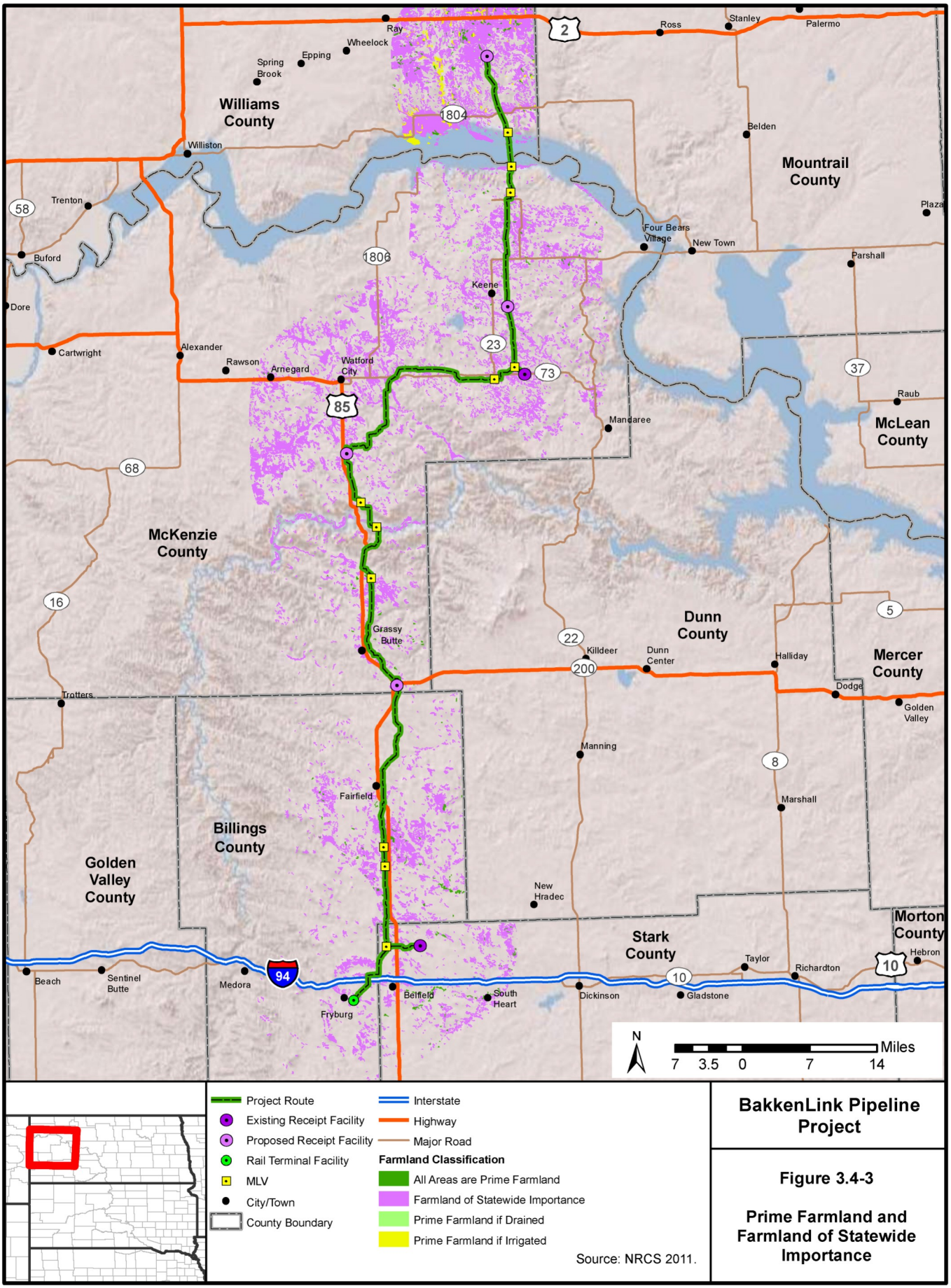


Source: NRCS 2011.

BakkenLink Pipeline Project

Figure 3.4-2

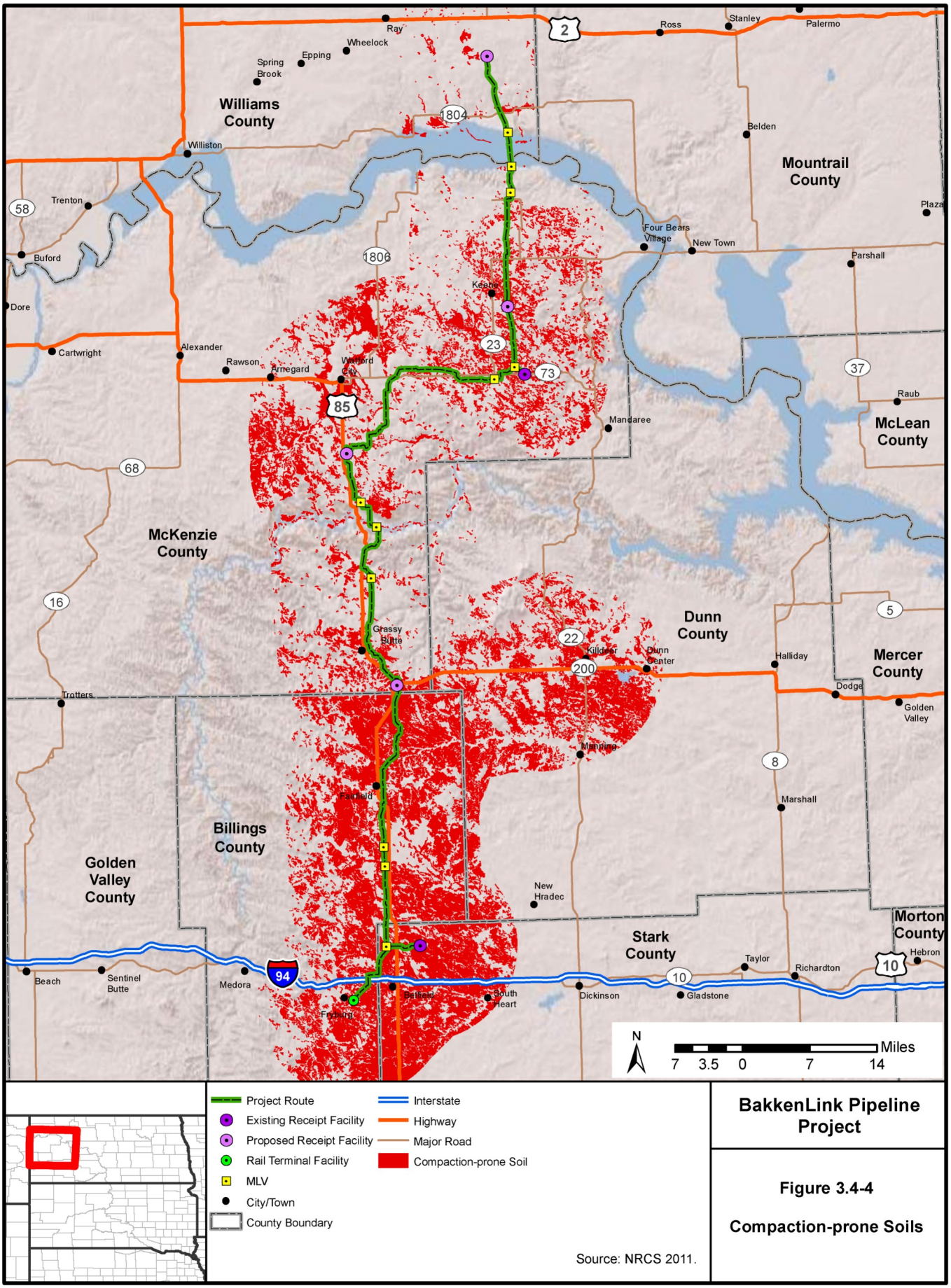
Wind Erodible Soils



BakkenLink Pipeline Project

Figure 3.4-3

Prime Farmland and Farmland of Statewide Importance


Williams County
Mountrail County
McLean County
McKenzie County
Dunn County
Mercer County
Billings County
Golden Valley County
Stark County
Morton County
Ray
Wheelock
Epping
Spring Brook
Ross
Stanley
Palermo
Belden
Williston
Trenton
Buford
Dore
Cartwright
Alexander
Rawson
Arnegard
Watford City
Four Bears Village
New Town
Parshall
Plaza
Keene
Raub
Mandaree
Grassy Butte
Killdeer
Dunn Center
Halliday
Dodge
Golden Valley
Trotters
Manning
Marshall
Fairfield
New Hradec
Beach
Sentinel Butte
Medora
Belfield
South Heart
Dickinson
Gladstone
Taylor
Richardton
Hebron
Fryburg
1804
1806
2
58
23
73
85
37
68
16
22
200
5
8
94
10
N
Miles
7 3.5 0 7 14
Project Route
Existing Receipt Facility
Proposed Receipt Facility
Rail Terminal Facility
MLV
City/Town
County Boundary
Interstate
Highway
Major Road
Compaction-prone Soil
Source: NRCS 2011.
BakkenLink Pipeline Project
Figure 3.4-4
Compaction-prone Soils

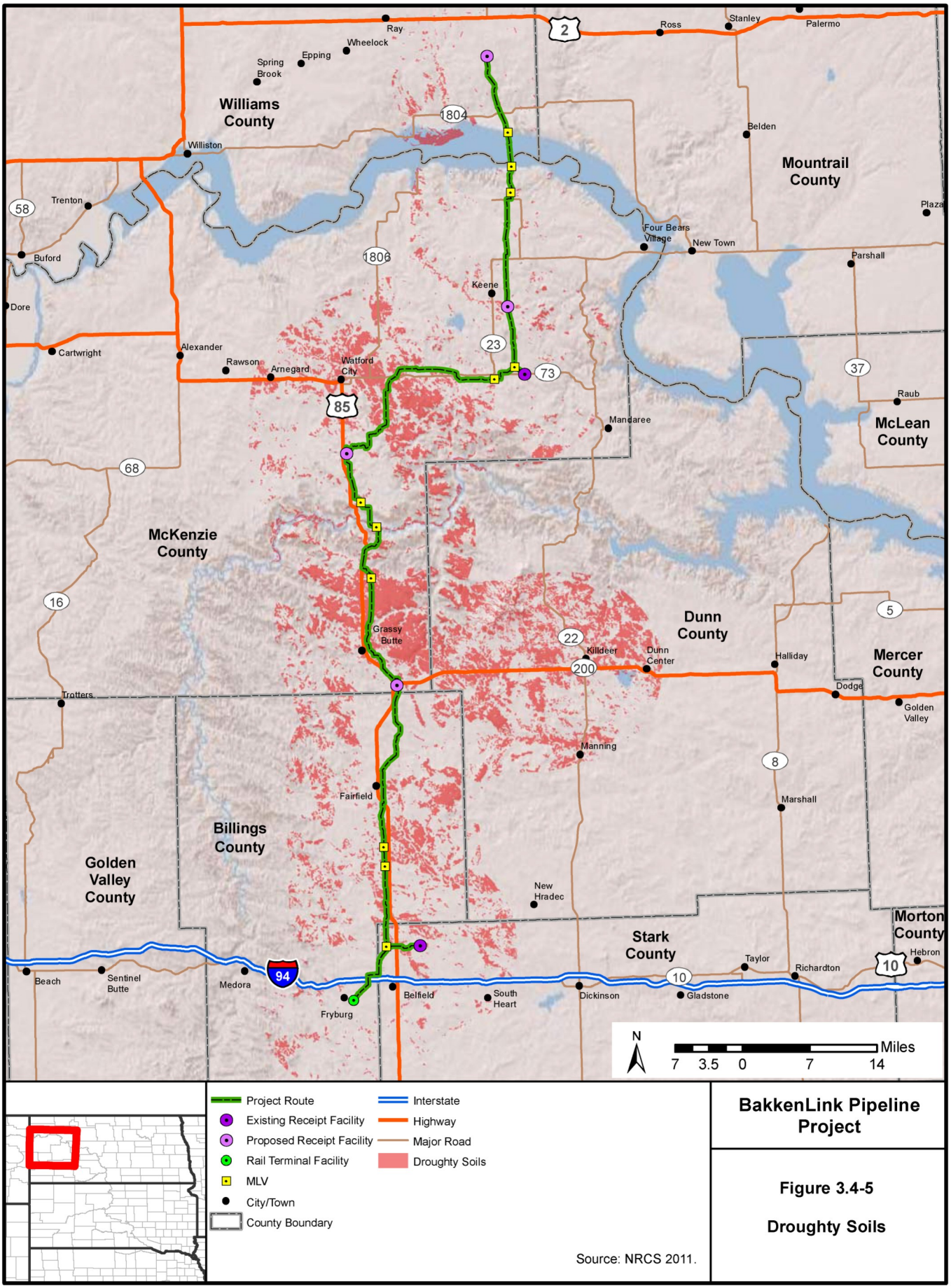


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Figure 3.4-5

Droughty Soils

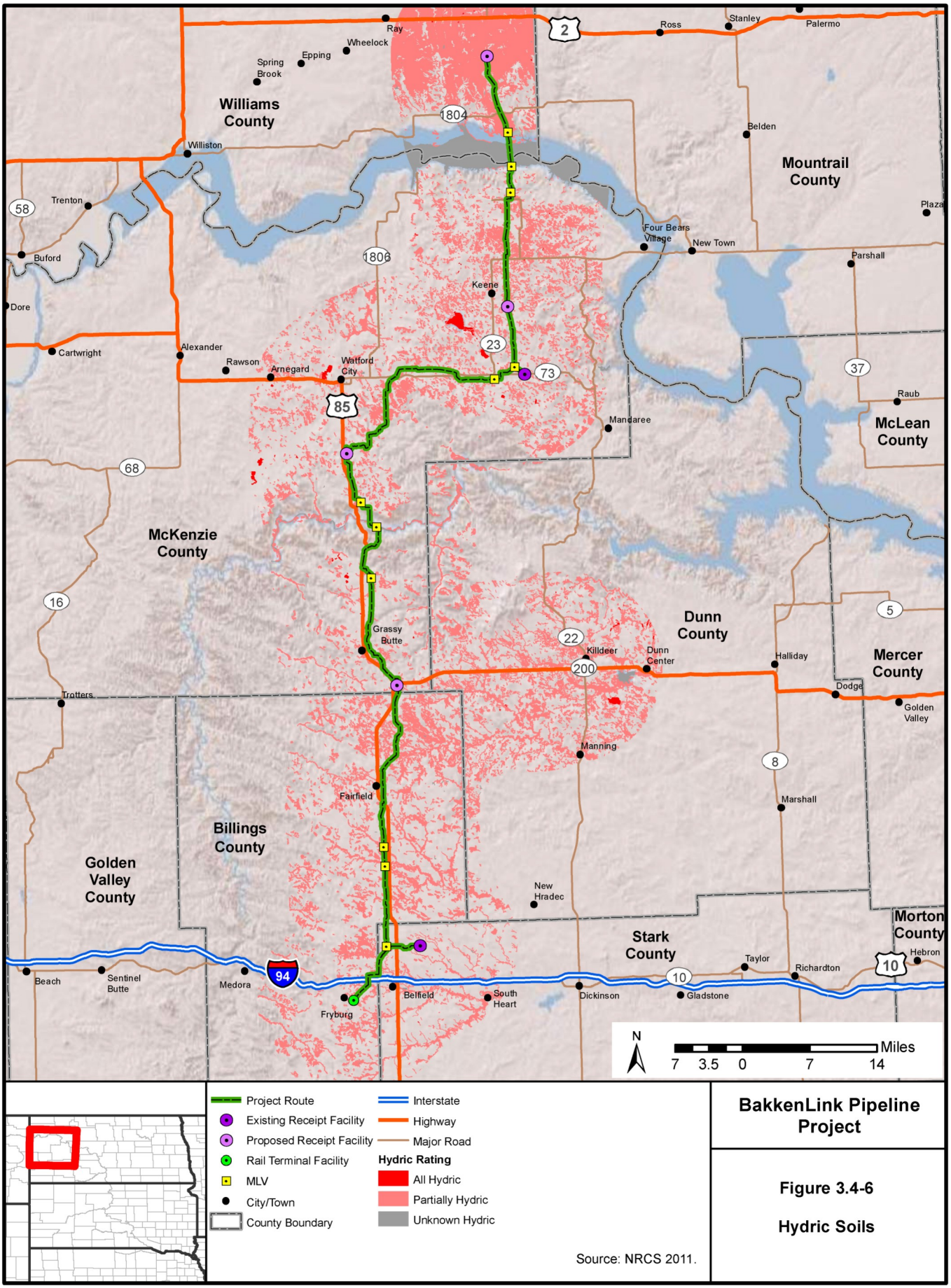

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Figure 3.4-6

Hydric Soils

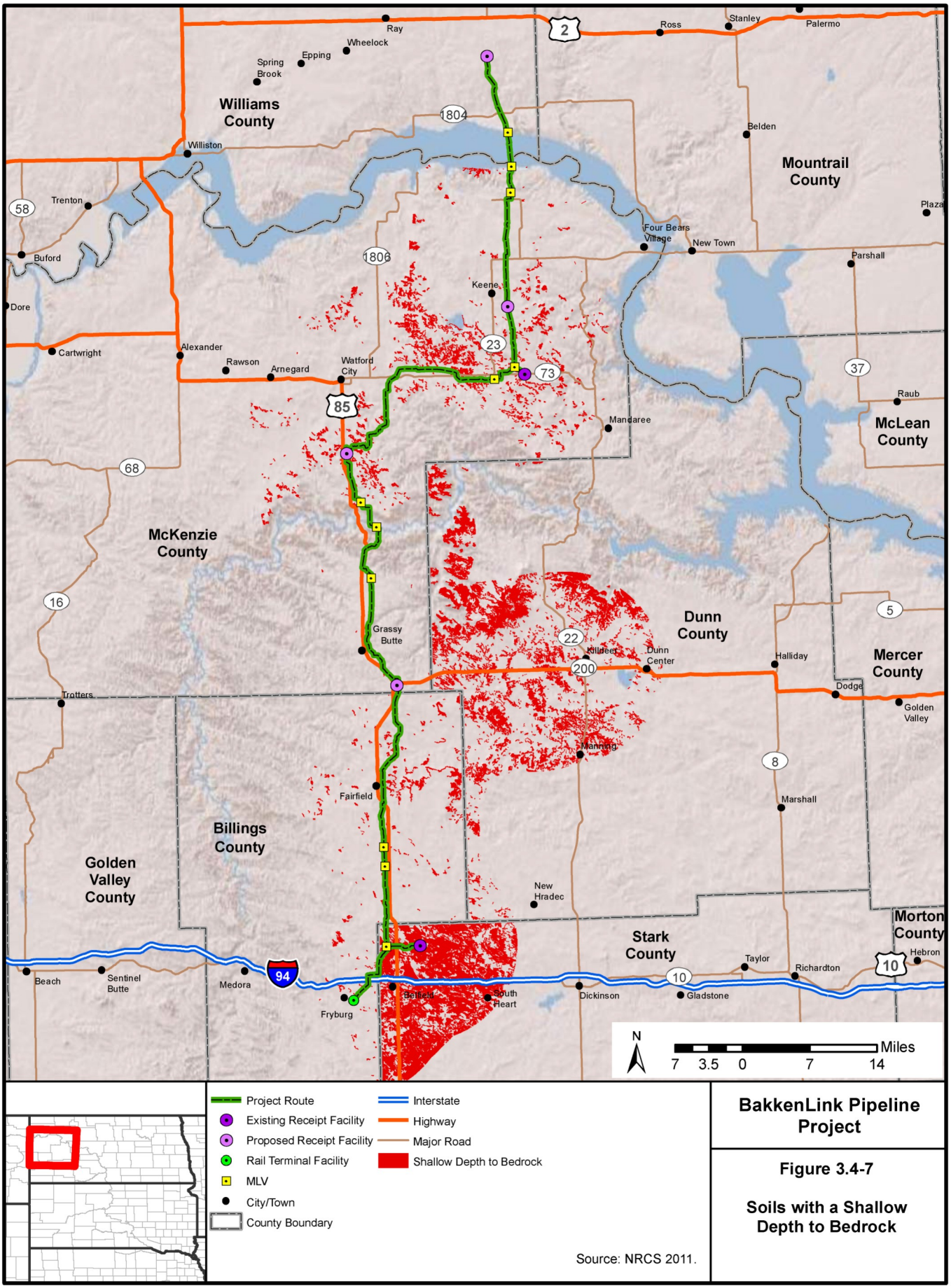

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Figure 3.4-7

Soils with a Shallow Depth to Bedrock