APPENDIX E
Vegetation Management Plan

Castle Rock Solar Project
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IP7137/GS-24-267

Vegetation Management Plan

Castle Rock Solar Project
Dakota County, Minnesota
Stantec Project #:193709215

November 12, 2024

Prepared for:

Castle Rock Solar LLC
3316 Highland Avenue
Wayzata, Minnesota 55391

Prepared by:

Stantec Consulting Services Inc.
One Carlson Parkway, Suite 100
Plymouth, Minnesota 55447

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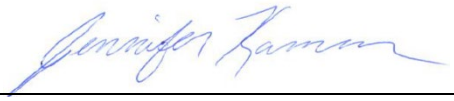
Prepared by 

(signature)

Tony Kaster, Associate, Senior Environmental Scientist

Reviewed by 

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Jennifer Kamm, Associate, Senior Environmental Scientist

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Executive Summary

Introduction

Castle Rock Solar LLC is developing the Castle Rock Solar Project in Dakota County, Minnesota (**Figure 1**). The proposed project area is approximately 1,355 acres, with approximately 934.2 acres developed to support the Preferred Project infrastructure and 420.8 acres would remain undeveloped land based on the preliminary design configurations (**Figure 2**). Castle Rock Solar LLC has developed a Vegetation Management Plan (VMP) to guide vegetation and soil management for the project area from the pre-construction phase through post-construction operation. If approved, the facility would operate under a site permit issued by the Minnesota Public Utilities Commission. The VMP covers site preparation, installation of seed materials, management activities during the vegetation establishment and maintenance phases along with annual monitoring.

Land use within the proposed project area is primarily row-crop agriculture. As a result of the construction of the Castle Rock Solar Project, based on the preliminary design, more than 1,355 acres will be converted and/or managed for perennial, regionally appropriate vegetation for the course of the permit lifetime (approximately 45 years). Areas to be converted to perennial vegetation include all areas within facility fence lines including underneath and between panels and areas outside perimeter of the facility fence lines within the Project Area that will not continue to be used for agricultural production and excluding areas that already consist of perennial vegetation.

For the purpose of this VMP, “regionally appropriate” was defined as having one or more of the following characteristics:

- Native to the region and the state prior to large scale agricultural development.
- Commonly occurs within the landscape of the project area and is not considered to have invasive plant species characteristics that can negatively impact existing plant communities.
- Not listed by the Minnesota Department of Agriculture as a Noxious Weed.

The VMP sets vegetation goals and provides guidance on steps recommended and required to achieve goals in a manner that are consistent with regulatory standards, economic and operationally feasible, and provides environmental benefits. The VMP will be used for internal communication between teams and contractors as a guide and reference document to successfully achieve the vegetation goals for the Castle Rock Solar Project.

The site has three goals for vegetation including 1) establishing low-growing, regionally appropriate grasses within the arrays and associated buffers, 2) minimizing the presence of noxious weeds and 3) protecting adjacent natural areas from impacts during construction and operation of the Project facility.

1.0 VEGETATION ESTABLISHMENT AND MANAGEMENT PLAN OVERVIEW

1.1 Introduction

Castle Rock Solar LLC (Castle Rock Solar) is developing the Castle Rock Solar Project (Project) in Dakota County, Minnesota (**Figure 1**). The proposed Project Area is approximately 1,355 acres. Approximately 934.2 acres of the Preferred Project Area would be developed to support the Preferred Project infrastructure and 420.8 acres would remain undeveloped land based on the preliminary design configurations (**Figure 2**). Castle Rock Solar has developed this VMP to establish and maintain vegetation at the Castle Rock Solar Project in a manner allowing for safe and reliable solar energy generation while providing environmental benefits during operation of the Project. Castle Rock Solar will apply for a site permit for the Project from the Minnesota Public Utilities Commission. The purpose of the VMP is to provide goals and guidelines for successfully establishing and maintaining vegetative cover within the Project Area for the life of the Project.

The VMP was developed during the Project planning phase for the Castle Rock Solar Project using the most current information available. The VMP is intended to be a living document that is updated as needed to reflect changes in on-site conditions, clarifications of previous assumptions, and incorporation of gained knowledge that provides for better management of the Project's vegetation. Upon completion of final construction, the VMP will be reviewed and updated to reflect final construction conditions.

The site has three goals for vegetation including 1) establishing low-growing, regionally appropriate grasses within the arrays and associated buffers, 2) minimizing the presence of noxious weeds and 3) protecting adjacent natural areas from impacts during construction and operation of the Project facility.

1.2 Goals and Objectives for Vegetation Establishment and Management

The following are goals and objectives for vegetation establishment and management associated with the Project:

Goal 1: Perennial Vegetation within Arrays and Associated Buffers

Establish and maintain low-growing regionally appropriate grass-dominated vegetation within the array fields and along the perimeter areas to stabilize the soil.

Objective(s)

- Establish and maintain low-growing regionally appropriate grass-dominated vegetation within the array field and along buffers to meet or exceed requirements of the Project National Pollutant Discharge Elimination System (NPDES) permit. Short-term and long-term vegetation management will be guided by performance standards outlined in this VMP.
- Use maintenance practices that are consistent with typical industry standard practices including periodic mowing and spot herbicide treatment.

- Establish as many acres of perennial vegetation as possible during the pre-construction and construction phases of the Project to provide soil stabilization, meet NPDES and the Project-specific Stormwater Pollution Prevention Plan (SWPPP) requirements, and minimize post-construction re-vegetation efforts.

Goal 2: Noxious and Invasive Plant Species

Minimize the presence and abundance of plant species listed on the Minnesota Department of Agriculture's (MDA) Noxious Weeds List.

Objective(s)

- Use Integrated Vegetation Management to reduce and eliminate MDA Noxious Weed-listed species.
- In areas within the Project boundary not developed for energy generation (i.e. outside of most fence lines and substations), maintain agricultural and other land uses.

Goal 3: Natural Areas Within and Adjacent to Perimeter Fencing

Protect existing natural areas within and adjacent to the perimeter fence including streams, drainages, wetlands, and native plant communities through site evaluation and mapping, implementation of best practices during construction, revegetation in accordance with practices outlined in the VMP and Minnesota Department of Natural Resource (MNDNR) *Prairie Establishment and Maintenance Technical Guidance for Solar Projects* (MNDNR 2020).

Objectives(s)

- Evaluate and map existing natural areas within and adjacent to perimeter fencing to establish baseline conditions. Periodically update information during inspection and/or monitoring activities so current conditions can be compared against baseline conditions.
- Avoid disturbance to any areas outside of the perimeter fence buffers during construction using flagging and signage as shown on the civil site plans in **Appendix A**, contractor education, and erosion and sediment controls.
    - Wetlands within and adjacent to the perimeter fence will be protected from unauthorized fill and sediment during construction and operation of the Project in accordance with the SWPPP developed for the Project.
- Establish and maintain vegetation within the Project Area that meets the desired conditions outlined in the VMP, which uses predominantly regionally appropriate grasses to achieve permanent cover while minimizing the percent cover of MDA-listed noxious weeds and invasive species.
- Select regionally appropriate seed mixes based on local site conditions including hydrology and soil type.
- Protect adjacent native plant communities and wetlands from impacts due to facility construction and operation.

- Avoid disturbance to all native plant communities and wetlands outside of the perimeter fence.
- Apply herbicides within the perimeter fence and vegetated buffer in the appropriate manner that minimizes drift to adjacent plant and wildlife habitats as described in Section 7.6.
- Prioritize invasive species control in management units adjacent to native prairie and other natural communities through seasonal inspections, Early Detection Rapid Response, and collaborating with landowners adjacent to natural areas.

1.3 Monitoring and Implementation Technical Expertise

The implementation of the VMP including pre-construction through monitoring and maintenance period activities will be completed by qualified vegetation management professionals. For the purposes of the VMP and the Project, a qualified vegetation management professional includes individuals or contractors that have one or more of the following qualifications:

- Five or more years implementing and management natural vegetation with specific experience in applying techniques to establish and maintain regionally appropriate grassland communities and vegetation.
- Knowledge of plant identification with an emphasis on regionally appropriate vegetation.
- Post-secondary education or training in the field of natural resources such as degrees, course work, or certification programs.
- Applicable state certifications such as pesticide applicator, erosion control inspector, or erosion control installer.
- Uses specialized equipment characteristic of the tools of the trade for natural resource management.

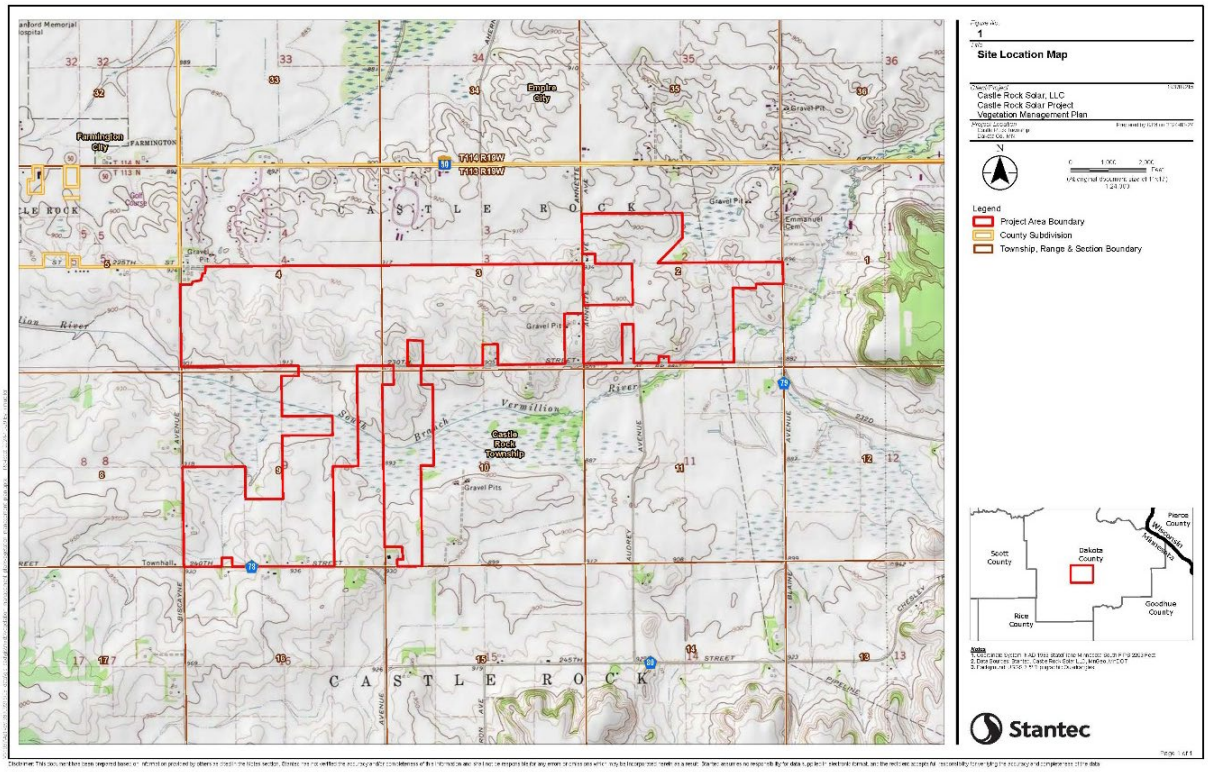
Qualified vegetation management professionals may be internal staff from Castle Rock Solar future facility owners, facility operators, or hired contractors. Likely over the course of the lifetime of the Project, it will be a combination of multiple entities implementing one or more portions of the VMP. The role of the VMP and its associated programs such as adaptive management and monitoring will be to provide a consistent basis for how vegetation will be managed for the lifetime of the Project.

2.0 Site Description

2.1 Project Location and Description

The Project is in Sections 2-4, and 9-10, Township 113 North, Range 19 West, Castle Rock Township, Dakota County, Minnesota (**Figure 1**). The City of Farmington city limits is approximately 500 feet to the northwest, the City of Hampton is approximately 2.5 miles east of the Project Area, and the unincorporated community of Castle Rock is approximately 3 miles southwest of the Project Area.

Figure 1. Site Location Map

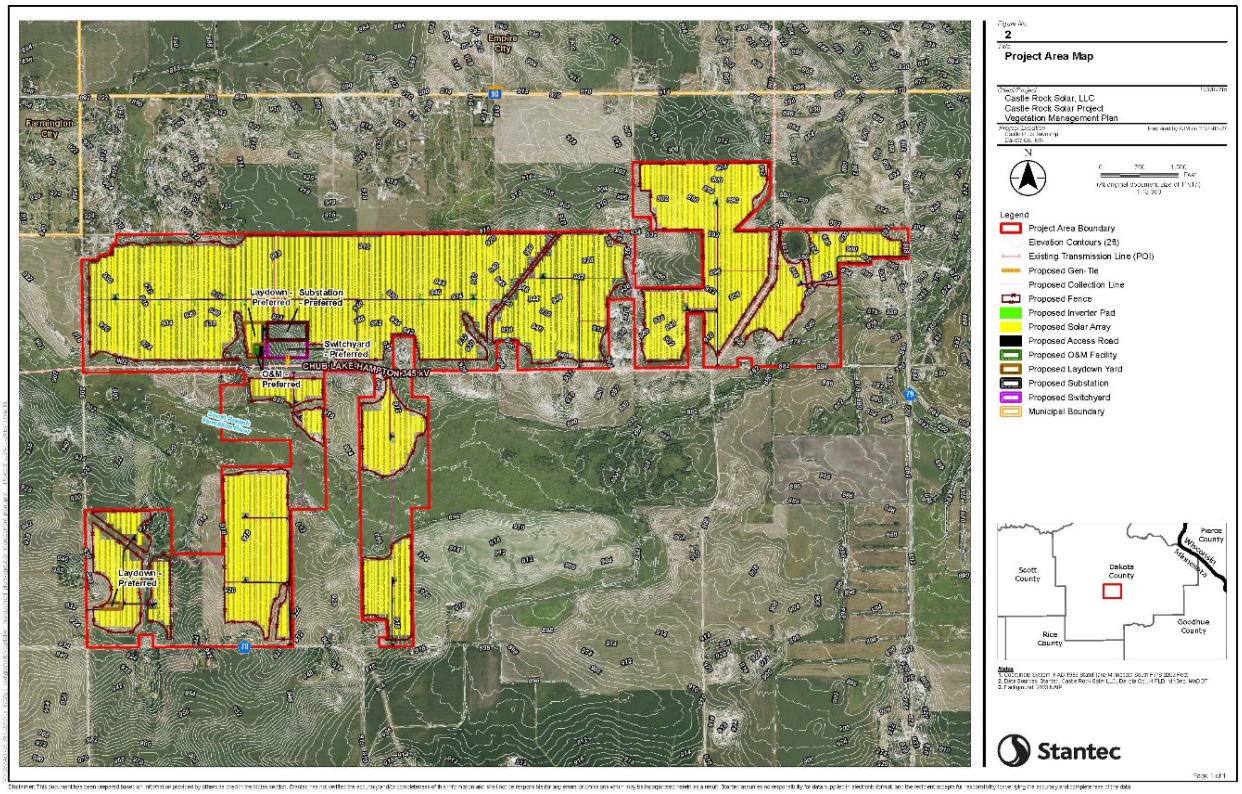


The 150 MW Solar Facility will be a single axis tracking system, situated on approximately 1,355 acres of predominantly agricultural land. The Development Area refers to the portion of the Solar Project on which the solar equipment will be located. The Preferred Project Development Area constitutes a total of 934.2 acres and the Alternate Project Development Area constitutes a total of 933.5 acres within the proposed fence and includes access roads and underground cables located outside the fence (**Figure 2**). The Project is consistent with and capable of supporting Minnesota's mandate and goals found in the Renewable Energy Objectives, Solar Energy Standards, and other applicable energy planning requirements.[1] The Project will support the recently enacted "100 percent by 2040" law that, generally, sets a standard for electric utilities to generate or acquire 100 percent of the energy for retail sales from carbon-free resources and expands the previous Renewable Energy Standard (RES) to require public utilities to generate or procure 55 percent of their energy used to serve Minnesota customers from

[1] See Minn. Stat. §§216B.1691, Subd. 2f, Subd. 2g, 216C.05, and 216E.02, Subd. 1.

renewables by 2035.[2] Further, the Project is directly aligned with the law's goal that ten percent of the retail electric sales in Minnesota be generated by solar energy by 2030.[3]

Figure 2. Project Area Map



2.2 Project Size and Boundary Description

The total acres for the Project are 1,355 acres, with approximately 934.2 acres developed to support the Preferred Project infrastructure and 420.8 acres would remain undeveloped land based on the preliminary design configurations. Approximately 933.5 acres would be developed to support the Alternate Project infrastructure and 421.5 acres would remain undeveloped land based on the preliminary design configurations (**Figure 2)**. The project is surrounded by mostly agricultural areas, with some residential areas to the north of the site. The site is south of MN State Highway 50, east of Biscayne Avenue, west of County Road 79, and north of 240th Street West.

2.3 Historic and Current Vegetation and Land use

Historic Vegetation and Land Use

According to the MNDNR Ecological Classification System, the Project Area is within the Eastern Broadleaf Forest Province. Within this Province, the majority of the Project Area is located within the Minnesota & NE Iowa Morainal Section (222M) and the Oak Savanna Subsection (222Me) (MNDNR

[2] See Minn. Stat. §§ 216B.1691, Subd. 2f, Subd. 2g.
[3] See Minn. Stat. § 216B.1691 Subd. 2f.

2023 and MNDNR 1999). The Oak Savanna Subsection is characterized by loess plain over bedrock or till with moraines and outwash. The bedrock in this area consists of limestone, sandstone, and shale that may be exposed in some areas. Mollisols and Alfisols that range from wet to well-drained are the primary soils in the area. Drainage in the area is well developed and few lakes are present. Annual normal precipitation ranges from 28 inches in the north to 31 inches in the south with the growing season lasting between 146 and 156 days. As such, much of this Subsection is presently farmed; however, historically, bur oak savanna with some tallgrass prairie and maple-basswood forest were the primary vegetation (MNDNR 2023).

According to the Natural Resources Conservation Service (NRCS) Land Resource Region and Major Land Resource Area (MLRA), the Project is located in the Central Feed Grains and Livestock Region and the Eastern Iowa and Minnesota Till Prairies (USDA 2022). LLRs are a group of geographically associated major land resource areas, and MLRAs are geographically associated land resource units. This MLRA is part of the recently glaciated till and outwash plains. This area was covered with loamy alluvium or loess after glaciation. Lakes, ponds, and marshes are common throughout the area, and streams generally have a dendritic pattern (USDA 2022).

The Dakota County online collection of aerial photographs includes aerial images of this site from 1937 to present. The 1937 photo shows the site in agricultural production (**Figure 3)**. There are no significant changes until the 1990s when residential development appears to the north of the site.

Figure 3. Historical Aerial from 1939

VEGETATION MANAGEMENT PLAN

Current Vegetation and Land Use

The Project Area is within the Mississippi River – Lake Pepin Major Watershed Basin. The project is located within the watershed of the South Branch Vermillion River which crosses the site from west to east. The Vermillion River is a Minnesota Public Waters Inventory (PWI) mapped waterway.

Current vegetation within the Project Area is primarily cultivated crops, along with some small deciduous forested areas, prairie, and several wetland types included wet meadow, sedge meadow, shallow marsh, shrub-carr, hardwood swamp, and floodplain forest.

Wetland delineation field investigations were performed in October 2022 and 2023. A total of 22 wetlands and one open water feature were delineated within the Project Area (**Table 3**) and six waterways (**Table 4).** The Project has been designed to avoid temporary and permanent impacts to wetlands.

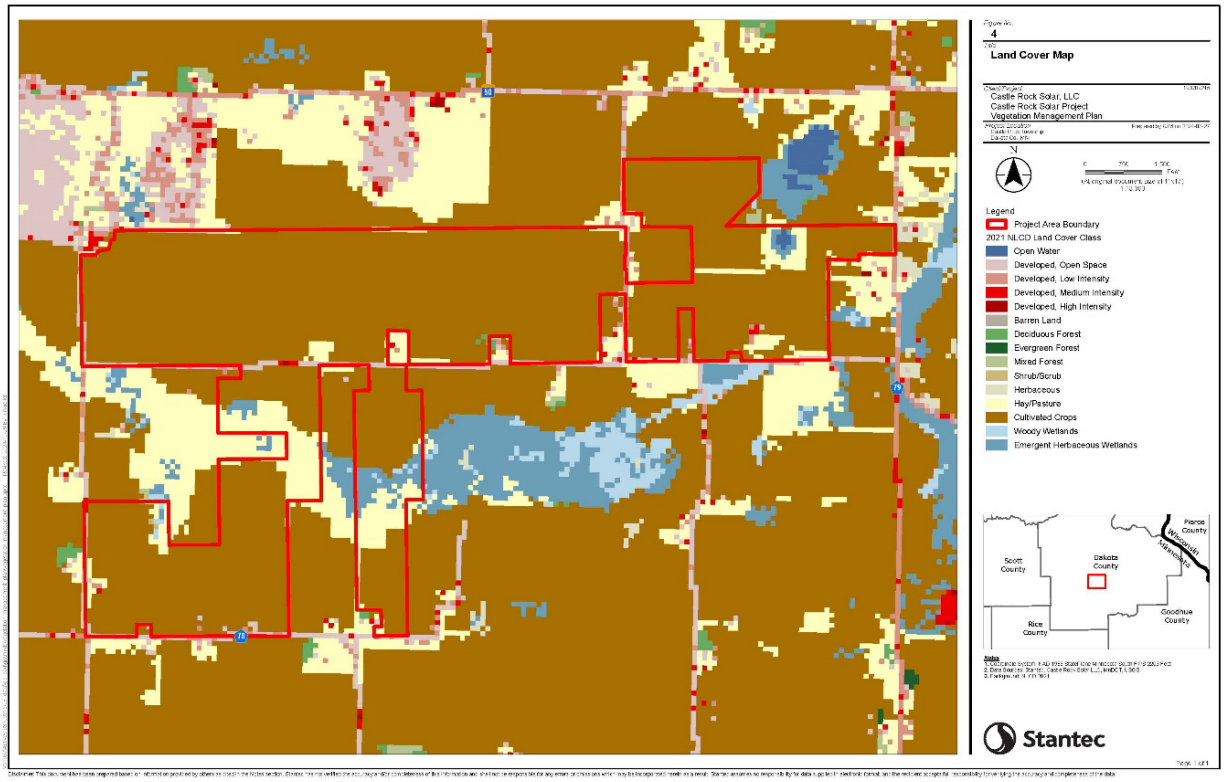
The Project is located within a rural landscape, and therefore the primary land use in the Project Area is agricultural (95%). The remaining identified land uses include wetlands, forest, and development. Most of the agricultural land in the Project Area is subject to row-crop agriculture, such as corn and soybeans. Land use within the Project Area, based on U.S. Geological Survey National Land Cover Database (NLCD) mapping, is summarized in **Table 1** and a map is provided in **Figure 4**.

Table 1. NLCD Mapped Land Use within the Project Area

Land Use Type	Acres in Solar Facility Development Area
Cultivated Crops	1181.49
Deciduous Forest	0.89
Developed, High Intensity	0.22
Developed, Low Intensity	7.92
Developed, Medium Intensity	2.45
Developed, Open Space	25.81
Emergent Herbaceous Wetlands	23.68
Herbaceous/Hay/Pasture	107.11
Mixed Forest	0.14
Open Water	1.78
Shrub/Scrub	0.44
Woody Wetlands	2.95
Total	**1354.90**

Source: USGS National Land Cover Data 2021.
[1]*Note: Table totals may differ slightly from sum of rows as a result of rounding.*

Figure 4. Land Cover Map

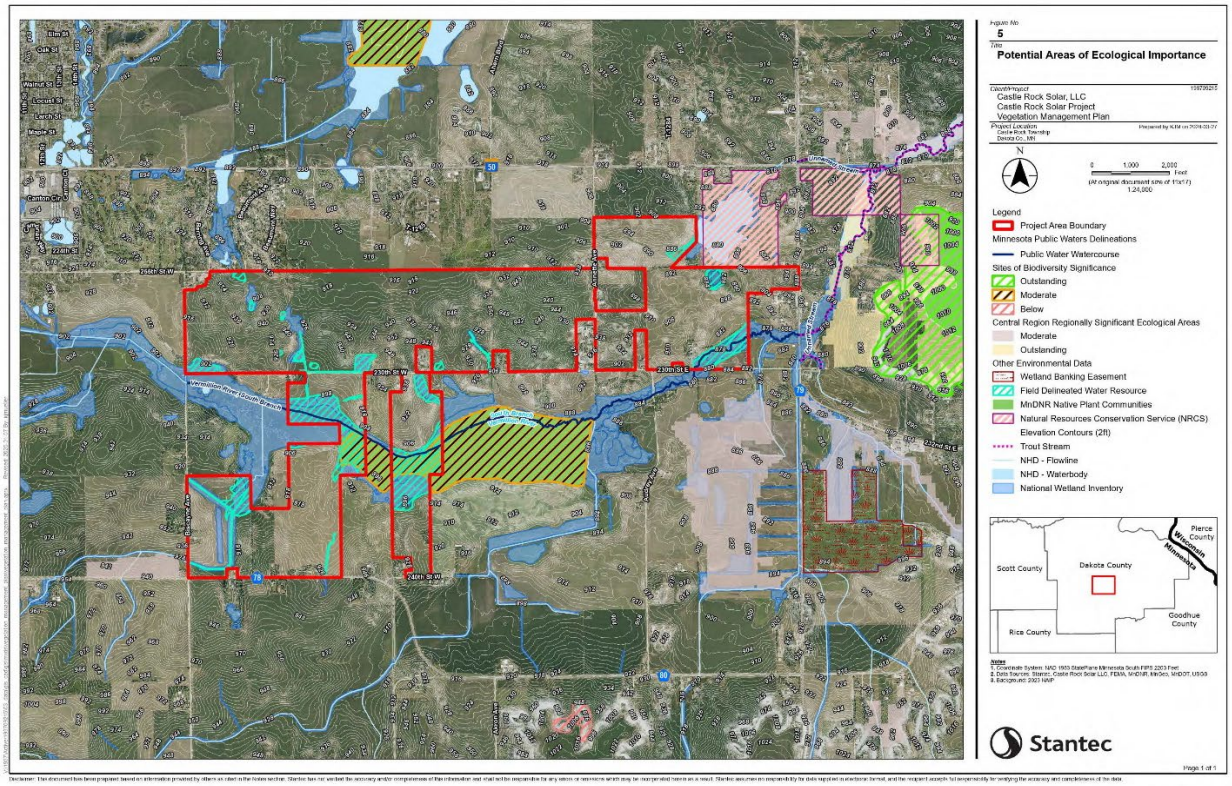


Locations of potential areas of ecological importance are shown in **Figure 5**. There are one MBS Sites of Biodiversity Significance (SBS) located within the Project Area, within the riparian area of the South Branch Vermillion River. A “Moderate” rank is associated with this area and extends to the east of the Project Area. An additional area ranked as “Outstanding” is located to the east of the Project Site.

The MNDNR describes native plant communities as a group of native plants that are not greatly altered by modern human activity or introduced organisms and are classified and described by considering vegetation, hydrology, landforms, soils, and natural disturbance regimes including wildfires and floods (MNDNR 2024). A MNDNR Native Plant Community is within the site and is associated with the MBS feature described above.

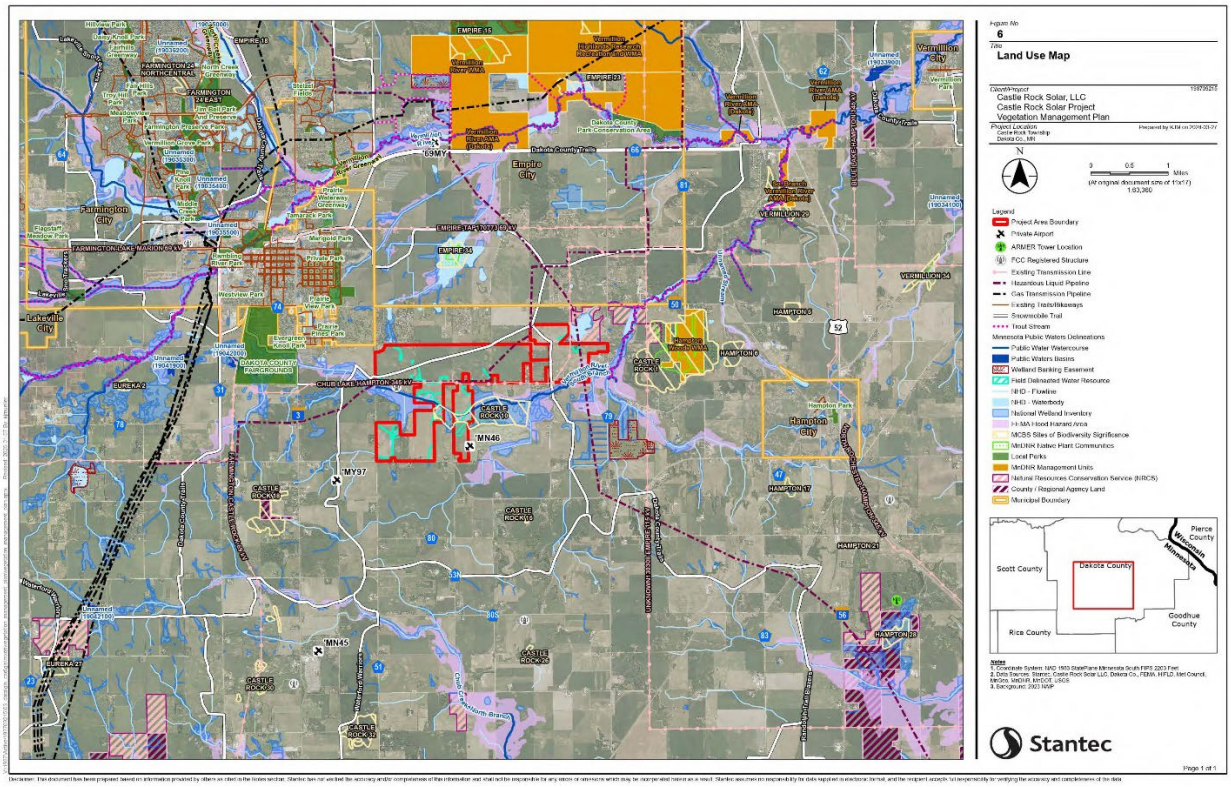
No CREP or RIM parcels or other conservation easements or land enrolled in government conservation programs known to be present within the Project Area.

Figure 5. Potential Areas of Ecological Importance



There is no public land including recreation or public conservation areas (ex. WMAs, SNAs, etc.) located within the Project Area. Public land located within a mile of the Project Area includes Hampton Woods WMA, the Dakota County Fairgrounds, and Prairie View Park. Public lands in the vicinity of the Project are shown in **Figure 6**.

Figure 6. Land Use



2.4 Topography

The Project Area is a gently rolling landscape area with ground surface elevations typically between 876 feet above mean sea level (ft amsl) and 969 ft amsl. The northern portion of the site drains to the north, with the central and southern portions draining toward the South Branch Vermillion River. Existing two-foot contours are shown in **Figure 5**.

2.5 Soils

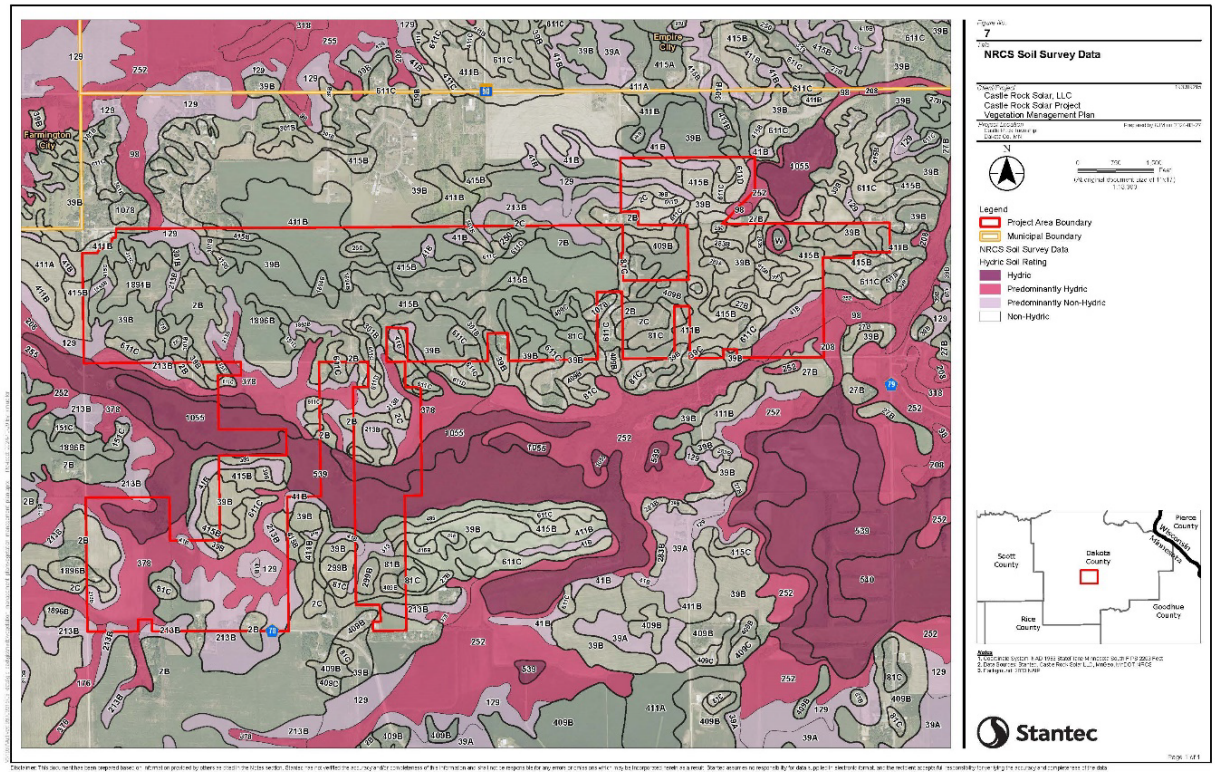
Soils in the Project Area and the surrounding region are derived from glacial and post-glacial activity. The surface soil texture is dominated by sandy loam to silty glacial till and outwash sediments. Repeated periods of glacial activity and erosional forces has washed away soil and deposited them in varying landscape positions. The nature of deposition ultimately influenced the chemical and physical properties that affect their natural chemical and physical properties today.

Soil designated as Hydric, Predominantly Hydric, Predominantly Non-Hydric, and Non-Hydric were identified in the Project area. The majority of the soils are predominantly non-hydric or non-hydric. The largest concentration of Hydric soil resides in mapped wetlands surrounding the South Branch Vermillion River. The soil in the Project Area ranges from Excessively drained, Well drained, Moderately Well drained, Somewhat poorly drained, Poorly drained, and Very Poorly drained. Soil hydric and drainage ratings are two of many physical and chemical characteristics that are considered to determine prime farmland areas.

The project area contains several major surface geological units. They include:

- Pierce Formation Till (pt) - Loam diamicton; Unsorted sediment with a loamy matrix, containing uncommon to common pebbles and rare cobbles and boulders. Pre-Wisconsinan glaciation sediment deposited by ice of Winnipeg provenance.
- River Falls Formation Outwash (rfo) – Sand and gravel; Stratified sand and gravel deposited by subaerial meltwater carrying sediment dominantly from the Superior lobe. Sand ranges from course- to fine-grained and is poorly to well-sorted; cobbly and bouldery in places. Pre-Wisconsinan glaciation sediment deposited by ice of Superior provenance.
- Cromwell Formation St. Croix Phase Outwash (cso) – Sand and gravel deposited by subaerial meltwater carrying sediment dominantly from the Superior lobe. Sand ranges from course- to fine-grained and is poorly to well-sorted; cobbly and bouldery in places. Wisconsinan glaciation sediment deposited by ice of Superior provenance.
- New Ulm Formation Outwash (nuo) – Sand and gravel deposited by subaerial meltwater carrying sediment dominantly from the Des Moines lobe. Sand ranges from course- to fine-grained and is poorly to well-sorted. Wisconsinan glaciation sediment deposited by ice of the Riding Mountain provenance.
- Holocene Alluvium (al) – generally stratified, coarse-grained sand and gravel deposited in fluvial channels, and finer-grained loam, silt, and sand on floodplains. May be interbedded with, or underlying, organic material.
- Organic debris, clay, and silt (pe) – Decomposed organic matter (peat: >50% organics; fine-grained sediment <50% organics), typically deposited in marshes, ponded water, alluvial floodplains, and other depressions in the landscape.

Figure 7. NRCS Soil Survey Data



Soils were characterized as hydric throughout the Project location during the wetland delineation conducted for the Project. Wetlands are associated with some of these areas, however other areas appear to be effectively drained by agricultural practices. There are no known springs or seeps at the site. The Project site is comprised of approximately 584 acres of Prime Farmland. NRCS Soil Survey Soil Drainage Classification and Hydric Soils mapping is shown in **Figure 7**.

The primary constraint, for the purpose of vegetation, is soil moisture (**Table 2**). Soils associated with the Castle Rock Solar Project tend to be loams that are well drained, however poorly drained and excessively drained soils are also found within the site. High moisture soils are conducive for robust vegetation establishment and cover but are also susceptible to soil compaction and nutrient levels that may facilitate weed growth.

Soil drainage and water holding characteristics are considered for seed mix design. Soils are generally loams with moderate drainage qualities. Compaction during construction will also decrease drainage efficiency and increase water holding capacity, favoring species adapted to higher moisture conditions. In general, moist soils, along with a potential legacy of agricultural fertilizers, encourage robust vegetation growth. Based on existing soil drainage characteristics, past land use, and anticipated soil hydrology impacts following Project construction, a mesic low growing solar array seed mixes has been designed that includes species that are compatible with the drainage characteristics across the site as described. These mixes are provided in **Appendix B, Table B.2, B.3, and B.4**.

Table 2. Soil Characteristic Constraints Over Vegetation

Vegetation Hydric Types	Drainage Characteristics	Modal Species	% Cover
Moist Mesic to Mesic Vegetation	Moderately to poorly drained High to moderate water holding	Marsh Bluegrass (*Poa palustris*)[1] Blue-joint Grass (*Calamagrostis canadensis*)[2] Big Bluestem (*Andropogon gerardii*)[2]	16%
Mesic Vegetation	Moderately well drained Moderate to low water holding	Big Bluestem (*Andropogon gerardii*)[2]	5%
Mesic to Dry Mesic Vegetation	Well drained to Excessively drained Low water holding capacity	Side Oats (*Bouteloua curtipendula*)[1] Little Bluestem (*Schizachyrium scoparium*)[1]	79%

[1] Native and highly suitable for site specific array seed mix.
[2] Dominate historic vegetation, but too tall for solar purposes.

2.6 Hydrology

The Project is located in the Mississippi River – Lake Pepin Watershed Basin. One MNDNR Public Watercourse Vermillion River South Branch (M-049-005), within the Study Area. The Vermillion River South Branch generally flows west to northeast through the entire Study Area.

Field investigations were performed October 17-21, 2022, and October 11-12, 2023, by Stantec. The northwest corner of the Study Area has a previously approved wetland delineation which was completed by Kimley-Horn and Associates in October 2023. The Notice of Decision (NOD) was issued for the delineation of 314 acres of Section 4 in Township 113 North, Range 19 West by the WCA Local Government Unit (LGU), the Dakota County Soil and Water Conservation District (SWCD), on February 23, 2024. Boundary concurrence on the Stantec delineated wetlands and waterways has been submitted for review to the LGU and the boundary concurrence decision is pending.

A total of 22 wetlands and one open water feature were delineated within the Project Area and six waterways (**Tables 3 & 4**). See the Site Permit Application for more information on wetland impact avoidance and minimization measures. Wetland types and acreages and waterbody types and linear feet are summarized in **Table 3** and **Table 4** respectively.

Table 3. Delineated Wetlands Within the Project Area

Wetland ID	Wetland Type*	Adjacent Surface Waters	Area in Study Area (acres)
W1	Degraded Wet Meadow	KH-ES2, KH-W5	0.61
W2	Hardwood Swamp, Farmed Wetland, Degraded Wet Meadow, Sedge Meadow, Shrub-Carr	Vermillion River, South Branch (M-049-005)	42.06

Wetland ID	Wetland Type*	Adjacent Surface Waters	Area in Study Area (acres)
W3	Degraded Wet Meadow	---	0.50
W4	Degraded Wet Meadow	---	0.64
W5	Farmed Wetland, Degraded Wet Meadow	---	0.02
W6	Farmed Wetland, Degraded Wet Meadow	S2	0.31
W7	Hardwood Swamp, Degraded Wet Meadow	S2	1.15
W8	Hardwood Swamp, Farmed Wetland, Degraded Wet Meadow	S3, S4	13.61
W9	Hardwood Swamp, Floodplain Forest, Degraded Wet Meadow, Sedge Meadow, Shallow Marsh, Shrub-Carr	Vermillion River, South Branch (M-049-005)	39.31
W10	Hardwood Swamp, Farmed Wetland, Degraded Wet Meadow, Shrub-Carr	---	4.99
W11	Farmed Wetland	---	0.86
W15	Floodplain Forest, Shrub-Carr	Vermillion River, South Branch (M-049-005)	14.84
W16	Degraded Wet Meadow	OW1	1.47
W18	Floodplain Forest, Farmed Wetland, Wet Meadow	---	3.32
KH-W1	Degraded Wet Meadow, Shallow Marsh	Vermillion River, South Branch (M-049-005)	4.60
KH-W2	Farmed Wetland	---	0.24
KH-W3	Degraded Wet Meadow, Shallow Marsh, Shrub-Carr	KH-ES1, KH-ES2	1.54
KH-W4	Farmed Wetland	---	0.60
KH-W5	Degraded Wet Meadow, Shrub-Carr	---	4.04
KH-W6	Farmed Wetland	---	0.44
KH-W7	Farmed Wetland	---	1.32
KH-W8	Farmed Wetland	---	0.64
		TOTAL	**137.10 acres**

Table 4. Delineated Watercourses within the Project Area

Waterway ID	PWI ID	Flow Class	OHWM Width/Height (feet)	Bank Width/Height (feet)	Length In Study Area (linear feet)
S1	Vermillion River, South Branch (M-049-005)	Perennial	18 ft, 3 ft	20 ft, 1-2 ft	5,948
S2	--	Perennial	4 ft, 3 ft	10 ft, 4 ft	643
S3	--	Perennial	3.5 ft, 0.60 ft	5 ft, 4 ft	3,442
S4	--	Perennial	2.5 ft, 0.75 ft	10 ft, 5 ft	1,485
KH-ES1	--	Ephemeral	2 ft, 1 ft	--	597
KH-ES2	--	Ephemeral	2 ft, 1 ft	--	154
				Total	**12,269**

2.7 Drain Tile

Castle Rock Solar has had discussions with the participating landowners and understands that drain tiles are minimal in this area. Pre-construction farm field drain tile mapping challenges often exist on solar energy Projects. Identifying and locating drain tiles is complicated because of missing, incomplete, and inaccurate mapping. Castle Rock Solar will review available drain tile maps from participating landowners with land in the Project Area. Castle Rock Solar will attempt to avoid and/or relocate existing drainage systems as needed for construction of the Project. Drain tile or drainage system adversely affected by the Project will be identified, repaired, relocated, or replaced as needed to achieve the function and scope to its original size and capacity. Replacement or rerouting of tile will take place during construction or as it is identified in order to maintain the integrity of the drainage lines. This practice should minimize interruption of drainage on site or on neighboring farms that may drain through the Project leased property. New or modified drain tile systems installed by Castle Rock Solar will be located using Global Positioning System equipment and archived in Project construction files and the Project Decommissioning Plan.

The following considerations will also apply:

- Tiles will be repaired with materials of the same or better quality as that which was damaged.
- Tile repairs will be conducted and located in a manner consistent with industry-accepted methods.

- Before completing permanent tile repairs, tiles will be examined within the work area to check for tile that might have been damaged by construction equipment. If tiles are found to be damaged, they will be repaired.

Castle Rock Solar's design minimizes conflicts between known tile and the solar racking systems to minimize damage to tile to the extent feasible. In some areas, re-routing of the tile is necessary, and this re-routing work will take place immediately prior to or during construction. Additional tile may be installed prior to or during construction to augment the existing system and to maintain the drainage profile of the site.

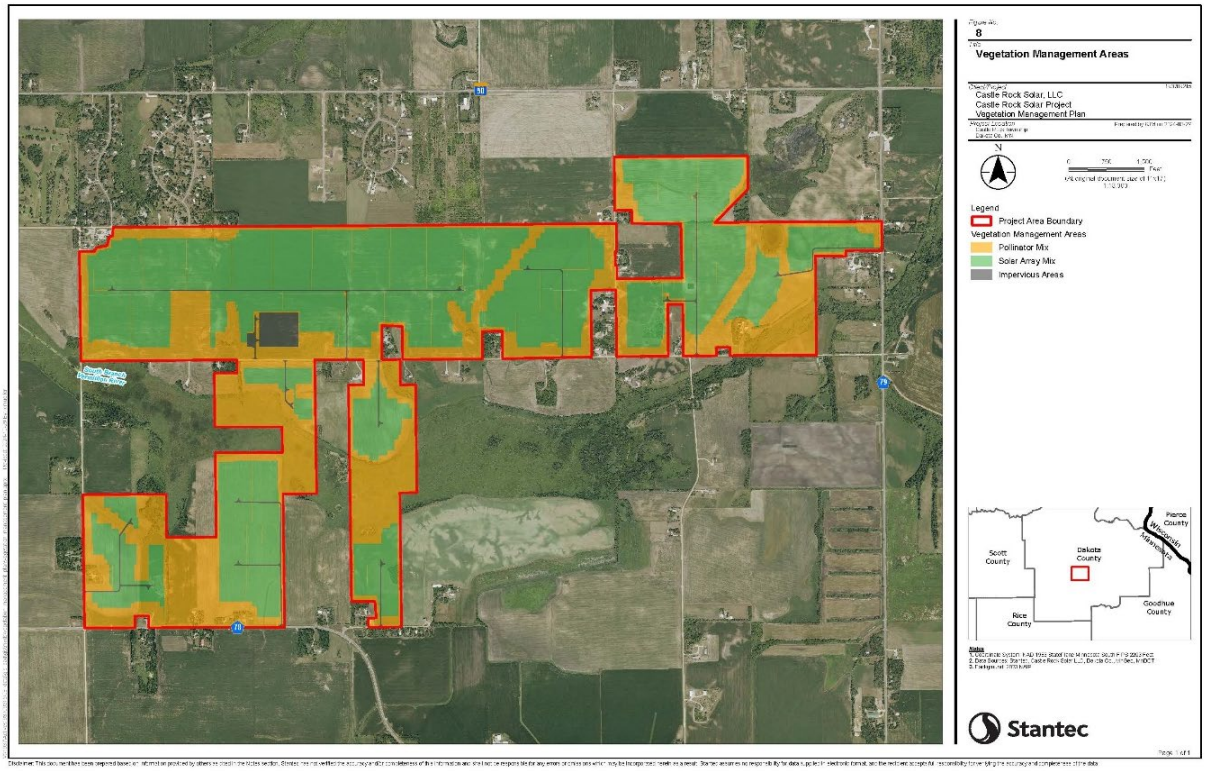
Following completion of construction, Castle Rock Solar will inspect the Project Site after significant snow melt or rainfall events for evidence that tile systems are functioning adequately. If localized wet areas or standing water are observed, it is likely the tile system is not operating as anticipated. In this situation, the Tile Contractor will be reengaged to pin-point damaged tile that may have been missed during construction. Tile would be repaired following the process outlined above.

3.0 Vegetation Management

3.1 Management Areas

The Project area consists of blocks of panels throughout the solar facility. Management units across the site have been defined by the vegetation type specified for installation. A Solar Array Mix, comprised of low growing species suitable for mesic conditions will be planted in all solar arrays. Additionally, a Pollinator Mix will be planted in perimeter areas and non-solar array areas. **Figure 8** shows a representation of the management areas. Descriptions of the steps to establish and maintain the management areas are included in the following sections.

Figure 8. Vegetation Management Areas



The Solar Array Mix is suitable for mesic to dry conditions and is expected to grow well in the loam soils of the site. Water availability is expected to be moderate and is not anticipated to be a limiting factor in growth. This management unit is indicated in green on **Figure 8.** The Pollinator Mix is also suitable for mesic to dry mesic conditions and is expected to grow well on the site based on soils and hydrology.

3.2 Vegetation Management Objectives

Vegetation management objectives have been developed for the pre-construction/construction phase, as well as short-term establishment and long-term establishment for the Project Area.

Pre-construction/Construction Phase Objectives

Pre-construction is defined as the period that begins when Castle Rock Solar assumes control of parcels within the proposed Project Area to the initialization of construction activities associated with the solar facility. Construction is the period when the solar facility infrastructure is being installed. Construction activities can include, but not limited to, access road construction, array and collection cable installation, and fencing. Construction typically lasts 12-18 months and is anticipated to begin for the Project in Q3 2025, with expected completion by early 2027.

The following are the objectives for vegetation and soil management during the pre-construction phase prior to the installation of any solar facility assets or land disturbing activities:

- In areas where no civil construction (grading) is required as part of the construction activities, establish the designated Solar Array Mix, or Pollinator Mix to initiate long-term perennial vegetation during the soonest available optimal seeding window to increase the probability of successful vegetation establishment.

Construction schedule and sequencing will be an important driver for the seed mixes used to meet pre-construction/construction objectives. In areas where no civil construction is required and the pre-construction period allows for the establishment of perennial vegetation prior to construction, permanent low-growing regionally appropriate seed mixes (Solar Array Seed Mix and Pollinator Seed Mix), **Appendix B, Tables B.2, B.3, and B.4** will be used in the locations shown in **Figure 8**. In areas where no civil construction is required and the pre-construction period does not allow for adequate permanent perennial vegetation establishment prior to construction, temporary seed mixes would be used until the completion of construction in that area. Section 6 provides greater detail on the use of temporary seed mixes for soil and erosion control throughout the construction phase of the project.

Permanent perennial seed mixes were developed by referencing the guidelines outlined in MNDNR (2020) *Prairie Establishment and Maintenance Technical Guidance for Solar Projects* and multiple Minnesota Board of Water and Soil Resources (MN BWSR) seed mixes, including low-growing array mixes suitable for conditions present within the Project Area.

Each low-growing grass-dominated seed mix has the following characteristics:

- A minimum seeding rate of 55 seeds/sq. ft.[2]
- At least 30% of the total seeding rate should be composed of perennial forbs.
- 5 or more native grass/sedge species with at least 2 species of bunchgrass.
- 10-15 or more native forbs with at least 3 species in each bloom period: Early (April-May), Mid (June-August), and Late (August-October).

In areas where civil construction (grading) is required as part of the construction activities, establish and maintain a designated temporary seed mix until grading is complete to provide soil stabilization and compliance with SWPPP conditions. If construction activities extend beyond the life cycle of a temporary seed mix, consider re-seeding areas, as necessary.

The following are the objectives for vegetation and soil management during the construction phase:

- In areas where perennial vegetation was established during the pre-construction phase, manage vegetation in a manner that supports remaining compliant with SWPPP conditions including mowing, herbicide applications, and re-seeding areas disturbed by construction activities.
- In areas where civil construction requires grading or land disturbance, establish the designated Solar Array Seed Mix and Pollinator Seed Mix in the locations as shown in **Figure 8** following the completion of grading activities and prior to the installation of solar facility assets such as arrays, collection cables, or fences. Use typical vegetation management practices such as mowing, spot spraying, and re-seeding to minimize establishment of MDA-listed noxious weeds.
- In areas where establishing the Solar Array Seed Mix and Pollinator Seed Mix immediately following the construction phase is not possible, use a temporary seed mix to remain compliant with SWPPP conditions and then establish permanent regionally appropriate grass-dominated vegetation during the soonest available optimal seeding window to increase the probability of successful vegetation establishment. Use typical vegetation management practices such as mowing, spot spraying, and re-seeding to minimize establishment of MDA-listed noxious weeds.

Post Construction Phase Objectives

Establishment and maintenance phases occur over the course of years. Demonstrating incremental progress towards a desired objective is important. **Table 5** provides a summary of performance criteria for the components of vegetation cover for both short-term and long-term objectives. Phase year benchmarks are included as a reference to measure during monitoring and to demonstrate trends or progress towards meeting and maintaining the long-term management objectives. Actual vegetation performance against reference year benchmarks will be used as indicator of the success of current vegetation management or the need for additional management or resources.

Table 5. Performance Criteria for Vegetation Cover

Phase	End of Growing Season Reference Year	Perennial Cover (Overall)	Perennial Cover (Regionally appropriate Species)	MDA-listed Noxious Weed Cover	Invasive Weedy Species Cover
Establishment	Year 2	>30%	>20%	<10%	<50%
	Year 4	>50%	>40%	<5%	<30%
	Year 5	>70%	>50%	<5%	<15%
Maintenance	Year 6+	>90%	>70%	<5%	<15%

Short-term Establishment Objectives

Short-term establishment objectives are defined as the desired conditions for vegetation management units in Years 0 to 5 immediately following construction activities and focus on establishing perennial regionally appropriate vegetation.

Specifically, short-term establishment objectives include:

- Establish or maintain a temporary seed mix with greater than 70 percent vegetation cover during the seasonal periods each year when conditions are not conducive to establishing perennial vegetation to meet or exceed requirements of the project NDPES permit. This primarily includes areas that have not undergone initial perennial re-vegetation during pre-construction or construction phases.

- In areas that have not been re-vegetated with a perennial seed mix during the pre-construction or construction phase, install the designated regionally appropriate seed mix within the first 6 months following construction during the soonest available optimal seeding window to increase the probability of successful vegetation establishment.

- During Years 1 and 2, use mowing to reduce annual weed competition, minimize MDA-listed noxious weed species to less than 10 percent cover, minimize weedy species (See **Table 8** and **9** in Section 4.5 for a list of invasive and potentially invasive species) to less than 50 percent cover, and establish 30 percent or greater perennial vegetation cover.

- During Years 1 and 2, use seasonal inspections and annual monitoring to identify areas where re-seeding may be required. Consider modifying or supplementing seed mixes to match local-scale conditions as additional information about the site is obtained. For example, supplemental re-seed areas with the low-growing wet mesic seed mix in areas that end up being wetter than planned.

- By Year 4, establish 50 percent or greater perennial vegetation cover with less than 5 percent MDA-listed noxious weed species and less than 30 percent weedy species cover.

- Use spot-spraying with the appropriate herbicides to reduce and control weed species that cannot be controlled through mowing practices to less than 20 percent total cover.

- By the end of Year 5, perennial vegetation cover will be 70 percent or greater with 50 percent or greater cover from regionally appropriate species. MDA-listed species will be 5 percent or less of total cover and weedy species will be 15 percent or less of total cover.

- By the end of Year 5, reduce the number and need for mowing and herbicide treatments as a form of weed control, if possible, because each vegetation management unit has well-established low-growing regionally appropriate grass sod (or regionally appropriate grasses and forbs, where planned).

Long-term Management Objective

Long-term management objectives are defined as the desired conditions for vegetation management units in Year 6 to the end of the permit and will focus on maintaining regionally appropriate, perennial vegetation. Specifically, long-term management objectives include:

- Maintain 90 percent or greater perennial vegetation cover, including 70 percent or greater regionally appropriate grass-dominated vegetation cover or regionally appropriate grasses and forbs, where planned within each vegetation management unit as mapped using prescribed mowing, spot-spraying, and supplemental seeding to minimize MDA-listed noxious weed species.

MDA-listed species will be 5 percent or less of total cover, and weedy species will be 15 percent or less of total cover.

- Initiate vegetation management activities if invasive weedy species cover becomes 20 percent or greater and/or MDA-listed noxious weed cover becomes 10 percent or greater to maintain meeting long-term management objectives.

4.0 Site Preparation and Seasonal Timing

The placement of the seed mix will be refined once the site design has been finalized, but the general approach to the installation of the planting mixes based on the current design is provided. Installation timing, construction sequencing, and site conditions at the time of installation play a large role in determining the correct steps required for successful installation. At the time of this writing, the construction sequencing is not fully developed for a detailed seeding schedule to be outlined. The proper steps to take upon development of the construction sequencing can, however, be outlined. The purpose of this section is to describe the appropriate steps for a given condition to cover a wide range of scenarios that may occur during project development and provide the steps necessary should those conditions occur.

The Solar Array Mix and Pollinator Mix for Mesic to Dry-Mesic Soils will be installed in fenced areas and perimeter areas outside of the fence that require permanent vegetative cover (**Figure 8**). There will be no planting on the internal access roads, the substation, switchyard, or operation and management facility areas, along public road ROWs, or in areas identified as streams or wetlands where existing vegetation is present. State of Minnesota Seed Mix 33-261 Stormwater South and West Mix for vegetation of permanent stormwater ponds and a Pollinator Seed Mix for use in perimeter areas is provided in **Appendix B**.

4.1 Site Preparation

Any site preparation should maintain compliance with the SWPPP (**Appendix E**). Whether the Project requires soil preparation is dependent on preceding land use and construction activities. Typically, no site preparation is required when the preceding vegetation has been soybeans, small (cereal) grains (oat, wheat, barley, cereal-rye), or forage crops such as alfalfa or corn silage. Harvested soybean, small (cereal) grains, and forage fields provide a low crop residue, level ground, and perfect soil firmness to seeding all seed mixes associated with solar. The Plan advises working in advance with the current land manager to accommodate above mentioned crops. If site preparation is required, it may consist of removing existing biomass by haying or herbicide, and or discing, harrowing, and soil-packing to assist with installation and establishment of seed mixes.

While harvested soybean, small grains, and hayed or chopped forage crop fields require little or no site preparation, other crops, such as corn, unharvested small grains, unharvested forage crops, and weedy fallow fields may create excessive vegetation residue and soil compaction that will hinder seeding and seeding establishment. If site preparation is required, it may consist of a variety or combination of crop residue reduction methods, including haying, mowing, chemical burn down by herbicide (glyphosate), and or shallow tilling. Excessive soil compaction is often associated with corn fields and soil decompaction by shallow tilling may be required to create a viable seedbed. Fallow fields often exhibit annual weeds that can be chemically treated by glyphosate and or mowing, but in either case, treatment needs to occur before weeds produce seed.

If tillage is required, caution is advised to avoid tilling too deep. While deep tillage reduces soil compaction, it can create soils too loose for seeding native species. Grass seed may not establish if seeded deeper than 1/2 inch and many native forbs may not establish if seeded deeper than 1/8 inch. Most agricultural crops germinate from large seeds that can be planted much deeper than grass seed. Therefore, most agricultural tillage implements tend to cultivate soil too deep for grass seed. If soil

preparation involves deep tillage, it is advised soils are firmly packed before seeding.

Site preparation requirements and treatments also vary based on crop type and time of year, as follows:

- Soybean fields and forage crop fields (e.g., alfalfa, corn silage) typically provide low crop residue soil surfaces suitable for seeding.
    - Soybean fields are typically harvested beginning in late-September. Harvested soybean fields may be seeded immediately after harvest, preferably before October 1. No-till drill seeded into soybean stubble is preferred. Seed may also be broadcast seeded if prepped by shallow-tillage and followed by a packer.
    - Forage crop fields, such as alfalfa-hay, are harvested throughout the year. Forage crop fields often require some level of site preparation prior to seeding, such as removal of excess residue (e.g., haying) and/or herbicide to suppress existing vegetation and potential weeds. Following herbicide treatment, and based on herbicide manufacturer's recommendations, seed can be directly no-till drilled into forage crop stubble. Seed may also be broadcast seeded but requires shallow tillage prior to broadcast seeding and followed by a packer.
    - Corn harvested for silage provides marginal conditions for seeding. Excessive crop residue following harvest makes no-till drilling seed into corn silage stubble difficult. The residue can plug the seeder double disc-openers. Broadcast seeding requires shallow discing and packing prior to seeding and for best results, packing after seeding. Even in the best-case seeding scenario, crop residue may prevent adequate germination.
- Cornfields, grown for grain, create excessive crop residues and severely compacted soils that can impede seed installation and vegetation establishment. Adequate seedbed preparation for grain corn fields includes baling stocks to remove plant residue, and shallow tillage, possibly followed by packing prior to seeding, and packing following seeding. As grain corn is the last regional crop to be harvested, usually in November, it is often too late for seed germination, including cover-crops prior to winter.

Table 6 provides guidance for a planned schedule and sequence of site preparation activities under different construction start scenarios. This table along with consultation from a qualified vegetation management professional will be used to develop the appropriate prescription based on the final project schedule. **Table 10** and Section 6.3 provide additional information about preferred annual seeding time periods for temporary and perennial seeding, respectively.

Table 6. Site Preparation Sequence and Activities Based on Construction Start Period

Pre-construction Period	Pre-construction Site Conditions – Seeding Preparation	Pre-construction Seeding	Construction Start
Spring	Previous row-crop – None Winter crop - Harvest winter crop	Perennial seed mix in optimal seeding window – Areas that will not be graded. (April 1 – June 30) Temporary seed mix (spring/fall seed mix) – Areas to be graded. (April 1 – June 1)	Summer
Summer	Terminate row-crop – Mow, disk or herbicide application	Perennial seed mix in optimal seeding window – Areas that will not be graded. (June 30 – August 1) Not recommended – Assess current seasonal weather trends; Monitor and prepare for supplemental seeding) Temporary seed mix (summer seed mix) – Areas to be graded. (May 1 – August 15)	Fall
Fall	Harvest row-crop	Perennial seed mix in optimal seeding window – Areas that will not be graded. (September 10 – October 31, less than ideal; November 1 – Frozen conditions; when soil temperature is 40°F or less) Temporary seed mix (spring/fall seed mix) – Areas to be graded. (August 1 – September 15)	Winter or spring
Winter	Previous row crop - None	Perennial seed mix in optimal seeding window – Areas that will not be graded. (February 15 – April 7 – Frost Seeding; Complete when snow depth is 1 ft or less) Temporary seed mix (winter mix) – Areas to be graded. (September 1 – November 15)	Spring

In summary, pre-existing vegetation plays a significant role in the potential to establish a desirable vegetation compatible with the Project objectives. Stantec highly recommends working with cooperating agriculture producers and construction contractors prior to construction to ensure desirable crops precede Project construction.

4.2 Soil Handling

Grading may be required to provide flat surfaces for the installation of arrays (**Appendix A**). Grading contractors will be responsible for segregating and stockpiling topsoil and grading spoils, the excess material generated from construction activities, by soil layer. Excess material will be placed in a manner that preserves soil health and integrity. Typically, this will entail spreading subsoils first and then placing topsoil material over subsoils. Excavation and grading requiring trenching (temporary disturbance of the ground to bury facility infrastructure) will segregate soil material by layer and re-fill trenches in the reverse order the soil layer was encountered so that topsoil layer is placed at the surface and depth of topsoil is maintained as much as possible. Appropriate soil handling as described in the Agricultural Impact Mitigation Plan (AIMP) (**Appendix F**) will be implemented to preserve soil health so that the Project may be returned to agricultural production after the life of the Project.

4.3 Mitigation of Soil Compaction Prior to Seeding

To minimize soil compaction, grading and facility contractors will use areas proposed as access roads as much as possible for travel. Following construction activities and prior to the installation of regionally appropriate seed mixes, areas of heavy use such as the laydown yard may be tilled or ripped to alleviate soil compaction and then disked to provide a uniform surface. Depending on a combination of soil conditions, the time elapsed between disking and seeding, and methods used for seeding, rolling the seedbed with a cultipacker may be necessary. A qualified vegetation management professional will be consulted for recommended techniques for each vegetation management unit prior to seeding.

Wet areas such as in hydric soil units will be avoided to the extent practicable to minimize compaction and de-compaction activities. The AIMP (**Appendix F**) provides greater detail regarding best management practices that may be implemented to alleviate compacted soils should they occur.

4.4 Seedbed Preparation

Potential steps for seedbed preparation are determined by the timing of the end of construction and the installation of the regionally appropriate seed mix. Prior to seeding, a survey of pesticide use by the previous farm operators should be completed to determine if potential pesticide carryover will be an issue that prevents or impacts regionally appropriate seed germination rates. In locations where carryover may be a potential, the extended use of temporary cover crops or other carryover resistant vegetation may be required until the residual effect potential has decreased. A qualified vegetation management professional should be consulted to determine the potential for pesticide carryover. **Table 7** provides potential seedbed preparation activities based on the timing and conditions of the vegetation management units post-construction.

Table 7. Seedbed Preparation Activities Based on Seedbed Conditions Prior to Seeding.

Pre-Seeding Seedbed Conditions	Potential Seedbed Activities
Not compacted, bare ground (Typical tilled row-crop field)	• Cultipacking to firm seed bed, depending on seed installation technique and equipment.

Pre-Seeding Seedbed Conditions	Potential Seedbed Activities
Harvested row-crop field	• Soybeans – None. • Corn – Mowing stalks to mulch corn stover or raking and baling to remove corn stover.
De-compacted, no existing vegetation (Areas where grading occurred)	• Disk to provide uniform surface when post-grading surface would impact seed installation or growth. • Cultipacking to firm seed bed, depending on seed installation technique and equipment.
Not compacted, temporary seed mix present, no large areas of annual or perennial weeds	• Spot spray areas of annual or perennial weeds to reduce competition and prevent weed establishment. • Depending on life stage and density of temporary seed mix, consider spraying, mowing, or rolling prior to or immediately after seeding to terminate crop, reduce competition and provide mulch layer for regionally appropriate seeding.
Not compacted, sparse to no temporary seed mix present, extensive areas of annual or perennial weeds	• Broadcast spray with a non-selective, non-residual herbicide such as glyphosate to reduce weed competition.
Existing vegetation is temporary cover crop that includes species such as winter wheat.	• Broadcast spray with a non-selective, non-residual herbicide such as glyphosate to terminate crop either prior to or immediately after seeding.
Existing vegetation is pasture/hayland, but **NOT** native sod	• Broadcast spray with a non-selective, non-residual herbicide such as glyphosate to reduce vegetation competition.
Wet areas with existing invasive vegetation or bare ground.	• Broadcast spray within a non-selective, non-residual herbicide such as glyphosate. Consult a qualified vegetation management professional to determine if a wetland-approved formulation is required based on site conditions.
Existing vegetation is NATIVE sod	• Do not impact the sod and consult a qualified vegetation management professional.

4.5 Invasive Species Prevention

Invasive plant species, including MDA-listed noxious weeds and other weedy species such as reed canary grass, can negatively impact desired vegetation establishment and management for extended periods of time and prevent accomplishing vegetation management goals and objectives. MDA-listed

noxious weeds (**Table 8**) are plant species designated under state law that require some form of control or eradication by landowners, if present and requested by state or local officials. Failure to comply with a formal request to control or eradicate can result in the landowner being responsible for the financial cost of work performed by others at the request of the inspecting governmental unit.

Table 8. MDA-listed Noxious Weeds

MDA-listed Noxious Weed Species			
Eradicate – Not currently known to be present or widely distributed in the state. If found, all above and belowground parts must be destroyed. Transportation, propagation, or sale is prohibited by law.			
Black swallow-wort	Dalmatian toadflax	Japanese honeysuckle	Palmer amaranth
Brown knapweed	Diffuse knapweed	Japanese hops	Red hailstone
Common teasel	Giant hogweed	Johnsongrass	Tree of heaven
Cutleaf teasel	Grecian foxglove	Pale swallow-wort	Yellow starthistle
Control – Established throughout or in regions of the state. If found, control efforts shall focus on preventing the spread, maturation, and dispersal of propagating parts such as seeds, rhizomes, and root parts. Herbicide applications that reduce the local abundance or mowing that prevents seed formation would be control techniques. Transportation, propagation, or sale is prohibited by law.			
Bohemian knotweed	Giant knotweed	Narrowleaf bittercress	Purple loosestrife
Canada thistle	Japanese knotweed	Non-native phragmites	Round leaf bittersweet
Common barberry	Leafy spurge	Plumeless thistle	Spotted knapweed
Common tansy	Meadow knapweed	Poison hemlock	Wild parsnip
Restricted – Widely distributed in the state and is detrimental to human and animal health or the environment, but feasible control is limited to prohibiting importation, sale and transportation. **(Presence of restricted-listed species on-site will not require management action by law; however, due to the widespread distribution and negative impact to natural communities, control or management actions for these species is highly recommended to achieve the desired vegetation conditions for the Project.)*			

MDA-listed Noxious Weed Species			
Amur honeysuckle	Crown vetch	Lesser celandine	Siberian peashrub
Amur silvergrass	European alder	Morrow's honeysuckle	Tatarian honeysuckle
Bell's honeysuckle	Garlic mustard	Multiflora rose	Wild carrot/Queen Anne's lace
Black locust	Glossy buckthorn	Porcelain berry	Winged burning bush
Common or European buckthorn	Japanese barberry cultivars	Saltcedar	

Invasive plant species are primarily non-native, but sometimes native plant species that can be aggressive and outcompete other plant species. **Table 9** provides a list of plant terrestrial plant species that MNDNR considers to be invasive to natural areas (https://www.dnr.state.mn.us/invasives/terrestrialplants/index.html#text-1-4).

Table 9. Non-native Terrestrial Plants Considered to be Potentially Invasive in Natural Areas

Flowering plants			
Birdsfoot trefoil	Cow vetch and hairy vetch	Hoary alyssum	Poison hemlock
Bull thistle	Creeping Charlie	Leafy spurge*	Queen Anne's lace*
Butter and eggs	Crown vetch or axseed*	Musk or nodding thistle	Spotted knapweed*
Canada thistle*	Erect hedgeparsley	Orange hawkweed	White and yellow sweet clover
Common tansy*	Garlic mustard*	Oxeye daisy	Wild parsnip*
Grasses			
Amur silver grass	Reed canary grass	Smooth brome grass	
Trees and shrubs			
Amur cork tree	Buckthorn*	Non-native knotweeds	Siberian pea shrub
Amur maple*	Japanese barberry*	Norway maple*	Winged burning bush*
Autumn olive	Multiflora rose*	Russian olive	
Black locust*	Non-native bush honeysuckles*	Siberian elm	

*Denotes species is also an MDA-listed noxious weed, but not required to be eradicated, if found.

The best strategy is to make prevention and control from the start of construction activities a priority. Strategies to reduce invasive (weedy) species during construction include:

- Require construction equipment comes to the construction site free of soil and existing vegetation and leaves the site free of soil and existing vegetation.

  - Have contractors self-inspect all equipment arriving and departing from the site and prepared to provide proof of inspection upon request.
  - Designate wash stations for cleaning equipment and monitor cleaning areas for invasive species.

- Survey construction areas and adjacent lands prior to construction to determine the presence of MDA-listed noxious weeds, other invasive plants species, and native vegetation. Identify in project maps and with signage areas where noxious weeds or native vegetation is located to prevent equipment from picking up and spreading seed and plant parts or disturbing native vegetation to make it more susceptible to invasive species establishment.
- Monitor the site on a seasonal basis to identify, map and treat areas where invasive species are present.
  - In areas of known invasive species, make herbicide treatment a priority before regionally appropriate seed is installed.

When vegetating areas with a history of row-cropping, both annual and perennial noxious weeds and invasive plant species will be a primary threat to successfully establishing vegetation due to existing seedbanks and the potential for seed sources in adjacent row-crop areas. Mowing and herbicide treatments that are completed prior to seed development are effective means to control annual weed species and reduce the spread of perennial weed species. Well-established regionally appropriate grass-dominated vegetation (years 6+) may be less susceptible to invasive species establishment; however, it is anticipated that invasive species management will be an on-going priority for vegetation management throughout the lifetime of the project. Within the Project Area, the period between construction and vegetation maintenance is when the vegetation management units will be most vulnerable to invasive species establishment.

4.6 Soil Amendments

Soils in the Project Area have been historically cropped with nitrogen fixing legumes (soybeans) and augmented with nitrogen fertilizer for corn. Typically, the fertility is constrained by excess fertilizer rather than lack thereof. Likewise, seed mix design selects species and strains that do not require fertilizer, water, or pesticides to establish and maintain. There are no soils amendments required for the Project.

4.7 Seeding Phases and Cover Crops

Seeding of the Solar Array Mix and Pollinator Mix is anticipated to be completed in phases, as follows.

4.7.1 Pre-construction

The preference is to install and establish this seed mix prior to construction. The advantages of seeding prior to construction include:

- 100 percent coverage by seeding equipment for 100 percent vegetation coverage whereas seeding post-construction prohibits drill-seeding under panels leaving a significant portion of the site inadequately seeded.
- Significantly less time consuming, therefore less expensive.

- Eliminates the potential of damage to solar infrastructure by seeding equipment.
- Additional time for establishment of the root system which facilitates better drainage that lessens mud and rutting; and
- Established turf holds down dust that is hard on construction equipment.

In summary, seeding prior to construction can facilitate more extensive vegetation cover, requires less technical operation of seeding equipment, is less expensive, minimizes damage to solar infrastructure, and improves construction conditions by making it less muddy and dusty.

There are three potential pre-construction seed installation windows, dependent on the status of the fields prior to construction:

1. If the Project Area is not cropped, then the preferred seeding window is early to mid-spring, mid-April through May to allow the seed mix to establish for a full growing season prior to start of construction.
2. If the Project Area is cropped, then seeding will occur in fall immediately following crop harvest and seedbed preparation. Soybean is recommended as the final crop to minimize seedbed preparation requirements and to allow for an early harvest to accommodate seed installation. If seeding is done immediately after crop harvest, depending on site and weather conditions, and seed installation timing, seed may germinate and grow prior to the first killing freeze, then overwinter.
3. If seed is not installed immediately after soybean harvest, then dormant seeding will be done. Seedbed preparation should occur when there is no snow cover and soils are not frozen. Seed should be installed after November 1 so it can overwinter and germinate in the spring. Dormant seeding rates should be increased by at least 20 percent.

A temporary cover crop should be installed with native seed following **Tables B.1-A – Table B.1-D (Appendix B)** to provide cover and assist with grow-in of permanent seed, as follows:

- If permanent seed is installed during the spring, the cover crop should consist of oats, at the recommended rates provided in **Table B.1-D Appendix B**.
- If permanent seed is installed during fall through winter, the cover crop should consist of winter wheat and or annual ryegrass as described in **Table B.1-B Appendix B**. Dormant seeding rates for the permanent seed should be increased by 20 percent.

The site should then be assessed in spring and any bare or thin spots remediated through additional seeding of the Solar Array Mix, or Pollinator Mix and a temporary cover crop as outlined in **Appendix B, Tables B.1-A – Table B.1-D**.

4.7.2 Construction through Post-Construction

Construction activity (e.g., pile driving, access road construction, and routine traffic) in areas where the seed mix is established is expected to result in minor to moderate disturbance. Disturbed areas should be prepped and re-seeded using the Solar Array Mix, or Pollinator Mix and a temporary cover crop for compliance with the SWPPP. If repair seeding occurs in the spring through early summer, the cover crop

should consist of oats. The cover crop should be installed at a lower rate when combined with permanent seed.

Temporary seeding may also be used to temporarily stabilize soils disturbed by Project construction prior to permanent seed installation. Species selection should be based on timing and seeding rates following **Tables B.1-A – Table B.1-D (Appendix B)**. The cover crop should be installed at a higher rate when seeded alone.

For areas that are more impacted (e.g., routine traffic lanes, staging and laydown yards, etc.), soil compaction may limit vegetation establishment. If accessible, these areas should be deep tilled with an off-set disc, chisel plow or soil-ripper to fracture compacted soils. Following deep tillage, soils should be harrowed to create a smooth, firm, and friable seedbed, and then packed. Soil fracturing and harrowing is not possible in inaccessible areas (e.g., under PV panels). Seeding rates should be increased by at least 20% when re-seeding areas that are not fully prepped because they are inaccessible.

5.0 Seeding Methods

Seed installation methods are dependent upon existing conditions and installation timing. The three common seeding methods are: 1) drill seeding, 2) broadcast seeding, and 3) culti-packer seeding (e.g., Brillion seeder). **Appendix D** highlights comparisons between the three types of seeding.

5.1 Drill Seeding

Drilling is the preferred method for seed installation for preconstruction seeding, especially where crop residues are present. Drill seeding typically requires less soil preparation and less seed. However, drill seeding is difficult or impracticable in tight spaces (e.g., near panels) and is not viable for placing seed under PV panels. A native seed drill (e.g., Truax or Great Plains) is recommended to install native grasses and forbs. The tractor-drill operator needs to check and confirm seed placement is not deeper than ½ inch and preferably less than ¼ inch deep into the soils. It is critical that the tractor-drill operator understands how to adjust drill depth for proper seed burial depth.

5.2 Broadcast Seeding

Broadcast seeding requires soil preparation to create a friable bare soil surface. If soils are too fluffy, grass seed may sink below the 1-inch threshold for adequate germination and establishment. If the soils are deemed too fluffy for successful installation, then the soils should be packed before seeding. In almost every case, broadcasted seed should be packed following seeding to enhance seed-soil contact.

Broadcast seeding, although not preferable, provides the only method to install post-construction temporary and permanent seed mixes under PV panels. If this becomes the default seeding method, it is recommended to increase seeding rates by 20 percent. For broadcast seeding post construction, the following sequence is recommended:

1. Site preparation, including soil ripping or deep discing,
2. Firming with a drag harrow or packer,
3. Broadcast seed installation, and then
4. Finishing with an additional packing or light drag-harrowing.

Mechanical broadcasters are acceptable for sowing native seed mixes if the device manufacturer specifies use for evenly concurrently spreading seeds that are very small as well as bearded native grass seeds (those with attached appendages such as awns, pappus, hulls, etc.). Broadcasting of native seed may be done in the winter in areas of mostly bare soils without packing as seeds are likely to be incorporated into soils via natural freeze-thaw cycles.

Inert fillers, such as fine wood shavings, rice hulls, or cracked wheat may be used to assist with mixing and calibration in spreader hoppers.

Cultipacker seeding is the preferred seeding method for soils with low crop residue and finely textured soils. Cultipacker seeders are a good choice in pre-construction scenarios, for array and perimeter seed mixes blends in soybean stubble, or bare soils with little crop residue and finely tilled soils.

5.3 Seeding Depth

Caution is recommended to minimize burying seeds too deep, either during broadcasting and subsequent packing / raking or during drilling. Loose soils, such as in areas that are shallow disced prior to seeding, are prone to deep seed burial. The recommended planting depth is between 1/16 - 1/4 inch deep, especially for small seeds that comprise much of the permanent mixes. Large seed, such as cover crop seed can be seeded slightly deeper, no more than 1/2 inch deep. It is recommended to minimize vehicle and equipment traffic on recently seeded areas to minimize additional compaction and seed burial.

5.4 Mulching

Mulch may need to be applied following permanent seeding to assist with seed germination. Local sources of clean, seed-free hay of straw mulch are acceptable. Certified weed-free hay or straw is preferred. Hydromulch is a suitable substitute for hay or straw mulch. Hydromulching has the potential to incorporate seed with the mulch; therefore, seed and mulch are applied in the same procedure. Hydromulching is expensive, but sometimes necessary for seeding and stabilizing soils in areas difficult to establish with traditional seeding tactics. This often includes slopes around storm water run-off ponds and other areas prone to extensive washing following rainstorms. Mulching and other forms of erosion control should be done following the SWPPP, including provisions for materials, anchoring, and product selection.

A two-step process is recommended for hydroseeding native seed:

1. Broadcast seed at the recommended rate (increase seeding rate by 20% for broadcast seeding), then
2. Apply hydromulch material following manufacturer instructions.

6.0 Seed Mixes

6.1 Array and Vegetated Buffer Planting

One of the objectives for seeding within the array and buffer areas is to install a regionally appropriate grass-dominated seed mix that is influenced by the guidelines outlined in the MNDNR *Prairie Establishment and Maintenance Technical Guidance for Solar Projects* (MNDNR, 2020). To accomplish this, Castle Rock Solar is proposing to establish low-growing, regionally appropriate grass-dominated seed mixes with the following characteristics, which were informed by the 2020 MNDNR guide:

- A minimum seeding rate of 40 seeds/sq. ft.[2]
- At least 30% of the total seeding rate should be composed of perennial forbs.
- 5 or more native grass/sedge species with at least 2 species of bunchgrass.
- 10-15 or more native forbs with at least 2 species in each bloom period: Early (April-May), Mid (June-August), and Late (August-October).

Temporary and permanent seed mixes are custom designed to establish vegetation suitable to existing soil characteristics, shade created by solar facility equipment, and in strict adherence to height restrictions to prevent vegetation from competing with PV panels for sunlight. The seeding plan for this Project includes installation of permanent seed paired with quickly establishing temporary cover crop species.

Proposed seed mix tables including species name, seeding rate, and seeds/square foot are provided in **Appendix B**. As part of agency consultation in developing this VMP, Castle Rock Solar met with the Minnesota Department of Commerce (DOC) Vegetation Management Plan Working Group (VMPWG) on May 16, 2023. The VMPWG is comprised of representatives of the Minnesota Department of Commerce Energy Environmental Review and Analysis Staff, the MNDNR, the MDA, and the MN BWSR. The seed mixes provided in this VMP were developed in coordination with the DOC VMPWG and based on MN BWSR's Low Growing Solar Array Mix – Southwest seed mix and Low Growing Solar Array Moist Soils-South and various other regionally available regionally-appropriate seed mixes. **Figure 8** generally delineates where the seed mixes should be used throughout the proposed re-vegetation areas based on the current facility design.

As part of the Adaptive Management program (see Section 8.3), modifications to seed mixes, especially during the establishment phase, may be required based on greater understanding of local or micro-scale site conditions, climatic trends, individual species performance, and market availability. Decisions about potential species substitutions, additions, or subtractions will be based on a combination of the following:

- Maintaining a minimum seeding rate that has shown to be effective in establishing vegetative cover on recently disturbed surfaces.
- Maintaining species functional group composition when substitutions are required.
- Referencing recognized sources of information for acceptable substitutions and seed mix design such as MNDNR and MN BWSR.
- Integrating lessons learned about vegetation management from others within solar energy industry.

Two factors that are important to a successful seeding is the timing of the seeding and the equipment used. Based on the Solar Array Seed Mix and Pollinator Seed Mix proposed for the Project, MN BWSR recommends the following dates:

- February 15 to April 7, when broadcast frost seeding
- April 1 to June 30, after soil temperature is above 60^{O} F
- After November 1, in particular when soil temperatures are below 60^{O} F

Temporary seed mixes are likely to be used in areas not stabilized with permanent perennial vegetation during the pre-construction or construction phases until a regionally appropriate seeding window is available.

Seed availability through commercial vendors can vary year to year based on market demand, previous year's growing conditions, and individual species seed production. For the project, seed for designated mixes will be required over several years and include the pre-construction, construction, and vegetation establishment phases. Species substitutions based on limited availability will likely be necessary. When selecting substitutions for designated mixes, it is important to consider the plant functional group that a species belongs to and select species from same group. For example, if a warm season grass species is unavailable, a different warm season grass species with a similar plant height should be selected and not a cool season grass.

MN BWSR and Minnesota Department of Transportation (MNDOT) maintain and annually update an approved seed substitution list for many regionally appropriate species based on querying approved seed vendors. If one or more species are not available or are available at limited quantities, these lists should be referenced to select appropriate substitutions. Using the MN BWSR and MNDOT substitution lists helps to ensure that plant species substitutions are made within the same functional groups. Nurseries specializing in native plants can also provide recommendations for substitutions. Proposed substitutions will need to be approved by Castle Rock Solar staff prior to installation.

6.2 Stormwater Detention Area Planting

In areas designated a permanent stormwater detention area within the Project Area, MN BWSR's Stormwater South and West will be used (**Appendix B, Table B.5**). Vegetation management around stormwater detention areas will be similar to other vegetation management techniques; however, due to the potential for ponded water or wet conditions, equipment access may be limited with more work being conducted by hand. Qualified vegetation management professionals should have the equipment and expertise to address the needs of these areas to establish and maintain the regionally appropriate plant community.

6.3 Temporary Seed Mixes / Cover Crops

Temporary seeding of cover crops may also be planted to stabilize soils if agricultural fields are left idle or overwintered prior to permanent seeding or to temporarily stabilized soils that are disturbed during Project construction (e.g., graded soils, stockpiled soils, etc.), per the Project's SWPPP (**Appendix E**).

Temporary seed mixes / cover crops are designed to meet two primary objectives:

- Compliance with the Project's SWPPP; and

- Assist with establishment of permanent vegetation.

Cover crops are composed of annual grasses that establish quickly, provide erosion control, build soil organic matter, reduce soil compaction, and assist with weed suppression. Three annual grasses – winter wheat (*Triticum aestivum*), annual ryegrass (*Lolium multiflorum*) and seed oats (*Avena sativa*) will be utilized, depending on installation timing.

Seeding rates for temporary species are selected based installation timing, seeding methods, and whether cover crops are installed with or without permanent seed. Seed mix specifications for temporary cover crops are provided in **Appendix B, Tables B.1-A – B.1-D**. Temporary cover crop seeding rates are higher when seeded without permanent seed and when installed during the dormant season. Final cover crop seed selection should occur when seeding dates are known. Annual cover crops are terminated with regular ongoing management mowing or with killing frosts.

The success of seedings that occur between October 15 and April 1 (fall to dormant season seeding) will be dependent on seasonal weather conditions that influence soil temperature and soil moisture. Fall and dormant season temporary seed mix seedings may need to be monitored the following spring to determine germination rate and winter kill. Areas may be re-seeded, as necessary. Seeding rates should be increased by 50 percent when broadcast seeding is used and/or culti-packing or dragging is not used to incorporate the seed into the soil.

Table 20. Temporary seed mixes for areas where perennial vegetation is not immediately available.

Seed Mix	General Recommended Seeding Dates*
Spring-Fall Season	April 1 – June 1 August 1 – September 15
Summer Season	May 1 – August 15
Winter Season	September 1 – November 15
*Determine appropriate mix based on seasonal trends and conditions.	

To reduce competition from temporary cover crops to perennial vegetation germination, cover crops should be terminated with a non-selective, non-residual herbicide such as glyphosate prior to seed installation or immediately after installation.

6.4 Pesticide Drift

The Project Area is located within a rural landscape but borders few additional agricultural areas. Though limited to a small stretch in the northeast corner and the interior boundary of the central block, there is the potential for landowner use of pesticides outside of vegetation management units. Impacts due to pesticide drift to the vegetation within the arrays are reduced using the following practices:

- Establish and maintain a buffer composed of regionally appropriate low growing grass-dominated buffers along the outside perimeter of the fence lines.
- Adjacent landowners will be annually notified of the importance of avoiding pesticide drift. Impacts due to pesticide drift will be recorded during seasonal inspections and annual monitoring.

Landowners will be notified that repeated impacts to Project vegetation due to pesticide drift will result in the landowner paying for re-seeding and establishment costs.

6.5 Seed Mix Vendors

Seed will be purchased from local vendors that supply quality local sourced seed, or at a minimum, seed that has proven successful under the Project site environmental parameters. All seed, including temporary cover crop and permanent seed mixes, should be supplied with seed tags that indicate seed weight, pure live seed, region of origin, and noxious weed content. A list of potential seed vendors is provided in **Appendix C**.

7.0 Vegetation Maintenance

Properly timed mowing and spot herbicide treatments can reduce overall maintenance requirements during the Project life cycle. Maintenance can be divided into two phases: the establishment maintenance phase and the long-term maintenance phase. Establishment maintenance, consisting of mowing and herbicide treatments for noxious and invasive weeds, is critical to successful vegetation establishment during the first three years. Long-term maintenance, consisting of mowing and spot herbicide treatment, allows desirable vegetation to persist over the life of the Project.

Monitoring establishing vegetation during this period should facilitate proper timing and treatment activities to ensure early problems do not become larger issues.

Despite the clean appearance of recently harvested agricultural fields, incompatible weeds often persist and thrive. Noxious and weed species management should be conducted as needed to:

- Minimize the spread of noxious weeds from existing populations, if present,
- Prepare seeding areas for permanent vegetation to reduce competition and improve establishment and success of the permanent seed mixes (as needed), and
- Reduce vegetation impacts on PV panels and other solar facility infrastructure.

Noxious and weed species management may consist of cutting / mowing and herbicide treatments.

7.1 Cutting / Mowing

Vegetation cutting should be appropriately timed to assist with control of noxious and weedy species (e.g., mow biennial species during the flower-bud stage, and prior to seed production) and to remove vegetation to assist with site seedbed preparation. Methods should be selected based on the aerial extent of vegetation and site accessibility.

Cutting, by mowing or hand-trimming, is the primary management tool used to aid in the establishment of desirable vegetation. Cutting can reduce height, reduce flowering of undesirable vegetation, and maintain sunlight at the ground surface to encourage germination and growth of desirable species. Mowing using a deck mower is applicable in areas that are accessible with a small tractor and mower. Flail mowers are preferred but rotary mowers are acceptable if significant clumping of grass clippings is minimized. A 3-point side-mounted trimmer mower attached to a small tractor may also be used to cut vegetation around steel piles and under panels.

7.2 Frequency and Timing

The frequency and timing of cutting and mowing is dependent on the growth phase of the vegetation, with different practices required for the establishment, transition, and long-term maintenance phases. Specifications for each phase are provided below.

7.3 Pre-Construction and Construction Phase Practices (Prior to Year 0)

Construction may take one or more years to complete. However, one of the goals and objectives for the overall Project is to vegetate as many acres as possible to a perennial low-growing regionally appropriate cover type by establishing the A Solar Array Seed Mix and Pollinator Seed Mix during the pre-construction phase. To accomplish this, re-vegetation will focus on areas that do not require grading prior to installing facility infrastructure. Vegetation management within areas of management units that have been seeded with a perennial seed mix during the pre-construction phase will be managed in a similar fashion to short-term establishment practices described in Section 7.4. Mowing, spot spraying, and re-seeding disturbed areas are the likely main tools that will be used. Construction activities such as running over vegetation with equipment, localized excavation to install posts for arrays, or burying collection lines may cause limited disturbance that may require additional re-seeding. The need to re-seed will be managed on a case-by-case basis.

Temporary seed mixes will be used to stabilize soil and remain compliant with SWPPP conditions in areas that require grading prior to installing facility infrastructure. The need to re-seed areas with temporary seed mixes during the construction phase is anticipated when the temporary seed mix is at the end of its life cycle and/or when ground disturbing activities occur, but the next optimal seeding window for perennial vegetation does not occur for several months.

It may be the case where within a management unit block is a mosaic of perennial vegetation, temporary seed mixes, and areas under active construction. Each vegetation type will be managed in the appropriate manner until the entire management unit can be transitioned into the short-term establishment period (Year 0).

7.4 Short-Term Establishment Practices (Years 0 – 5)

The period between regionally appropriate seed and plant installation (Year 0) through the fourth or fifth growing season (Year 5) is typically defined as the establishment period. The key priorities for establishment during this time period include:

- Reducing competition from annual weeds that shade out or smother regionally appropriate plant seedlings.
- Preventing the establishment of perennial invasive or noxious species.
- Re-seeding in areas where vegetation is not establishing or is impacted by herbicide applications necessary to control invasive species.

Understanding the expectations for vegetation during the establishment period is an important factor in success and determine vegetation management actions. Many plant species native to this area are deep-rooted to access moisture during hot, dry summer months and to store energy during the winter months.

Typically, the first growing season or two, seedlings invest a lot of energy in root growth while maintaining sparse above ground vegetation. In Years 2 and 3, there is a marked increase in above ground vegetation density and abundance increases to the point that it can shade out annual plant species and more easily compete with invasive species.

Mowing

Mowing during the establishment period is typically the most common and cost-effective strategy for controlling weed species. **Table 11** provides mowing guidelines for both timing and maintaining vegetation heights. It is important to adjust the timing of mowing based on an individual year. Spring and summer weather conditions determine when mowing should occur. Mowing too frequently or too low of a height can negatively impact regionally appropriate vegetation and make establishment more difficult. However, mowing after annual and perennial weed species have set seed is counterproductive for long-term vegetation management. The finished mowing height for each mowing event during the establishment period should be determined prior to mowing and should consider the life cycle and percent cover of weedy species present. In other words, finished mowing height should be driven by current vegetation performance. Feedback from seasonal inspections and annual monitoring will help to determine finished mowing heights during the establishment period.

A qualified vegetation contractor will have the experience and the equipment to correctly mow regionally appropriate plantings. Using a mower that does not windrow thatch that can smother regionally appropriate seedlings or can be set at the appropriate height such as a flail or rear-discharge mower is key. In the event of a build-up of thatch, raking and haying may be considered.

During the short-term establishment period, areas under the arrays will be mowed once annually at a minimum. Mowing frequency after the second growing season for areas outside of the arrays will be based on vegetation conditions and quality. Either seed mix areas may be mowed when the vegetation is at the appropriate height and mowed down to the appropriate level. In stormwater detention areas, hand trimming or low ground pressure equipment may be used to prevent rutting and ground disturbance.

Specialized mowing equipment may be used around and under arrays. Additionally, hand work using brush cutters and strip trimmers may be necessary to access difficult areas around arrays and in wet areas where equipment would cause vegetation disturbance.

During the establishment phase, mowing typically occurs throughout the entire site. Within a vegetation management unit, it may be possible that some areas require spot mowing on a more frequent basis because of the presence of fast-growing weed species. Conversely, there may areas that require less mowing due to both sparse and weedy vegetation or that desired vegetation quickly develops and becomes well-established. The vegetation will be inspected during the growing season to inform appropriate mowing and herbicide management. Frequent mowing required to manage weedy plant species in particular areas during and after the third growing will be a potential trigger to determine if supplemental seeding is required due to a lack of regionally appropriate vegetation establishment.

Table 11. Mowing Conditions and Specifications During the Short-Term Establishment Period

Initial Mowing	Mowing Height	Mowing Period	Mowing Triggers
Late spring/early summer when vegetation reaches a height of 12 – 18 inches	Finished height of 4 – 6 inches during first growing season. Continue mowing to finished height of 4 – 6 inches in Years 1 – 4, as necessary based on weed pressure. Finished height of 8 – 12 inches during Year 5, if not sooner based on weed pressure.	May – November, typically two events per growing season	Flowering annual weeds Dense annual vegetation with a height of 12 – 18 inches.

Herbicide Application

Herbicide application following seed installation and during the establishment period is likely to primarily be spot spraying to prevent large areas devoid of vegetation being created. Spot spraying consists of using low volume equipment applied manually through either backpack sprayers or equipment mounted hand sprayers. Localized broadcast spraying can occur in instances when weeds and invasive species are present in patches large enough or dense enough that off-target damage to regionally appropriate vegetation can be justified given the benefit to long-term management. Areas treated with herbicide may be mapped and accessed to determine if supplemental seeding is required.

Two important considerations to herbicide applications include herbicide selection and herbicide timing. **Table 13** in Section 7.6.5 provides a list of preferred herbicides to use during vegetation establishment and maintenance periods. Herbicide formulations and labeled uses are constantly being updated so **Table 13** should not be considered a comprehensive list. Herbicide applicators should read and understand the herbicide label and apply at labeled rates to labeled species. Additionally, the use of herbicides that have a residual effect should be avoided to prevent unintended impacts to perennial seed germination and persistence. None of the herbicides listed in **Table 13** are classified as neonicotinoids, a class of insecticide that is believed to have a negative impact on pollinating insects.

Since the majority of the vegetation management units will be seeded to a regionally appropriate grass-dominated seed mix, the use of broadleaf-specific herbicides will be effective against many noxious and invasive plant species while minimizing the opportunity to off-target damage to regionally appropriate grass vegetation. Herbicide applications will be timed when the plants are actively growing and with enough time prior to a precipitation event so that the herbicide can be absorbed or become rainfast. Seasonally, herbicide applications can be timed to occur early in the growing season before many regionally appropriate grass species have started to grow or after the growing season has ended for many warm season species, but while many cool season species such as reed canary grass are still actively growing. This seasonal timing helps to minimize off-target damage.

Supplemental Seeding

When perennial vegetation establishment has not reach at least 70 percent coverage, supplemental

seeding will be required. Vegetation monitoring detailed in Section 8 will determine if and/or where supplemental seeding is required. The necessity for supplemental seeding does not indicate that the initial seeding was a failure. Supplemental seeding will occur during the same seeding windows as described in **Table 6**.

Potential areas that are candidates for supplemental seeding include:

- Areas where localized broadcast herbicide application occurred.
- Areas with observed hydrology requiring either wetter or drier species.

During monthly inspections and annual monitoring, areas where supplemental seeding will be required will be mapped and considered during the annual review of the adaptive management program. Repeated supplemental seedings in the same general vicinity may indicate that a change in management techniques, soil amendments, or seed mix may be required.

7.5 Long-Term Maintenance Practices (Years 6+)

In Year 6, a well-managed regionally appropriate seeding typically transitions from establishment to maintenance. The transition from the establishment phase to maintenance phase will be marked by having 70 percent or greater perennial vegetation established throughout the site. The key feature of the transition is a decrease in the amount of time and resources dedicated to working towards achieving the desired vegetation management outcomes. By Year 6, vegetation should be positively trending towards meeting the objective set in the VMP. For the Project Area, this means:

- Desired vegetation succeeding in the appropriate locations throughout the Project Area.
- Meeting or exceeding vegetation standards outlined in the long-term vegetation objectives.
- Using inspections and monitoring to trigger proactive management actions that keeps the facilities vegetation meeting the management objectives.

Year 6 through the end of the permit period is referred to as the maintenance period because regionally appropriate plant species have evolved to persist in the environment through a wide range of conditions. However, maintenance does not infer maintenance-free. Regionally appropriate vegetation in the Project Area represents a grass-dominated or prairie conditions. Grass-dominated plant communities and prairies are disturbance-dependent and help to maintain plant community health. Disturbances were historically provided by both wild and human-set fires, drought, and grazing herds of large herbivores. Mowing within the vegetation management units will likely be the main form of disturbance.

Mowing

Mowing during the long-term maintenance period varies from the establishment period in frequency and desired outcome. The desired outcome for establishment period mowing is to reduce competition. During the maintenance period it is to simulate disturbance. **Table 12** provides guidelines for mowing during the maintenance period. The mowing frequency is reduced during the maintenance period when compared to the establishment period; however, the number of mowing events in the maintenance period may increase if vegetation grows to a height that impacts solar energy capture by the arrays. Mowing that generates thatch that may be detrimental to vegetation growth will be collected as part of the mowing activity or addressed by using equipment that minimizes thatch accumulation.

Table 12. Guidelines for Mowing During the Maintenance Period

Initial Mowing	Mowing Height	Mowing Period	Mowing Triggers
Prior to May 31 and after August 1 to minimize impacts to grassland nesting birds	Finished height of 4 – 6 inches	Annually to once every 2 – 3 years	• Vegetation exceeds 18 inches, which has the potential to shade panels. • Presence of woody vegetation seedlings • Accumulation of thatch and dead stems that represent a fire hazard. • Vegetation that does not look healthy or vigorous. • Desired perennial vegetation cover is less than 70% of total vegetation cover. • Weedy or annual species compromise greater than 40% of the total vegetation cover.

Mowing one-third of a vegetation management unit every year on a rotational basis and avoiding mowing in the same area in consecutive years provides refugia for pollinator species using the thatch layers for overwintering, nesting, or egg laying while also providing habitat for grassland birds that prefer a range of cover densities and thatch thickness. Mowing only one-third of a management unit every year also reduces the overall maintenance budget.

The feasibility of setting a rotation mowing program that results in up to two-thirds of the perennially vegetated areas mowed once every three years to create refugia for pollinators and grassland birds will be evaluated several years into the maintenance period (potentially Year 7 or 8) after observations have been obtained on the typical growth height within the given site conditions. The potential to create refuges will depend on the annual growth rate, height of the vegetation, the potential to impact solar energy captured by the arrays, or the creation of unsafe working conditions for the operations personnel.

Currently grazing by livestock and haying are not proposed management activities. In the event that either is considered in the future, Castle Rock Solar will assess the current state of knowledge to determine their suitable and best management practices before implementation.

Woody Vegetation Control

The establishment of woody vegetation within the arrays and along fence line perimeter borders when not used for visual screening is a potential negative impact to facility infrastructure through shading of both the solar panels and the regionally appropriate grass vegetation.

Mowing will likely control most woody vegetation seedlings, if conducted annually during the establishment phase and every two to three years during the maintenance phase. Additional woody vegetation control techniques include:

- Hand cutting with brush saws and chainsaws around arrays and fence lines where mowing does not do an effective job and trees and shrubs are reaching waist height or greater. Many tree species will continue to re-sprout so herbicide may be applied to the cut stump.
- Applying a foliar herbicide to the leaves using a spot spray treatment technique during the growing season. This is typically an effective treatment for dense stands of small saplings that are difficult to mow and hand cut. Care will be taken to avoid overspray and off target damage to existing vegetation.

Herbicide Application

Similar to the establishment period, herbicide applications during the maintenance period are likely to primarily be spot spraying using low volume backpack sprayers and equipment-mounted hand sprayers. Herbicide selection and timing are similar between establishment and maintenance period. Regular inspections throughout each entire vegetation management unit will identify areas for treatment.

Completing multiple inspections throughout the growing season will identify species and areas needing treatment that may not have been an issue earlier in the year.

Supplemental Seeding

Ideally, supplemental seeding will be minimal during the maintenance phase because the vegetation should be well-established; however, annually, it is likely that due to herbicide applications, operation, and maintenance activities, or changing conditions, that a small amount of supplemental seeding may be required. It is important to be prepared to supplemental seed to avoid allowing invasive species to get established in bare ground or sparsely vegetated areas.

Agricultural Areas included in Project Area and Planned for Future Facility Expansion

As previously discussed, areas outside of fenced array areas and the designated vegetated buffers will likely remain in agricultural production. Castle Rock Solar will inform landowners of the importance of preventing pesticide drift onto regionally appropriate vegetation, implementing practices that protect soil health, and managing noxious and invasive plant species.

7.6 Herbicides

Herbicide treatments are recommended for management of perennial noxious species, as mowing alone is not typically sufficient for adequate control. Ongoing management of noxious species may be required for compliance with noxious and invasive plant species regulations. Herbicides are also used to remove undesirable vegetation to prepare seeding areas for permanent seed installation.

7.6.1 Herbicide Types

Three general types of herbicides are applicable to the Project: non-selective herbicides, broadleaf-selective herbicides and grass-selective herbicides. Each is detailed below.

7.6.1.1 Non-Selective Herbicides

Non-selective herbicides injure or kill all types of vegetation, including broadleaves, grasses and grass-like plants, and woody plants. Glyphosate is a non-selective herbicide that is commonly used to remove all vegetation to prepare areas for permanent seeding.

7.6.1.2 Broadleaf-Selective Herbicides

Broadleaf-selective herbicides are intended to injure or kill only broadleaf plants. There are many types of broadleaf herbicides. Two types commonly used in natural settings include 2,4-D and triclopyr. Both 2,4-D and triclopyr are used to remove broadleaf plants from grass-stands and turf lawns. Some broadleaf herbicides are highly selective, for example, the active ingredient clopyralid is very effective for controlling weedy asters (*Asteraceae,* e.g., Canada thistle (*Cirsium arvensis*) and legumes (*Fabaceae,* e.g., sweet

clover (*Melilotus spp.*). Care should be taken to avoid injury to desirable grass species by waiting to apply herbicides after grass seedlings have matured for at least 90 days or have flowered at least once. Also consult the herbicide label for application restrictions following seeding.

7.6.1.3 Grass-Selective Herbicides

Grass-selective herbicides are intended to injure or kill only grasses. The most common grass-selective herbicide is clethodim. It is used to selectively target undesirable grasses growing among desirable broadleaf plants.

7.6.2 Herbicide Application Methods and Timing

There are two primary methods to apply herbicides: low volume/spot applications and broadcast applications. Methods and timing should be based on a site-specific evaluation of target species, vegetation composition, and sensitivity of adjacent areas to herbicide applications.

7.6.2.1 Low Volume/Spot Applications

This method utilizes a hand-held sprayer mounted to small (3.5 to 25 gallon) tanks to selectively deliver herbicide to individual plants or small clumps of plants. Backpack sprayers are suitable for small areas while pistol sprayers mounted to an all-terrain vehicle or utility terrain vehicle (UTV) are suitable for larger areas or large clumps of vegetation. Wicks may also be used for ultra-low volume delivery of herbicide to undesirable plants growing in sensitive ecological areas. These methods are appropriate for managing discrete populations of weedy and invasive species after construction.

7.6.2.2 Broadcast Applications

This method utilizes a boom or boomless sprayer tanks mounted to a UTV or tractor to broadcast herbicide to large areas. This method is appropriate for large-scale site preparation to remove weedy and invasive vegetation from large areas using a non-selective herbicide.

7.6.2.3 Herbicide Adjuvants

Adjuvants are typically added to herbicide mixes to improve herbicide performance. Adjuvants typically used for natural areas management include hard water treatment additives, surfactants, and penetrants. Herbicide labels should be consulted for recommendations on the types of adjuvants to add to a mix. In general, aquatic-approved adjuvants should be used to minimize potential impacts on wildlife, including pollinators. Aquatic-approved adjuvants should always be used in and near areas of standing water.

7.6.3 Herbicide Standard Industry Practices

Herbicides are a valuable vegetation management tool when used according to manufacturer's instructions and following standard industry practices. The following practices are recommended when using herbicides to manage undesirable vegetation:

1. Vegetation managers should apply principles of integrated vegetation management. Herbicides should be used as one of several available 'tools in the toolbox' to manage vegetation and habitats in an ecologically sensitive manner, in addition to mechanical controls (cutting), engineering controls, cultural controls, and in unique circumstances, biological controls.

2. Herbicide labels and Safety Data Sheets should be read prior to transport, mixing, loading, and application.

3. The appropriate volume of herbicides and adjuvants necessary to complete a vegetation management task should be utilized. This includes targeted application techniques when practicable and use of properly calibrated equipment to minimize environmental effects.

4. The appropriate concentrations of herbicides and adjuvants as recommended by product labels are used to achieve intended outcomes.

5. Use of selective herbicides to limit effects on non-target plants.

6. Persistent noxious weeds typically require several treatments to adequately control re-growth and spread.

7. Herbicide applications should be conducted during favorable weather conditions to maximize herbicide efficiency and minimize off-site drift and run-off. Avoid herbicide application during persistent heat, drought, freezing or wet conditions.

8. Herbicide should be applied to plants when plants are most physiologically prone to injury by active ingredients. Plants are most prone to herbicide injury when they are actively growing. Plant life cycles targetable for herbicide application include the flower bud-stage and rosette stage. Plants that have senesced following flowering or are inactive due to high heat or drought should not be treated.

7.6.4 Herbicide Permitting

Herbicide treatments should be performed by individuals with a current Commercial Pesticide Applicator certification and license issued through the MDA (https://www.mda.state.mn.us/pesticide-fertilizer/pesticide-applicator-licensing), and in accordance with all applicable laws, regulations, and herbicide label instructions.

7.6.5 Proposed Herbicides

The herbicides that may be used in the Project are listed below in **Table 13**. These herbicides are frequently used in natural area settings to assist with management of species that would be expected to occur in the Project Area. These herbicides have a relatively short half-life and moderate to very unlikely potential to reach shallow groundwater.

Table 13. Environmental Information for Proposed Herbicides

Active Ingredient	Herbicide Type	Potential Uses	Environmental Fate[1,2]			
			Water Solubility	Soil Half-life	Mineral Soil Sorption Coefficient KOC / FAO Mobility Classification[3]	Groundwater Ubiquity Score (GUS)[4] / Potential to Reach Shallow Groundwater
Glyphosate	Non- selective systemic foliar	Non-selective treatment of grasses and broadleaf plants	Very soluble	3.6 days	40,000 in silty/loam soils / Immobile	-0.25 in silty/loam soils / Very unlikely
2,4-D	Broadleaf systemic foliar	Selective treatment of weedy and invasive broadleaf plants	Moderately soluble	2.9 days	88 in silty/loam soils / Mobile	1.13 in silty/loam soils / Unlikely
Triclopyr	Broadleaf selective foliar	Selective treatment of woody plants	Moderately soluble	13 days in unknown soil	93.5 in unknown soil / Mobile	2.26 in unknown soil / Moderate potential
Aminopyralid	Broadleaf selective foliar Species selective	Specific noxious and invasive weeds	Very soluble	81.5 days in unknown soil	2.33 in unknown soil / Highly Mobile[5]	6.94 in unknown soil / Likely[5]
Clopyralid	Broadleaf selective foliar Species selective	Specific noxious and invasive weeds Asters and legumes	Very soluble	12.8 days	2.64 in silt loam / Highly Mobile[5]	3.96 in silt loam / Likely[5]
Clethodim	Grass- selective systemic foliar	Selective treatment of weedy and invasive grasses	Very soluble	3 days in unknown soil	137.5 in unknown soil / Moderately mobile	0.89 in unknown soil / Unlikely

[1] Information from Herbicide Properties Tool at the National Pesticide Information Center – Oregon State University. Accessed online on 8/7/2020 at http://npic.orst.edu/HPT/#.
[2] Reported for silty/loam or silt loam soils unless otherwise stated in the Herbicide Properties Tool search results.
[3] Based on FAO Mobility Classification in *Guidance for Reporting on the Environmental Fate and Transport of the Stressor Concern in Problem Formulations*. Accessed online on 8/7/2020 at https://www.epa.gov/pesticide-science-and-assessing-pesticide-risks/guidance-reporting-environmental-fate-and-transport#II_C.
[4] Potential to Reach Shallow Groundwater based on discussion in the Herbicide Properties Tool search results.
[5] Appropriate for low volume foliar herbicide applications targeting individual plants or clumps of plants.

8.0 Vegetation Monitoring and Adaptive Management

8.1 During Construction

Qualified vegetation management professionals will monitor construction practices that maintain soil health including reducing impacts due to construction such as compaction, soil erosion, soil separation and storage, and stormwater runoff. Construction will be conducted in compliance with the AIMP developed for the Project (**Appendix F**). Qualified vegetation management professionals will also be able to identify, and report weed establishment and proliferation as part of monitoring events, which will be important to avoid weed problems that negatively impact vegetation conditions outlined in the objectives section.

8.2 Post-Construction

Post-construction will focus on collecting data that indicates when the NPDES permit may be closed out and on informing establishment management activities. Specifically, the monitoring program will focus on collecting data on percent cover represented by regionally appropriate species (both seeded and volunteer), annual species, perennial species, and noxious/invasive species. The highest priority for vegetation management is to achieve and maintain 70 percent or greater perennial vegetation coverage to terminate the NPDES permit (Goal 1). Understanding the development of perennial cover over time and the species that comprise the vegetation cover will inform annual management activities such as reseeding, mowing, or spot herbicide applications.

The monitoring program will include two components: multiple inspections and annual monitoring. During the growing season, multiple inspections will occur throughout the Project Area. Inspections will be completed by a qualified vegetation management professional with the intent to determine the current state of vegetation and confirm/update vegetation management activities for the current growing season.

Inspections will be a combination of meander surveys through management units and as needed, observations to address troublesome areas. Inspection reports will be developed that include areas inspected, representative photos, outcomes of previous management activities, and prescriptions for future management activities. Inspection reports will be kept internally within the Project team; however, inspection reports will be summarized in the annual monitoring report.

Annual monitoring will consist of a timed meander survey through each vegetation management unit. The meander survey will be modified based on procedures in Bohnen and Galatowitsch (2016). During the time meander survey, species observed along with an estimate of cover class will be recorded. Representative photos during each meander survey will be taken and spatially linked. Each timed meander survey route will be at least 30 minutes long. The number of routes will vary based on the size of the vegetation management unit, but will follow guidelines in Bohnen and Galatowitsch (2016):

- One route for each management unit 5 acres or less.
- Two routes for each management unit between 5 and 59 acres in size.
- One route for every 30 acres in management units between 60 and 300 acres in size.
- Ten or more routes in management units 300 acres in size.

Monitoring will occur late in the growing season annually in the first five years and continue on an annual basis through the remaining period of the permit. Monitoring late in the growing season allows for an understanding of the effects of the previous and current management activities while setting the basis for the following year's work. A monitoring report will be developed by January 31 of the following year. As part of the adaptive management program, monitoring data and monitoring protocols will be evaluated every 3 to 5 years to determine if the monitoring program needs to be updated. Rationale for updating the protocol could include:

- Changes to reporting requirements for permit compliance.
- Need for different information to effectively inform management decisions.
- New developments in technology or data analysis such as unmanned aerial vehicles, artificial intelligence, and data cloud processing.

8.3 Adaptive Management

Adaptive management is the process of collecting data about the response to management actions and incorporating new information to make future decisions. An adaptive management program will consist of the following elements:

- Following annual monitoring in the first six years, if a vegetation management unit is not meeting its objectives, developing a work plan for a vegetation management unit block that includes proposed management actions to achieve the Project objectives. This could be as simple as a one-to-two-page worksheet.
- Recording management actions completed during the growing season, environmental conditions such as temperatures and rainfall, and activities that impacted vegetation.
- Incorporating changed management actions into vegetation management unit work plans in response to new information and/or techniques.

Adaptive management decisions will be informed by a qualified vegetation management professional. The impact of using an adaptive management approach will be observed based on the description of the existing site conditions in the post-construction long-term management phase.

9.0 References

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APPENDIX A: CIVIL SITE PLANS

APPENDIX B: SEED MIX TABLES

Table B.1-A – Table B.1-D. Temporary Cover Crop Seed Mixes*

Table B.1-A Temporary Fall (Late August – Early November) Project site Cover Crop Seed Mix without Permanent Seed*			
Scientific Name	**Common Name**	**Pounds / Acre**	**Seeds / Sq Ft**
Triticum aestivum	Winter Wheat	128.00	44.32
Lolium multiflorum	Annual ryegrass	10.00	52.11

Table B.1-B Temporary Fall (Late August – Early November) Project site Cover Crop Seed Mix with Permanent Seed*			
Scientific Name	**Common Name**	**Pounds / Acre**	**Seeds / Sq Ft**
Triticum aestivum	Winter Wheat	25.00	8.60
Lolium multiflorum	Annual ryegrass	5.00	26.00

Table B.1-C Temporary Spring-Summer (Mid-April – Mid-August) Project site Cover Crop Seed Mix without Permanent Seed*			
Scientific Name	**Common Name**	**Pounds / Acre**	**Seeds / Sq Ft**
Avena sativa	Seed Oats	128.00	44.32
Lolium multiflorum	Annual ryegrass	10.00	52.11

Table B.1-D Spring-Summer and Early Fall (Mid-April – Mid-August) Project site Cover Crop Seed Mix with Permanent Seed*			
Scientific Name	**Common Name**	**Pounds / Acre**	**Seeds / Sq Ft**
Avena sativa	Seed Oats	25.00	8.60
Lolium multiflorum	Annual ryegrass	5.00	26.00

Final cover crop seed selection should occur when tentative seeding dates are known. All seed mixes calculated at Pure Live Seed (PLS). Seeding rates are designed for drilling seed in spring through summer. Broadcasting seed and seeding during the dormant season require at least a 20% increase in PLS rates. Broadcast seed should be packed or harrowed into the soils.

Table B.2 Solar Array Mix – Mesic to Dry[1,2]

Mesic to Dry, Sun - Full to Partial
10 lb/acre (55.7 seeds/square foot)

Common Name	Scientific Name	% of Mix	Seeds/ft2	Total (PLS lb)
Grasses				
Sideoats Grama	*Bouteloua curtipendula*	30.00%	6.6	3.000
Blue Grama	*Bouteloua gracilis*	2.50%	3.7	0.250
Prairie Brome	*Bromus kalmii*	5.00%	1.5	0.500
Slender Wheatgrass	*Elymus trachycaulus*	10.00%	2.5	1.000
Virginia Wild Rye	*Elymus virginicus*	11.50%	1.8	1.150
Little Bluestem	*Schizachyrium scoparium*	15.00%	8.3	1.500
Sand Dropseed	*Sporobolus cryptandrus*	0.50%	6.4	0.050
Prairie Dropseed	*Sporobolus heterolepis*	0.50%	0.3	0.050
Sedges & Rushes				
Bicknell's Sedge	*Carex bicknellii*	0.50%	0.3	0.050
Plains Oval Sedge	*Carex brevior*	3.00%	3.2	0.300
Troublesome Sedge	*Carex molesta*	0.50%	0.5	0.050
Brown Fox Sedge	*Carex vulpinoidea*	1.00%	3.7	0.100
Forbs				
Common Yarrow	*Achillea millefolium*	0.10%	0.7	0.010
Anise Hyssop	*Agastache foeniculum*	0.20%	0.7	0.020
Lead Plant	*Amorpha canescens*	1.00%	0.6	0.100
Canada Anemone	*Anemone canadensis*	0.20%	0.1	0.020
Wild Columbine	*Aquilegia canadensis*	0.10%	0.1	0.010
Common Milkweed	*Asclepias syriaca*	1.20%	0.2	0.120
Butterfly Milkweed	*Asclepias tuberosa*	0.40%	0.1	0.040
Canada Milkvetch	*Astragalus canadensis*	1.00%	0.6	0.100
Partridge Pea	*Chamaecrista fasciculata*	6.00%	0.6	0.600
Lanceleaf Coreopsis	*Coreopsis lanceolata*	0.80%	0.6	0.080
White Prairie Clover	*Dalea candida*	2.60%	1.8	0.260
Purple Prairie Clover	*Dalea purpurea*	3.00%	2.0	0.300
Prairie Cinquefoil	*Drymocallis arguta*	0.20%	1.7	0.020
Spotted Bee Balm	*Monarda punctata*	0.10%	0.3	0.010
Large-flowered Beardtongue	*Penstemon grandiflorus*	0.60%	0.3	0.060
Virginia Mountain Mint	*Pycnanthemum virginianum*	0.20%	1.6	0.020
Black-eyed Susan	*Rudbeckia hirta*	0.50%	1.7	0.050
Gray Goldenrod	*Solidago nemoralis*	0.20%	2.2	0.020
Sky Blue Aster	*Symphyotrichum oolentangiense*	0.20%	0.6	0.020
Ohio Spiderwort	*Tradescantia ohiensis*	0.40%	0.1	0.040
Hoary Vervain	*Verbena stricta*	0.20%	0.2	0.020
Golden Alexanders	*Zizia aurea*	0.80%	0.3	0.080

[1] Final seed selection should occur when tentative seeding dates are known, and actual species composition and rates should be based on availability at the time of procurement.

[2] Species heights are selected for under 24" tall. This modeling takes into account, species in over achieve height by 50% in high nutrient high moisture conditions that are common in Midwest agriculture fields.

Table B.3 Pollinator Seed Mix – Mesic to Dry-Mesic [1,2]

Mesic to Dry Mesic, Sun - Full to Partial
8 lb/acre (61.3 seeds/square foot)

Common Name	Scientific Name	% of Mix	Seeds/ft2	Total (PLS lb)
Grasses				
Sideoats Grama	*Bouteloua curtipendula*	25.00%	4.4	2.000
Blue Grama	*Bouteloua gracilis*	1.50%	1.8	0.120
Canada Wild Rye	*Elymus canadensis*	5.00%	0.8	0.400
June Grass	*Koeleria macrantha*	1.00%	5.9	0.080
Little Bluestem	*Schizachyrium scoparium*	15.00%	6.6	1.200
Prairie Dropseed	*Sporobolus heterolepis*	2.50%	1.2	0.200
Forbs				
Anise Hyssop	*Agastache foeniculum*	0.50	1.3	0.040
Prairie Onion	*Allium stellatum*	1.00	0.3	0.080
Lead Plant	*Amorpha canescens*	2.00	0.9	0.160
Swamp Milkweed	*Asclepias incarnata*	1.50	0.2	0.120
Common Milkweed	*Asclepias syriaca*	2.00	0.2	0.160
Butterfly Milkweed	*Asclepias tuberosa*	1.00	0.1	0.080
Canada Milkvetch	*Astragalus canadensis*	2.00	1.0	0.160
White Wild Indigo	*Baptisia alba*	0.50	0.0	0.040
Partridge Pea	*Chamaecrista fasciculata*	10.00	0.8	0.800
White Prairie Clover	*Dalea candida*	2.00	1.1	0.160
Purple Prairie Clover	*Dalea purpurea*	3.00	1.6	0.240
Showy Tick Trefoil	*Desmodium canadense*	0.50	0.1	0.040
Ox-eye Sunflower	*Echinacea angustifolia*	1.50	0.3	0.120
Narrow-leaved Coneflower	*Heliopsis helianthoides*	2.00	0.4	0.160
Round-headed Bush Clover	*Lespedeza capitata*	0.50	0.1	0.040
Meadow Blazing Star	*Liatris ligulistylis*	1.00	0.3	0.080
Prairie Blazing Star	*Liatris pycnostachya*	1.50	0.5	0.120
Great Blue Lobelia	*Lobelia siphilitica*	0.25	3.7	0.020
Wild Lupine	*Lupinus perennis*	0.50	0.0	0.040
Wild Bergamot	*Monarda fistulosa*	1.00	2.1	0.080
Virginia Mountain Mint	*Pycnanthemum virginianum*	0.50	3.2	0.040
Long-headed Coneflower	*Ratibida columnifera*	1.00	1.2	0.080
Yellow Coneflower	*Ratibida pinnata*	2.00	1.8	0.160
Prairie Wild Rose	*Rosa arkansana*	0.50	0.0	0.040
Black-eyed Susan	*Rudbeckia hirta*	1.00	2.7	0.080
Brown-eyed Susan	*Rudbeckia triloba*	0.25	0.2	0.020
Gray Goldenrod	*Solidago nemoralis*	0.25	2.2	0.020
Stiff Goldenrod	*Solidago rigida*	0.50	0.6	0.040
Showy Goldenrod	*Solidago speciosa*	0.50	1.4	0.040
Smooth Blue Aster	*Symphyotrichum laeve*	1.00	1.6	0.080
New England Aster	*Symphyotrichum novae-angliae*	0.50	1.0	0.040
Sky Blue Aster	*Symphyotrichum oolentangiense*	0.50	1.2	0.040
Ohio Spiderwort	*Tradescantia ohiensis*	2.00	0.5	0.160
Hoary Vervain	*Verbena stricta*	1.00	0.8	0.080
Culver's Rood	*Veronicastrum virginicum*	0.25	5.9	0.020
Golden Alexanders	*Zizia aurea*	4.00	1.3	0.320

[1] Final seed selection should occur when tentative seeding dates are known, and actual species composition and rates should be based on availability at the time of procurement.

[2] Species heights are selected for under 24" tall. This modeling takes into account, species in over achieve height by 50% in high nutrient high moisture conditions that are common in Midwest agriculture fields.

Table B.5 Stormwater Basin Seed Mix

33-361

Common Name	Scientific Name	Rate (kg/ha)	Rate (lb/ac)	% of Mix (% by wt)	Seeds/ sq ft
fringed brome	*Bromus ciliatus*	4.09	3.65	10.43%	14.75
bluejoint	*Calamagrostis canadensis*	0.06	0.05	0.13%	4.80
nodding wild rye	*Elymus canadensis*	2.24	2.00	5.71%	3.82
Virginia wild rye	*Elymus virginicus*	2.24	2.00	5.73%	3.09
tall manna grass	*Glyceria grandis*	0.18	0.16	0.44%	4.00
fowl bluegrass	*Poa palustris*	0.72	0.64	1.82%	30.40
	Total Grasses	**9.53**	**8.50**	**24.26%**	**60.86**
porcupine sedge	*Carex hystericina*	0.10	0.09	0.26%	1.00
pointed broom sedge	*Carex scoparia*	0.04	0.04	0.12%	1.30
dark green bulrush	*Scirpus atrovirens*	0.30	0.27	0.76%	45.00
woolgrass	*Scirpus cyperinus*	0.11	0.10	0.27%	60.00
	Total Sedges and Rushes	**0.56**	**0.50**	**0.27%**	**107.30**
Canada anemone	*Anemone canadensis*	0.11	0.10	0.29%	0.30
marsh milkweed	*Asclepias incarnata*	0.50	0.45	1.30%	0.80
flat-topped aster	*Doellingeria umbellata*	0.11	0.10	0.29%	2.50
common boneset	*Eupatorium perfoliatum*	0.06	0.05	0.15%	3.00
grass-leaved goldenrod	*Euthamia graminifolia*	0.04	0.04	0.11%	5.00
spotted Joe pye weed	*Eutrochium maculatum*	0.17	0.15	0.42%	5.10
blue monkey flower	*Mimulus ringens*	0.02	0.02	0.07%	20.00
giant goldenrod	*Solidago gigantea*	0.02	0.02	0.06%	2.00
eastern panicled aster	*Symphyotrichum lanceolatum*	0.02	0.02	0.05%	1.00
tall meadow-rue	*Thalictrum dasycarpum*	0.06	0.05	0.16%	0.40
	Total Forbs	**1.12**	**1.00**	**2.90%**	**40.10**
Oats	*Avena sativa*	28.02	25.00	71.43%	11.14
	Total Cover Crop	**28.02**	**25.00**	**71.43%**	**11.14**
	Totals:	**39.23**	**35.00**	**100.00%**	**219.40**

Purpose:	Stormwater pond edges, temporarily flooded dry ponds, and temporarily flooded ditch bottoms.

APPENDIX C: POTENTIAL REGIONAL SEED VENDORS

Table C.1 Potential Regional Seed Vendors

Company	Phone	Website	Specialty
Agassiz Seed	(651) 287-3400	https://www.agassizseed.com/	Native and non-native seed mixes
Agrecol Corporation	(608) 226-2544	http://www.agrecol.com/SeedMixes	Native and non-native seed mixes
Prairie Moon Nursery	(866) 417-8156	https://www.shootingstarnativeseed.com/	Native seed mixes
Shooting Star Seed Mixes	(608) 497-0655	https://www.shootingstarnativeseed.com/	Native and non-native Seed mixes

APPENDIX D: COMPARISON OF SEEDING METHODS

Table D.1 Comparison Summary Between Drill and Broadcast Seeding Methods

Circumstance	Drill Seeding	Broadcast Seeding	Culti-packer Seeder
Soil to Seed Contact	High	Low	Medium
Germination Efficiency	High	Low	Medium
Extra Seed Required to Achieve Compatibility	No	≥ 20%	10%
Seedbed Preparation	Low	High	Medium
Soil Finishing (packing or rolling)	Low	High	Low
Efficiency in Tight Spaces	Low	High	Medium
Ability to Seed Under PV Panels	No	High	No
Seed Washing Potential	Low	High	Medium
Harvested Soybean Field	Yes	Yes	Yes
Harvested Corn Field (followed by mowing, baling, and light discing)	Yes	Yes	Yes
Harvested Forage (hay or silage) Field	Yes	Yes Benefits from light discing	Yes
Post-construction Seeding Within Array Field	Not advised	Advised	Advised
Potential for Second Seeding Event	Low	High	Medium
Speed (acres per hour)	Low	High	Medium
Efficiency (achieve goals / time / cost)	Low	Highly Variable	Medium

APPENDIX E: STORMWATER POLLUTION PREVENTION PLAN (SWPPP)

APPENDIX F: AGRICULTURAL IMPACT MITIGATION PLAN

Agricultural Impact Mitigation Plan

Castle Rock Solar Project

Dakota County, Minnesota
Stantec Project #:193709215

August 27, 2024

Prepared for:

Castle Rock Solar LLC
3316 Highland Avenue
Wayzata, MN 55391

Prepared by:

Stantec Consulting Services
Inc. 3303 Fiechtner Dr, Suite
100 Fargo, North Dakota 58103

AGRICULTURAL IMPACT MITIGATION PLAN

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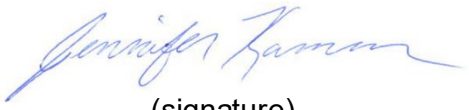
Approved by 
(signature)

Jennifer Kamm, Senior Associate, Project Manager

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Abbreviations

AC	alternating current
AIMP	Agricultural Impact Mitigation Plan
BMP	best management practices
DC	direct current
EPC	engineering, procurement, and construction contractor
GIS	Geographic Information System
MN DNR	Minnesota Department of Natural Resources
LCC	Land Capability Class
MV	medium voltage
mw	Megawatt
NEC	National Electric Code
NESC	National Electric Safety Code
NRCS	Natural Resources Conservation Service
O&M	Operation and Maintenance
POI	point of interconnection
Project	Castle Rock Solar Project
PV	photovoltaic
Stantec	Stantec Consulting Services Inc.
Stormwater General Permit	General Permit to Discharge under an Minnesota Pollutant Discharge Elimination System NPDES Permit
SSURGO	Soil Survey Geographic Database
SWMP	Stormwater Management Plan
VMP	Vegetation Management Plan

1.0 PURPOSE AND APPLICABILITY OF PLAN

The objective of this Agricultural Impact Mitigation Plan (AIMP) is to identify measures that Castle Rock Solar LLC (Castle Rock Solar) and its contractors will take to avoid, mitigate, repair, and/or compensate for potential agricultural impacts that may result from the construction, operation, and eventual decommissioning of the Castle Rock Solar Project (Project). The overall Project Footprint is 1,354.90 acres but the proposed disturbance footprint used for soil impact analysis in this AIMP is approximately 934.24 acres as shown on Figure 1, Site Location Map (Appendix A). Although agricultural operations would temporarily cease on most of the land on which the Project is constructed during the life of the Project, this Plan outlines measures to ensure the land may be returned to future agricultural use following decommissioning of the Project. This AIMP describes the Best Management Practices (BMPs) that will be used during construction, operation, and decommissioning to minimize long-term impacts to soil.

Castle Rock Solar will obtain authorization under the Minnesota Pollution Control Agency (MPCA) General Permit to Discharge under a National Pollutant Discharge Elimination System NPDES Permit General NPDES Permit No. MN R100001 (Stormwater General Permit) prior to the commencement of construction. Temporary stormwater BMPs will be used during Project construction, and construction will be completed in accordance with the MPCA Stormwater General Permit and a site-specific Erosion Control and Storm Water Management Plan to be developed for the Project.

The site-specific Vegetation Management Plan (VMP) developed for the Project describes the vegetation management practices, including seed mixtures, planting plans and methodologies, and maintenance practices to be conducted during the construction and operational phases of the Project. Permanent perennial vegetative cover will be established throughout the Project Area to manage erosion and increase stormwater infiltration within the Project Area.

This AIMP is separated into six sections: Section 2 provides an overview of the proposed Project and its components. Section 3 identifies soil limitations and suitability within the Project Area; Section 4 describes the BMPs that will be used during construction and operation of the Project; Section 5 summarizes key components of the Vegetative Management Plan in relation to agricultural impact mitigation; Section 6 describes Project Decommissioning and restoration/reclamation of the site.

2.0 PROJECT OVERVIEW

This report overviews the Preferred Project design for the Castle Rock Solar Project with a development area of 934.24 acres within the security fencing. The Alternative Project design occupies a development area of approximately 933.54. Acreage differences are a result of the Preferred Project design containing less roads and slightly greater solar array and collection line component footprints compared to the Alternative Project design.

The Castle Rock Solar Project consists of a 150-Megawatt (MW) alternating current (AC) solar power generating facility sited on 1,354.90 acres one mile southeast of the town of Farmington, Dakota County, Minnesota. Overall, 934.24 acres will be developed and/or within security fencing for the life of the project. The Project proposed to construct a new substation on site to interconnect to the grid but its location has not been finalized. The alternative design contains a different substation location.

Castle Rock Solar is responsible for all land acquisition, lease agreements, and easements required to build the Project facilities within the Project Area.

2.1 PROJECT COMPONENTS

The Project facilities will include the following major components or systems:

2.1.1 Solar Panels, Arrays, and Racking

A specific PV solar module has not yet been selected for the Project. The PV module selected for the Project will be thin-film technology (cadmium telluride [CdTe]) with approximate dimensions of 3.9 feet by 7.5 feet (1.2 meters by 2.3 meters), or crystalline plate glass modules with an aluminum frame. The PV modules will be connected in series for up to 1500V operation and will be mounted on a tracker system in-line and oriented such that the long side of the module is facing adjacent modules on racking which tracks east to west to follow the sun throughout the day. The final selection of the PV module and inverters will be made at a future date based on the available market offering. The First Solar Series 7 540-Watt module and the Solarware Ninja inverter were used as the basis of the preliminary Project design. The final module selected is expected to have similar physical construction and electrical characteristics.

The solar panels will be mounted on a steel and/or aluminum racking frame that is positioned approximately 4.75 to 6 feet from the finished ground with a +\- 60-degree range of motion (single axis tracking) driven by electric motors. The single axis tracking system is anticipated to be mounted on steel support posts driven into the ground or screw driven helical piles. To the extent practical, the racking system foundations will be a driven pier and/or screw driven helical piles and will not require concrete, although some concrete foundations may be required depending upon site specific soil conditions and geotechnical analysis.

The horizontal tracker would be in its highest position during the morning and evening hours when the trackers are tilted at their maximum angle and would be a maximum of 9 to 12 feet (2.75 to 3.7 meters) above the ground surface. The bottom edge of the modules will be a minimum of 18 inches above grade at maximum tilt, and a minimum of 5.5 feet above grade

when tilted flat at mid-day in a way that the maximum height of the system tilted at their maximum angle will not exceed 9 to 12 feet

Foundations or supports will be installed to a minimum depth of five (5) feet below ground surface to minimize impacts from freezing and thawing conditions. Exact embedment depth for the driven pile on which the solar panels are mounted will be determined with final engineering.

2.1.2 Electrical Collection System, Substation, and Gen-Tie

Underground 34.5 kilovolt (kV) collector circuits are proposed for the Project. Underground collector circuits are an industry standard method to route the collection cables while eliminating interference with other above ground infrastructure within the Project Area. The total length of AC collection lines installed for the Project will be approximately 12.3 mile (64,944 feet.). This includes AC collection lines within the PV array connecting to the medium voltage (MV) power stations, Switchyard, and generator tie (Gen-Tie) line connecting the PV array area to the proposed Substation on the north side of 230th St W pending finalization. Approximately 198.8 feet (0.04 miles) of overhead collector circuit runs are proposed for the Project.

The collection system will either be buried at a depth of at least 36 inches to the top of the cables or will be enclosed within a conduit and buried at a depth of at least 24 inches. These depths meet minimum cover requirements as specified in table 300.50 of National Electric Code (NEC) 2017, Chapter 3 “Wiring Methods and Materials.” The trench for the cable will be eighteen inches wide. Where multiple cables are installed parallel to each other, the cable separation will be up to eight feet apart, therefore the width of the trench will vary depending on the number of circuits within the trench.

2.1.3 Access Roads

Gravel access roads will connect the facility to existing public roads and provide access to Project equipment during facility operations and maintenance and to accommodate emergency access. Permanent internal access roads will provide access to the Project from 230th W crossing through the central portion of the Project Area east to west and 240th St W in the southern portion of the Project Area. These internal access roads are expected to be approximately 5.9 miles (31,152 feet) in total length and are approximately 16-feet wide.

2.1.4 O&M, Switchyard, and Inverters

The Project will use driven pier foundations and/or concrete foundations. The switchyard and inverters will likely be installed on driven pier foundations but could be placed on concrete foundations if required by soil and geotechnical conditions. The typical pier foundation will be from five (5) feet to 10 feet deep. For driven pier foundations, no excavation is required. For the concrete foundations, soil excavation quantities will be determined in the detailed engineering phase.

Foundation dimensions will be determined in the detailed engineering phase. Castle Rock Solar will locate the O&M facility near the Project substation and switchyard area on approximately 0.9 acres with a 25 foot x 56 foot pad to accommodate a building footprint of approximately 40 feet x 16 feet. A total of 40 inverters will be mounted on driven piers for the Project.

2.1.5 Laydown Yards

Laydown Yards will be used by Castle Rock Solar subcontractors for material storage, equipment parking, and delivery unloading. Impacts associated with the Laydown Yards are anticipated to be temporary. Most areas will be eventually developed as the solar array area, but one Laydown Yard will be reclaimed and revegetated. Temporary impact acreage is displayed in Tables 1, 2, and 3 for the Laydown Yards are not included in the table acreage totals of 934.23.

2.1.6 Security Fencing

Castle Rock Solar will utilize fencing around the PV solar arrays that is consistent with all applicable codes, including NEC and North American Electric Reliability Council Critical Infrastructure Protection requirements. Fencing is required to safeguard the public health. Array fencing will consist of seven to eight-foot-high woven-wire exclusion fence with wood fenceposts and total 20.7 miles (109,296 feet). Fenceposts will be driven into the ground. No concrete foundations will be used for the fenceposts.

2.2 CONSTRUCTION

The Project will be designed in conformance with the version of the International Building Code as required by the authority having jurisdiction, state, and local requirements. The Project will select an engineering, procurement, and construction contractor (EPC) to manage engineering, procurement, and construction of the Project; subcontractors will be selected to perform all necessary work to construct the Project. Project construction sequencing will follow the construction plan and will be developed in conjunction with the selected contractors and finalized prior to the start of construction. The following provides a general description of the staging and construction sequence for the Project:

- Tracking pads at construction entry and exit points, and erosion control and stormwater best management practices (BMPs) will be installed as outlined in the Stormwater Management Plan (SWMP) that will be prepared for the Project.
- Vegetation removal (crop removal) will start in areas where initial staging and lay-down areas will be located. Vegetation removal will continue across the site, sequenced to proceed in an organized and cost-efficient manner. Limited tree and brush clearing will commence in a similar fashion. Bare ground will be re-seeded if necessary, in accordance with the Stormwater Management Plan and MPCA requirements.
- Staging and lay-down areas will be developed to receive and store construction materials and equipment. The lay-down areas will also house trailers and parking for personnel and construction-related vehicles.
- Installation of access roads to facilitate continued clearing operations and construction of the facility (limited grading is anticipated as roads will be constructed at grade when possible).
- Delivery of equipment, including piles, aluminum supports/mounting structures, tracking systems, and inverters. The Project will be constructed in blocks and multiple blocks will be

constructed simultaneously over time. Deliveries will continue over time in advance of construction of the blocks.

- Solar block construction in sequence, starting with driving pile foundations, then installing aluminum supports/mounting structures onto the piles.
- Delivery of collection system equipment and installation via trenching and directional drilling.
- Delivery and installation of solar PV modules.
- Stabilization and revegetation of disturbed areas will occur in stages as construction of the solar blocks and collection trenches are completed. Bare ground will be re-seeded if necessary, in accordance with the Stormwater Management Plan and MPCA requirements.
- Connect Project Switchyard and Proposed substation to transmission infrastructure.
- Conduct interconnection inspections and testing and Project commissioning.

Site access will be controlled for personnel and vehicles. Permanent security fencing will be installed in advance of or in conjunction with site preparation activities (e.g., grading, mowing, etc.) in advance of large component deliveries. All temporary disturbance areas will be restored in accordance with the Project specific Vegetation Management Plan.

During construction, temporary utilities will serve the construction offices, laydown area, and Project Area. Temporary construction power before the construction of permanent distribution power will either be provided via a local distribution line extended to the Project Area or by temporary diesel generators. Temporary area lighting will be provided and strategically located for safety and security.

The Project on-site workforce will consist of laborers, craftsmen, supervisory personnel, support personnel, and construction management personnel. The construction crews will have approximately 200 to 375 direct workers for the Project. Construction of the Project will generally occur between 7:00 a.m. and 5:00 p.m., Monday through Friday. Additional hours may be necessary to make up schedule deficiencies or to complete critical construction activities. During the start-up phase of the Project, some activities (such as equipment and system testing) may continue 24 hours per day, 7 days per week. Construction hours will comply with local permit requirements.

Construction of the Project is currently expected to require approximately 15 months which includes mobilization, construction/installation, and commissioning/testing to achieve the targeted commercial operations date of Q4 2027.

The Project will require different equipment types depending on the phase of construction. The first phase consisting of civil work and road building will require dozers, motor graders, and rollers. The pile-driving phase will utilize pile drivers. After pile driving, the installation of racking and panels will be supported mainly by skid steers and telehandlers. Directional drilling equipment for installation of the collection line will be mobilized to the site on low-profile flatbed trailers. For other Project components including the O&M Building, Switchyard, and Inverters; small cranes, bucket trucks, and forklifts will be used to place equipment. Other support equipment such as skid steers, ATVs, and forklifts will also be used.

Delivery trucks will consist of standard, legal load (80,000 pounds or less) over-the-road flatbed and box trucks and will have standard turning radii. Vehicles used inside the arrays will be suitable for the engineered internal access roads and turn-arounds. Equipment typically used in construction and operation of utility scale solar facilities are generally similar in weight or less than equipment typically used in annual agricultural operations. Construction equipment distributes loads widely resulting in similar tire pressure distribution and contact pressures. During construction of a solar facility, the number of vehicle passes in the same wheel tracks is limited, with the exception of vehicles on internal access roads. During construction there will be a concentration of vehicle passes near the site entrances.

2.2.1 Site Preparation and Clearing

The Solar Production Area is defined as all portions of the Project facilities located inside the proposed fencing of the site. These areas include the panels and associated facilities such as medium voltage power stations, access roads, and underground collector lines. During construction most of these areas will be used for accessing panel locations and for temporarily staging materials and equipment.

Under existing conditions, much of the Project Area consists of active agriculture under row crop production. The dominant vegetation within the non-agricultural upland areas are comprised of grassland areas along the perimeter and between agricultural fields and isolated woodland areas. Upland woodlands located within the Project Area are comprised of relatively small, isolated woodlots and perimeter areas within the agricultural landscape.

Prior to the commencement of construction, site vegetation will be evaluated to determine which areas will be mowed, left undisturbed or will require pre-seeding. Areas with limited vegetation due to past farming operations or disruption of vegetation due to civil construction activities will be seeded and stabilized in a timely manner. Portions of the site not utilized for the Project facilities or not impacted during construction will remain vegetated however may be overseeded to promote additional vegetation as described in the VMP.

Anti-tracking pads will be installed at the construction exits. Temporary perimeter sediment controls and diversions will be installed concurrent with the progress of land clearing and grubbing activities. Prior to any clearing, the limit of disturbance will be surveyed and marked in the field. This limit will include the limit of tree clearing if conducted, the limit of stump grubbing and in areas where no clearing is required the limit of soil disturbance. Clearing and grubbing will not be conducted within wetlands unless authorized by permit from the Minnesota Wetland Conservation Act (WCA) Local Government Unit (LGU) and U.S. Army Corps of Engineers. Woody vegetation (trees, shrubs, etc.) removal, if required, will be conducted as described in the Project VMP. No tree clearing or woody vegetation removal is planned for the Project at this time.

A land surveyor will obtain or calculate Project benchmark, grades, elevations and alignment data from final design plans and detail drawings which inform control staking to establish the Project alignments in advance of construction commencement. During construction, these alignment control points will be reestablished as needed.

2.2.2 Grading

Site grading activities will only occur in select areas where elevations need to be modified to accommodate tracker/racking system slope tolerances, site drainage, access roads, laydown areas; and foundations for the O&M Building, Switchyard, and Inverters. This approach to grading minimizes impacts and/or preserves existing soil and root structures, topsoil nutrients, seed base, and pre-construction site hydrology.

Grading consists of excavation and soil stabilization of earth as required to meet solar array design load requirements. Grading within the solar array area will match existing grades as closely as possible, however some existing contours may require smoothing for access purposes. To the extent practical, grading of an area will take place shortly before trenching and then again post installation of Project components to minimize the area of open, uncovered ground present at all times during construction. The portions of the Project Area that need to be graded are expected to result in a balanced cut-and-fill quantity of grading to maintain the existing conditions to the extent practical for the protection of the equipment and facilities. Where grading occurs on site, topsoil will be salvaged in areas where cut will be greater than the topsoil depths and those areas where subsoil fill will be placed. Once all cut/fill is completed the topsoil will be replaced.

Materials suitable for soil stabilization and backfill will be stockpiled at designated locations using appropriate segregation and erosion control methods. Materials unsuitable for compaction, such as debris and large rocks, will be stockpiled at designated locations for disposal at an acceptable off-site location. Contaminated materials are not anticipated, but if any are encountered during excavation, they will be disposed of in accordance with applicable laws, ordinances, regulations, and standards.

2.2.3 Access Road Construction

Permanent access roads will consist of either an improved aggregate base or the existing compacted, vegetated soil surface. Roads will be constructed as close to existing grade as possible so that existing sheet flow and drainage patterns are maintained. Erosion control devices will be maintained throughout grading and stabilization according to the Stormwater Management Plan. Permanent access roads will be maintained for the life of the Project.

Permanent aggregate base access roads will be constructed by first removing the topsoil and organic material, compacting the subgrade, and constructing the road according to civil design requirements. Topsoil will be windrowed to the edges of the road area and distributed along the roadway edge after fill and aggregate installation. Geotextile matting will be installed prior to placement of aggregate to prevent mixing with native subsoil. A layer of road base will then be added and compacted. Road aggregate or fill will be a local pit run aggregate material. Upon completion of detailed engineering, the aggregate specifications will be available for construction quality assurance.

Access roads developed as native compacted soil will be created with existing in-situ soils unless soils are not suitable for roadway construction. In creating native soil compacted roadways a similar approach to aggregate road construction will be employed. Cut / fill areas

will have topsoil returned, where applicable, and seeded within 14 days of completion of the cut / fill / grading activities.

2.2.4 Solar Array Construction

Once grading activities are complete, the racking system supports will be constructed using steel piles driven into the ground. Driven steel pile foundations are typically used where high load bearing capacities are required. The pile is driven using a pile driver (hydraulic ram), which requires two workers. Soil disturbance would be restricted to the hydraulic ram machinery, about the size of a small tractor, temporarily disturbing soil at each pile insertion location.

Tracker mounting assemblies may be assembled at the Project laydown yard and transported to the array blocks prepared for installation; they can also be assembled at the point of installation. Tracker mounts are then fixed to prepared support foundations using forklifts and tractors. During array and racking assembly, multiple crews and various types of vehicles will be working within the Project Area.

These vehicles include flatbed trucks for transporting array components, small all-terrain vehicles, and pick-up trucks used to transport equipment and workers throughout the Project Area. Modules will be staged in advance throughout the Project Area and be brought to specific work areas for installation by wagon-type trailers pulled by skid steers. The Solar modules will be installed by multiple crews using hand tools.

2.2.5 Electrical Collection System

Collection system cabling will be installed in upland areas using one of three methods as needed: a chain-driven trenching machine, excavator, cable laying plow, MV cable trailer, or plow equipment pulled by a bulldozer. The trencher will cut an exposed trench approximately 1 foot wide by 3 to 4 feet deep depending on the type of cable installation. Soil disturbance from the trenching machines would be restricted to the trenching machine tracks. Once cables are installed, the trenches would be backfilled using a grader or small bulldozer and a compaction machine. See Section 4.6 for further description of BMP measures to be implemented during trenching activities.

The horizontal directional drill method will be used to install collection system under public roadways, wetlands, and waterways if crossed as described in Section 4.7.

2.2.6 O&M Facility, Switchyard, and Project Station

The O&M Facility, Switchyard and Project substation will be placed on footers with gravel pad foundations that will be designed to specifications necessary to meet the local geotechnical conditions. The Switchyard and Substation will sit on top of a slab foundation with rebar on center in each direction. A pull box for cable penetrations will be located directly under the Switchyard to facilitate through-floor cable connections. After the collection system is installed and foundations are poured, the units will be installed into position. Units will be lifted by crane off the manufacturer's delivery truck and set directly onto the pre-poured foundation.

The Contractor will use an appropriately sized rough-terrain crane to lift and set each Inverter/Switchyard unit. After the units are properly set and anchored, the Contractor will

connect the collection cabling previously installed in the adjacent trenches to the respective units.

2.2.7 Project Security Fencing

Array fencing will consist of eight-foot-high woven-wire exclusion fence with wood fenceposts. The Project Substation and Switchyard will require a seven- to eight-foot-high chain link fence which may include three strands of barb wire at the top. Fenceposts will be driven into the ground. No concrete foundations will be used for the fenceposts. Final fence and post specifications will be determined by the EPC.

3.0 SOIL LIMITATIONS AND SUITABILITY WITHIN THE SITE

Soil varies considerably in its physical and chemical characteristics that strongly influence the suitability and limitations that soil has for construction, reclamation, and restoration. Major soil properties include:

- soil texture;
- soil slope;
- drainage and wetness;
- fertility and topsoil characteristics; and
- presence of stones, rocks, and shallow bedrock.

Interpretative limitations and hazards for construction and reclamation are based to a large degree on the dominant soil properties, and include:

- prime farmland status;
- hydric soil status;
- susceptibility to wind and water erosion;
- susceptibility to compaction;
- fertility and plant nutrition; and
- drought susceptibility and revegetation potential.

3.1 IMPORTANT SOIL CHARACTERISTICS

The Soil Survey Geographic Database (SSURGO) is the digitized county soil survey and provides a Geographic Information System (GIS) relating soil map unit polygons to component soil characteristics and interpretations. Soil map unit polygons in the SSURGO database were clipped to the Project Area and major Project components including:

- Solar Array Area
- Access Roads
- Electrical Collection Line
- Inverters
- Substation
- Switchyard

- Laydown Yard
- Operation and Maintenance Room
- Gen-Tie
- Perimeter Area Outside the Solar Array

The acreage of major Project component physical properties, classifications, and limitation interpretations important for construction, use, revegetation, and reclamation were determined by spatial query of the SSURGO. A Custom Soil Resource Report for the Project Area which includes a SURRGO Map and descriptions of each map unit is provided Appendix A.

3.1.1 Physical Characteristics

Selected physical characteristics of site soils are broken down by acreage with the 934.24-acre Project Area in Table 1.

Soil texture affects water infiltration and percolation, drought tolerance, compaction, rutting, and revegetation among other things. Soil texture is described by the soil textural family which indicates the range of soil particle sizes averaged for the whole soil. Over half of the soils within the Project Area (503.61 acres, 53.9 percent) are in the loam textural class and can be characterized as a balanced soil with somewhat even presence of sand, silt, and clay particles. As a result, these soils are balanced in terms of crop growth and water infiltration.

Slope affects constructability, water erosion, revegetation, compaction and rutting, among other properties. Most of the construction is proposed to occur on soil with nearly level slopes in the 0 to 5 percent range (768.58 acres, 82.27 percent). No soils within the Project Area have representative slopes in excess of five percent. 91.03 acres (9.74 percent) of the Project Area contain soils in the >5 to 8 percent slopes range. 60.91 acres (6.52 percent) of the Project Area contain soils in the >5 to 8 percent slopes range. Only 11.28 acres (1.21 percent) of the Project Area occur in areas that have steep slopes >19 percent.

Soil drainage indicates the wetness in the soil profile along with the speed at which internal water moves. Soil Drainage affects constructability, erosion by wind and water, and revegetation success. None of the soils within the Project Area are excessively drained, indicating dry, droughty soils with very low water holding capacity. Approximately 613.94 acres (65.72 percent) are well drained or moderately well drained. Approximately 151.69 acres (16.24 percent) are wetter soils in the somewhat poorly drained, poorly drained, and very poorly drained classes and have an increased likelihood of a shallow water table, or seasonal saturation.

Topsoil depth affects soil plant nutrition and surface soil structure. To maintain soil productivity, soils with thick topsoil will require larger areas for storage of larger volume of topsoil stripped from permanent infrastructure footprints such as permanent access roads, O&M Building, Switchyard, and Inverters. Most of the soils within the Project Area are Mollisols and are characterized by the presence of relatively thick topsoil. Most of the soils within the Project Area contain topsoil in the >12 to 19 inches class (589.97 acres, 63.15 percent).

The presence of bedrock near the soil surface and rocks and stones in the soil profile affects constructability and revegetation. No soils in the Project Area are shallow to bedrock or have stones at the soil surface or within the soil profile However, the Hawick soil analysis shows

some of the proposed Switchyard is dominated by gravelly soil which can result in a rocky surface upon revegetation.

Soil Limitations and Suitability Within the Site

Table 1. Soil Physical Characteristics by Project Facility

Project Facilities	Total Acres[1]	Textural Class[2]	Slope Range[3]				Drainage Class[4]						Topsoil Thickness[5]			
		Loam	0-5	>5-8	>8-15	>15-30	E	SE	W	MW	SP	P	0-6	>6-12	>12-19	>19
	Acres															
Solar Array Area	272.84	152.70	226.72	25.08	17.61	3.44	37.9	9.46	183.64	2.29	22.81	16.74	10.19	56.13	175.47	31.05
Access Roads	12.77	6.84	11.15	1.02	0.51	0.09	1.47	0.20	7.95	0.00	1.55	1.61	0.55	1.65	8.86	1.71
Collection Line	2.16	1.14	1.81	0.10	0.24	0.00	0.22	0.05	1.44	0.02	0.16	0.27	0.15	0.16	1.54	0.31
Inverters	0.16	0.11	0.15	<0.01	<0.01	0.00	0.02	<0.01	0.11	0.00	0.01	0.01	0.01	0.20	0.11	0.02
Substation	6.01	4.50	4.50	0.00	1.50	0.00	0.00	1.50	4.50	0.00	0.00	0.00	0.00	1.50	4.50	0.00
Switchyard	6.01	3.58	3.59	0.00	2..42	0.00	0.00	2.42	3.58	0.00	<0.01	0.00	0.00	2.42	3.59	0.00
Laydown Yard[6]	*5.85*	*5.65*	*5.67*	*0.18*	*0.00*	*0.00*	*0.00*	*0.00*	*5.65*	*0.00*	*0.20*	*<0.01*	*0.00*	*0.00*	*5.85*	*<0.01*
O&M Building	0.11 (1.00)	0.11	0.11	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.11	0.00
Gen-Tie	0.64	0.53	0.53	0.00	0.11	0.00	0.11	0.00	0.53	0.00	0.00	0.00	0.00	0.11	0.53	0.00
Perimeter Area Outside the Solar Array Area	633.54	334.10	520.02	64.83	40.94	7.75	93.95	21.29	404.81	4.96	56.64	51.89	23.89	129.89	395.26	84.51
Total	**934.24**	503.61	768.58	91.03	60.91	11.28	133.67	34.92	606.67	7.27	81.17	70.52	34.79	192.06	589.97	117.6

[1] Total acres of Project features that are anticipated to be disturbed by supporting construction equipment traffic, excavation, and grading. Data obtained by merging project facility polygons with the SSURGO spatial data in ArcGIS.

[2] Data available directly from the NRCS SSURGO2 spatial or attribute database via geospatial query of the spatial or attribute data.

[3] Representative slope values are taken directly from the SSURGO database. The SSURGO2 database provides representative slope values for all component soil series. Slope classes represent the slope class grouping in percent that contains the representative slope value for a major component soil series. For example, a soil mapped in the 2-6% slope class has an average slope of 4%, which is within the 0-5% slope range.

[4] Drainage class as taken directly from the SSURGO database: "E" Excessively drained; "SE" Somewhat excessively drained; "W" Well drained, "MW" Moderately well drained; "SP" Somewhat poorly drained; and "P" Poorly drained and Very Poorly drained;

[5] Topsoil thickness is the aggregate thickness of the A horizons described in the SSURGO database. No field confirmation of topsoil thickness has been

performed.

[6] Laydown Yard Acreages are temporary and not included in Table acreage totals.

3.1.2 Selected Soil Classification

Selected classification information for site soils are broken down by acreage with the 934.24-acre Project Area in Table 2.

Natural Resources Conservation Service (NRCS)-designated prime farmland soils have the best combination of physical and chemical characteristics for producing food, feed, forage, fiber, and oilseed crops and are also available for these uses. Approximately 648.51 acres (69.42 percent) of soil in the Project Area is designated as Prime Farmland.

The NRCS also recognizes farmlands of statewide importance, which are defined as lands other than prime farmland that are used for production of specific high-value food and fiber crops (e.g., citrus, tree nuts, olives, fruits, and vegetables). Farmlands of statewide importance have the special combination of soil quality, location, growing season, and moisture supply needed to economically produce sustained high quality or high yields of specific crops when treated and managed according to acceptable farming methods. Farmland of statewide importance is similar to prime farmland but with minor shortcomings such as greater slopes or less ability to store soil moisture. The methods for defining and listing farmland of statewide importance are determined by the appropriate State agencies, typically in association with local soil conservation districts or other local agencies. Approximately 126.44 acres (13.53 percent) of soil in the Project Area is designated as Farmland of Statewide Importance.

Land Capability Class (LCC) is a system of grouping soils primarily on the basis of their capability to produce common cultivated crops and pasture plants without deteriorating over a long period of time. Capability classes are designated by the numbers 1 through 8. The numbers indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

- Class 1 soils have slight limitations that restrict their use.
- Class 2 soils have moderate limitations that restrict the choice of plants or that require moderate conservation practices.
- Class 3 soils have severe limitations that restrict the choice of plants or that require special conservation practices, or both.
- Class 4 soils have very severe limitations that restrict the choice of plants or that require very careful management, or both.
- Class 5 soils are subject to little or no erosion but have other limitations, impractical to remove, that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.
- Class 6 soils have severe limitations that make them generally unsuitable for cultivation and that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.
- Class 7 soils have very severe limitations that make them unsuitable for cultivation and that restrict their use mainly to grazing, forestland, or wildlife habitat.

- Class 8 soils and miscellaneous areas have limitations that preclude commercial plant production and that restrict their use to recreational purposes, wildlife habitat, watershed, or esthetic purposes.

Capability subclasses are designated by adding a letter, e, w, s, or c, to the class numeral. The letter e shows the risk of erosion unless close-growing plant cover is maintained; w shows that water in or on the soil interferes with plant growth or cultivation; s shows limitation due to shallow, droughty, or stony soil; and c, shows limitation due to climate that is very cold or very dry. In class 1 there are no subclasses because the soils of this class have few limitations.

Soils within the Project Area are in LCC 1, 2e, 2s, 2w, 3e, and 3s. Approximately 5.80 acres (0.62 percent) of the Project Area is designated with an LCC of 1. Most of the soils, 525.63 acres (56.26 percent) are in LCC 2e and have moderate limitations due to erosion. The second most abundance LCC rating is 3e and comprises approximately 125.99 acres (13.49 percent) of the Project Area. The third most common LCC rating was 4s (102.87 acres, 11.01 percent) and has severe limitations mainly due to potential droughty soil conditions.

Hydric soils are soils in poorly drained to very poorly drained drainage classes and are rated as hydric, predominantly hydric, partially hydric, predominantly non-hydric, and non-hydric. Hydric soils are a component of regulated wetlands and can be used to indicate areas with potential jurisdictional wetlands. Approximately 70.52 acres (7.55 percent) of the Project Area is designated as Hydric soil and is comprised of 6.22 acres of 100% hydric soil map units, and 64.30 acres of 66 to 99% percent hydric soil map units. Most of the Project Area is designated as Non-Hydric (716.62 acres, 76.71 percent).

Soil Limitations and Suitability Within the Site

Table 2. Selected Soil Classifications by Project Facility

Project Feature	Total Acres[1]	Prime Farmland[2]	Farmland of Statewide Importance	Land Capability Class[3]													Hydric Soil[4]
				1	2e	2s	2w	3e	3s	3w	4e	4s	6e	6s	7	8	
	Acres																
Solar Array Area	272.84	190.45	37.96	1.90	158.12	6.23	16.72	37.89	6.65	1.09	4.76	28.99	1.20	5.86	3.44	0.00	16.74
Access Roads	12.77	10.01	1.05	0.00	7.64	0.31	1.47	1.38	0.11	0.13	0.16	1.18	0.09	0.29	0.00	0.00	1.61
Collection Line	2.16	1.61	0.23	<0.01	1.27	0.02	0.20	0.27	0.04	0.06	0.04	0.14	0.01	0.10	0.00	0.02	0.27
Inverters	0.16	0.13	0.01	0.00	0.10	0.01	0.01	0.02	0.00	0.00	0.00	0.01	<0.01	<0.01	0.00	0.00	0.01
Substation	6.01	4.50	0.00	0.00	3.28	0.00	0.00	1.23	0.00	0.00	0.95	0.00	0.55	0.00	0.00	0.00	0.00
Switchyard	6.01	3.59	0.00	0.00	3.22	0.00	0.00	0.37	0.00	0.00	0.00	0.00	2.42	0.00	0.00	0.00	0.00
Laydown Yard[5]	*5.85*	*5.67*	*0.18*	*0.00*	*5.67*	*0.00*	*<0.01*	*0.18*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*0.00*	*<0.01*
O&M Building	0.11 (1.00)	0.11	0.00	0.00	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gen-Tie	0.64	0.53	0.00	0.00	0.53	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.11	0.00	0.00	0.00	0.00
Perimeter Area Outside the Solar Array Area	633.54	437.58	87.19	3.90	351.36	15.07	49.80	84.83	16.89	4.92	9.43	72.55	2.33	14.71	7.75	0.00	51.89
Total	**934.24**	**648.51**	**126.44**	**5.8**	**525.63**	**21.64**	**68.2**	**125.99**	**23.69**	**6.20**	**15.34**	**102.87**	**6.71**	**20.96**	**11.19**	**0.02**	**70.52**

1 Total acres of Project features that are anticipated to be disturbed by supporting construction equipment traffic, excavation, and grading. Data obtained by merging project facility polygons with the SSURGO spatial data in ArcGIS.

2 Data available directly from the NRCS SSURGO2 spatial or attribute database via geospatial query of the spatial or attribute data. Includes all areas Prime Farmland and Prime farmland if drained or irrigated.

3 Capability subclasses are designated by adding a letter, e, w, s, or c, to the class numeral. The letter e shows the risk of erosion unless close-growing plant cover is maintained; w shows that water in or on the soil interferes with plant growth or cultivation; s shows limitation due to shallow, droughty, or stony soil; and c, shows limitation due to climate that is very cold or very dry.

4 Data available directly from the NRCS SSURGO2 spatial or attribute database via geospatial query of the spatial or attribute data. Hydric soil was considered any soil with a Hydric Rating between 66-100.

5 Laydown Yard Acreages are temporary and not included in Table acreage totals.

3.1.3 Construction-Related Interpretations

Selected construction-related interpretative data for site soils are broken down by acreage within the Project Area in Table 3.

For the purposes of this report, a highly water erodible rating consists of soils with a NRCS rating of high for the NRCS Soil Erodibility Factor (Kw). Soil Erodibility Factor (Kw) describes the susceptibility of soil detachment by water runoff or raindrop impact, and predicts long-term average soil loss from sheet and rill erosion. The Kw is affected by soil texture, organic matter content, size and stability of soil aggregates, permeability, and depth to a restrictive layer. Soil erosion potential is also influenced by slope and exposure to erosion mechanisms. Soil erosion increases in inverse proportion to the effectiveness of vegetation cover (i.e., soils with denser vegetation cover are less susceptible to erosion). Removal of vegetation associated with construction activities, whether by direct stripping or by other mechanical means, greatly increases erosion potential. The Project Area is predominantly comprised of soil designated with a low water erodibility rating (604.43 acres, 64.70 percent). An additional 174.73 acres (18.70 percent) of the soil is designated as moderately water erodible Approximately 155.09 acres (16.60 percent) of the Project Area is designated as highly water erodible. This rating suggests a high risk of water erosion due to the presence of silt in the Lindstrom and Maxfield soil series.

Wind erosion was evaluated using the wind erodibility group. Highly wind erodible soils are medium textured, relatively well drained soils with poor soil aggregation, resulting in soils with soil surfaces dominated by particles that can be dislodged and carried by the wind. Most of the soil in the Project Area is designated as non-wind erodible (894.72 acres, 95.77 acres). Only 39.52 acres (4.23 percent) of the Project Area is designated as highly wind erodible and is likely a result of sandy soil textures.

Soils prone to compaction and rutting are subject to adverse changes in soil porosity and structure as a result of mechanical deformation caused by loading by equipment during construction. Factors considered are soil texture, soil organic matter content, soil structure, rock fragment content, and the existing bulk density. Each of these factors contributes to the soil's ability to resist compaction and rutting. All 934.24 acres, (100 percent) of soils within the Project Area may have issues with rutting. Approximately 197.00 acres (21.09 percent) were designated as moderately prone to rutting, whereas 737.24 acres (78.91 percent) were designated as severely prone to rutting. Rutting is primarily the deformation of the soil from equipment operation during suboptimal moisture conditions or on soils with low bearing strength. Construction matting as described in Section 4.9 should be used to prevent rutting especially within jurisdictional wetlands. Approximately 767.56 acres, (82.16 percent) of the soils are susceptible to compaction.

Even under relatively normal precipitation, some soils are prone to having drought stress occur in the plants growing on them. Soil may have an inherently low ability to store water which is typical of sandy or shallow soils or soils having a high content of rock fragments. Drought ratings include severely drought vulnerable, drought vulnerable, moderately drought vulnerable, somewhat drought vulnerable, and slightly drought vulnerable.

In the severely drought vulnerable rating, the soil and site properties are such that the plants growing on the soil must be very drought tolerant even in years with normal amounts of rainfall.

The soil may have very low water storage capacity. In the drought vulnerable rating, drought conditions generally occur every year and the soil may have low water storage capacity. Under moderately drought vulnerable soils, annual precipitation is generally adequate for plant growth. In dry years some water stress may occur. Slightly drought vulnerable soils are either in low-lying parts of the landscape where plant roots may exploit near-surface ground water or are in areas where precipitation is much higher than potential evapotranspiration. In an extremely dry year plants may be water stressed on these soils.

Soils susceptible to drought include coarse textured soils in moderately well to excessive drainage classes. Revegetation during seed germination and early seedling growth is severely compromised during dry periods on droughty soils. 736.42 acres, (78.83 percent) of the soils within the Project Area are moderately susceptible to drought, and 46.12 acres (4.94 percent) are designated as drought vulnerable .

Two basic methods are used to hold solar array systems to the ground, based on site conditions and cost. One method employs driven piles, screw augers, or concrete piers that penetrate into the soil to provide a stable foundation. The ease of installation and general site suitability of soil-penetrating anchoring systems depends on soil characteristics such as rock fragment content, soil depth, soil strength, soil corrosivity, shrink-swell tendencies, and drainage. The other basic anchoring system utilizes precast ballasted footings or ballasted trays on the soil surface to make the arrays too heavy to move. The site considerations that impact both basic systems are slope, slope aspect, wind speed, land surface shape, flooding, and ponding. Soil-penetrating anchoring systems can be used where the soil conditions are not limited. Installation of these systems requires some power equipment for hauling components and either driving piles, turning helices, or boring holes to install the anchoring apparatus.

For Soil-Based Solar Panel Arrays Anchor systems, soils are placed into interpretive rating classes of not limited, somewhat limited, or very limited. Approximately 732.29 acres, (78.38 percent) of the soils within the Project Area are somewhat limited, and 195.79 acres, (20.96 percent) are very limited. The primary causes for limitation for soil-based anchor systems within the Project Area are shallow depth to saturated soil, frost action, corrosion of steel, and low soil strength.

For Ballast Anchor systems, soils are also placed into interpretive rating classes of not limited, somewhat limited, or very limited. Overall, 738.41 (79.04 percent) of the soils within the Project Area are designated as somewhat limited for ballast anchors, and 189.66 acres (20.30 percent) of soils are designated as severely limited. The primary limitations for ballast anchor systems include frost action, depth to saturated zone, slope, and ponding.

Soil Limitations and Suitability Within the Site

Table 3. Soils in Selected Construction-related Interpretations by Project Facility

Project Facility	Total Acres[1]	Kw[2]	Wind Erodibility[3]	Compaction Risk[4]	Rutting Hazard[5]		Solar Array Soil-Based Anchor[6]		Sorry Array Ballast Anchor[9]		Drought Vulnerable[7]	
		High	High		Moderate	Severe	Somewhat Limited	Very Limited	Somewhat Limited	Very Limited	Moderately Vulnerable	Drought Vulnerable
	Acres											
Solar Array Area	272.84	42.31	10.89	227.54	55.28	217.56	217.80	53.07	219.73	51.13	220.64	12.66
Access Roads	12.77	2.82	0.68	10.05	2.41	10.36	9.65	3.04	9.65	3.04	8.99	0.63
Collection Line	2.16	0.34	0.19	1.60	0.43	1.73	1.69	0.44	1.69	0.44	1.57	0.16
Inverters	0.16	0.02	0.01	0.13	0.03	0.13	0.13	0.03	0.13	0.03	0.12	0.01
Substation	6.01	0.00	0.00	6.01	1.50	4.50	5.46	0.55	5.46	0.55	4.50	1.50
Switchyard	6.01	0.01	0.00	6.01	2.42	3.59	3.59	2.42	3.59	2.42	3.58	2.42
Laydown Yard[8]	*5.85*	*0.20*	*0.00*	*5.85*	*0.00*	*5.85*	*5.65*	*0.20*	*5.65*	*0.20*	*5.65*	*0.20*
O&M Building	0.11 (1.00)	0.00	0.00	0.11	0.00	0.11	0.11	0.00	0.11	0.00	0.11	0.00
Gen-Tie	0.64	0.00	0.00	0.64	0.11	0.53	0.53	0.11	0.53	0.11	0.53	0.11
Perimeter Area Inside Fence	633.54	109.59	27.75	515.47	134.81	498.73	493.33	136.13	497.52	131.94	496.38	28.63
Total	**934.24**	**155.09**	**39.52**	**767.56**	**196.99**	**737.24**	**732.29**	**195.79**	**738.41**	**189.66**	**736.42**	**46.12**

1 Total acres of Project features that are anticipated to be disturbed by supporting construction equipment traffic, excavation, and grading. Data obtained by merging solar facilities and easement polygons with the SSURGO spatial data in ArcGIS.

2 Erosion Factor Kw indicates the susceptibility of a whole soil to sheet and rill erosion by water, and is a function of percent silt, sand, organic matter, soil structure, and hydraulic conductivity (Ksat). Values range from 0.02 and 0.69. A rating of 0.0-0.24 is Low, a rating of 0.25-0.40 is Moderate, and a rating of 0.40-0.69 is High.

3 Highly Erodible Wind Includes soils in wind erodibility groups 1 and 2.

4 Soils are rated Low, Medium, or High based on their susceptibility to compaction from the operation of ground-based equipment for planting, harvesting, and site preparation activities when soils are moist. For soils with a Low rating, the potential for compaction is insignificant. For soil with a Medium rating, the potential for compaction is significant and the growth rate of seedlings may be reduced following compaction. For soil with a High rating, the potential for compaction is significant and the growth rate of seedlings will be reduced following compaction. Soils with a Medium or High rating are represented in this table

5 Rutting potential hazard based on the soil strength as indicated by engineering texture classification, drainage class, and slope. In general, soils on low slopes in wetter drainage classes, and comprised of sediments with low strength will have potential rutting hazards.

6 Soils are placed into interpretive rating classes of Not limited, Somewhat limited, or Very limited.

7 Soils are rated Slightly vulnerable, Somewhat drought vulnerable, Moderately drought vulnerable, Drought vulnerable, and Severely drought vulnerable. Soils rated as Somewhat drought vulnerable and Moderately drought vulnerable are represented in this table. No soils within the Project Area are rated as Drought vulnerable, and Severely drought vulnerable.

8 Laydown Yard Acreages are temporary and not included in Table acreage totals.

3.1.4 Summary of Major Soil Limitations

3.1.4.1 Topsoil

Most of the topsoil is within the >12 to 18-inch range. To the extent practicable, topsoil should be conserved by preselecting areas to receive excess topsoil from nearby areas, grading and seed bed preparation as appropriate, and revegetation to maintain a rhizosphere suitable for plant growth as described in the Project-specific Vegetation Management Plan. Areas of distribution will be marked with a GPS device for future reference upon decommissioning. Refer to Section 4 for storage practices for future reclamation for components such as access road installation, the O&M Building, Switchyard, and Inverters.

Topsoil may be additionally susceptible to excessive draining due to sandy soil textures and upland landscape positions. Reseeding and vegetation germination success will decrease if conducted during excessively dry periods or without follow-up watering, leaving a bare soil surface. Bare topsoil will be at increased risks risk of erosional loss according to the high water erodibility potential (Kw), and slightly at risk of wind erosion in areas of disturbance in highly wind erodible ratings without BMP's.

3.1.4.2 Solar Array Anchor Systems

Soils within the Project Area are predominantly rated as somewhat limited for both soil-based and ballast solar panel array anchoring systems. An additional approximate 20% of the Project Area is designated as severely limited for both methods of solar array anchoring. A geotechnical investigation will be conducted to determine the most appropriate method and anchoring depth. Site design, micrograding, and construction methods will be key to overcoming this major soil limitation.

3.1.4.3 Compaction and Rutting

Compaction and rutting may be significant limitations. Castle Rock Solar will design construction access and manage construction passes to minimize the number of trips occurring on a given soil and will implement wet weather procedures any time that rutting is observed. Deep compaction will be avoided as the number of construction equipment passes over a given area will be limited, and construction equipment consists of smaller, low-ground- pressure tracked vehicles. Practices to be implement to decompact soils are described in Section 4.2 and the project-specific VMP. Factors to be considered regarding wet weather conditions are described in Section 4.3. Rutting will be avoided by use of gravel access roads and temporary construction matting as described in Section 4.9. Care will especially be taken to avoid rutting within regulatory wetlands as rutting in wetlands is a regulated activity.

4.0 BMPS DURING CONSTRUCTION AND OPERATION

The Project will be constructed and operated on property owned by Castle Rock Solar. No direct impacts to adjacent land are expected. The Project is primarily located on farmland occupying silty and loamy sediments and underlying till within the watershed of the Rush-Vermillion River in southeastern Minnesota. Approximately 648.51 acres, (69.42 percent) of the farmland within the Project Area is considered prime farmland. None are considered farmland of statewide importance.

The prevailing topography of the Project Area will not be substantially changed by construction activities, including installation of the foundations for the tracking systems and trenching for the collection system. It is anticipated that panel arrays will be designed and constructed to conform to the existing topography to minimize the need for significant grading. However, some localized grading may be necessary to meet racking tolerances and to construct other project facilities such as the O&M building, Switchyard, and Inverters. Access roads will be constructed as close to existing grade as possible following topsoil stripping, maintaining preconstruction hydrologic flow patterns. Upon completion of construction activities, the areas temporarily impacted due to construction activities will be returned to their pre-construction topography.

The sections below describe the best management practices that Castle Rock Solar will implement to maintain soil health, slope stabilization, and infiltration and avoid sedimentation, erosion, spill-related impacts, and encroachment of noxious weeds within the Project Area due to construction and operation of the Project.

4.1 ENVIRONMENTAL MONITOR

Castle Rock Solar will engage a weekly inspection onsite to monitor earthmoving activities during the initial phase of Project construction to ensure appropriate measures are taken to properly segregate and handle the topsoils. The Monitor will have a variety of duties, including but not limited to:

- Perform regular inspections during the major earthmoving phases of Project construction, including trenching, and during activities in the below bullets;
- Observe construction crews and activities to ensure that topsoil is being segregated and managed appropriately;
- Monitor the site for areas of potential soil compaction (except within access roads) and make specific recommendations for decompaction;
- Make recommendations to Castle Rock's construction manager;
- Assist in determining if weather events have created "wet weather" conditions and provide recommendations to the construction manager on the ability to proceed with construction; and
- Submit reports of Castle Rock's adherence to soil BMPs during the major earthmoving phase of Project construction and upon completion of earthmoving activities to document SWPPP compliance.

Potential issues with BMPs will be reported directly to Castle Rock's construction manager who will use discretion to either correct the activity or stop work.

4.2 SOIL SEGREGATION AND DECOMPACTION

During construction, Castle Rock Solar will work to protect and preserve topsoil within the Project Area. Protective measures will include separation of the topsoil from subgrade/subsoil materials when earthmoving activities or excavation are conducted during grading, access road construction, cable installation, and all foundation installations. The depth of the topsoil to be stripped will be a maximum depth of 12 inches or actual depth of topsoil if less than 12 inches or as agreed upon with the landowner. Upon request from the landowner, Castle Rock Solar will measure topsoil depth at selected locations before and after construction.

The stored topsoil and subsoil will have sufficient separation to prevent mixing during the storage period. A thin straw mulch layer or geotextile fabric may be used as a buffer between the subsoil and topsoil to facilitate separation of the subsoil and topsoil during the excavation backfill process. Subsoil may not be stockpiled on top of, or upslope of topsoil due to potential mixing or runoff events. Topsoil will not be used to construct field entrances or drives, stockpiled in areas that will receive construction equipment traffic over it, or be removed from the property without the written consent of the landowner.

During the activities that require temporary excavations and backfilling (i.e., trenching activities) the subgrade material will be replaced into the excavations first and compacted as necessary, followed by replacement of topsoil to the approximate locations from which it was removed. Topsoil will then be graded to the approximate pre-construction contour. Castle Rock Solar will avoid compaction in other areas where it is not required by the design.

Following grading activities that required topsoil and subsoil stripping/separation, topsoil will be respread to disturbed areas only after subsoil has been backfilled and smoothed to maintain the overall integrity and character of the pre-construction farmland. Any excess topsoil material would be re-spread within the Project Area at pre-established locations and not relocated off-site. The location and amount of topsoil will be documented to facilitate re-spreading of topsoil after decommissioning.

Stripped topsoil and subsoil that will be necessary for future reclamation for components such as access road installation and the O&M Building, Switchyard, and Inverters will be removed to suitable locations near the site of removal and spread across existing topsoil for storage.

4.3 WET WEATHER CONDITIONS

Construction in wet soil conditions will not occur at times when or locations where the operation of heavy construction equipment may cause rutting to the extent that the topsoil and subsoil are mixed, or underground drainage structures may be damaged.

During construction, certain activities may be suspended in wet soil conditions, based on consideration of the following factors:

- extent of surface ponding;
- extent and depth of soil erosion, rutting, compaction, and mixing of soil horizons;
- areal extent and location of potential rutting and compaction (i.e., can traffic be rerouted around wet area);
- damage to drain tiles if present; and
- type of equipment and nature of the construction operations proposed for that day.

If adverse wet weather construction impacts cannot be minimized to the satisfaction of Castle Rock, the EPC will cease work in the applicable area until Castle Rock Solar determines that site conditions are such that work may continue.

4.4 INITIAL GRADING/ROAD CONSTRUCTION/ARRAY CONSTRUCTION

Micro-grading or site leveling will likely be necessary prior to array installation to accommodate slope tolerances allowed for by the solar array design. It is estimated that micro-grading or site leveling will occur on roughly 40-60 acres at one time, with the use of construction blocks, minimizing the acreage of exposed soils at any given time, to the extent practicable. The appropriate depth of topsoil that should be stripped and segregated from other materials during initial grading activities is described in Section 4.2.

During civil work, topsoil will be removed from the cut/fill areas and stored in designated locations for later use. Once topsoil is removed from the cut/fill areas, the sub-grade materials will be removed as required from higher ground elevations and relocated on-site at lower elevations. Prior to relocating sub-grade materials to the lower elevations, topsoil in the low areas will be stripped and set aside before the fill is added, then respread over the new fill. The stored topsoil will be re-spread over the reconditioned sub-grade areas. Newly spread topsoil will be loosely compacted and/or “tracked” and the erosion and sedimentation prevention BMPs will be implemented as described in Section 4.10 and in accordance with the Project Stormwater Management Plan.

After the majority of the micro-grading activities have been completed, internal access roads will be constructed. Topsoil will be stripped from the roadbeds to a depth of at least 12 inches and will be windrowed to the edges of the roadbed. Windrowing will consist of pushing materials into rows of spoil piles adjacent to the road which will be loosely compacted and/or “tracked” with stormwater and wind erosion BMPs in place. The sub-grade materials will then be compacted. After gravel is installed and compacted to engineers’ requirements, the Contractor will shape drainage ditches as identified on the final grading plan. Roads shall be constructed at grade to allow for existing sheet flow so that existing drainage patterns are maintained. Previously windrowed topsoil material will be respread around the new gravel material along the road shoulders.

Once grading and road construction is complete, the Contractor can begin the installation of foundation piles for the PV array racking system. This work will consist of directly driving the pile into the soil with pile drivers. These vehicles would operate on the existing surface of the ground

and impacts would be limited to what is typical when vehicles drive over the soil surface. Very little soil disturbance is expected from this activity.

Dust abatement measures may include restriction of vehicle speeds, watering of active areas, watering of stockpiles, watering on public roadways, the application of calcium chloride (or other similarly approved product), track-out control at site exits, and other measures.

4.5 FOUNDATIONS

The skids for the O&M Facility, Switchyard, and Substation will likely be installed on concrete foundations if required by soil and geotechnical conditions. The Contractor will strip topsoil off the area for the foundation, install the pier-type foundations, compact sub-grade materials, regrade spoils around the foundation area, and then install clean washed rock on the surface. All topsoil stripped from these areas will be pushed outside of the work area and collected into designated spots for later use. These topsoil piles will be windrowed or piled and loosely compacted and/or “tracked” with stormwater and wind erosion BMPs in place. Once construction is advanced, the topsoil piles would be distributed in a thin layer adjacent to the foundation area.

If concrete foundations are used, the foundations will be dug using a rubber-tire backhoe and then rebar and concrete installed and left to cure. After cure and testing of concrete strength is completed, the subgrade spoils will be compacted around the foundations. After the solar equipment is set, the adjacent topsoil will be re-spread around the foundation.

4.6 TRENCHING

Construction of the Project may require trenching for the installation of both DC and AC collection lines. The typical burial depth for collector circuits is 36 inches. The width of the trench is dependent upon the number of circuits. Typical trench widths are as follows:

- Single Feeder trench width: 12 to 18 inches
- Two Feeder trench: three (3)-foot spacing and three (3) to six-(6) foot trench width
- Four Feeder trench: three (3)-foot spacing and 15-foot to 16-foot trench width

During trenching, topsoil and subgrade materials would be excavated from the trench using typical excavating equipment or backhoes and segregated as described in Section 4.2. The bottom of each trench may be lined with clean fill to surround the cables. Castle Rock Solar anticipates that native subsoil will be primarily rock free, and that no foreign fill will be necessary. After cables have been installed on top of bedding materials in the trench, 1 foot of screened, native backfill will be placed on the cables followed by additional 2 feet of unscreened native backfill trench spoil. This material would be compacted as necessary. The last 1 foot of each trench will then be backfilled with topsoil material only to return the surface to its finished grade.

4.7 HORIZONTAL DIRECTIONAL DRILL

The horizontal directional drill method will be used to install the collection system under public roadways, non-farmed wetlands, and waterways- if crossed. Bore pits will be setback at least 10 feet from wetland boundaries or ordinary highwater mark (OHWM) of waterways. Proper sediment, erosion control, and invasive species control BMPs will be installed/utilized prior to and during construction activities.

Horizontal directional drilling equipment will be stored either in the Project laydown yard or near the location of the proposed boring. If the boring cannot be completed in one day, overnight storage of equipment will be in upland agricultural areas within 50 feet of the bore pits. Appropriate BMPs and contaminant management (oil absorbent booms, etc.) materials will be put in place prior to leaving the boring area for the day.

A typical bore pit is approximately 10 feet by 20 feet by 6 feet deep. Approximately 1,200 cubic feet (45 cubic yards) of material may be excavated for each pit. The boring will require two bore pits, one on each side of the feature being crossed. All materials removed from bore pits will be stored adjacent to the boring with appropriate BMPs installed. Once the boring is completed, the excavated material will be reused as backfill of the pit. Once a final grade is reached, the area will be seeded with a cover crop and permanent seed mixture with appropriate erosion control devices installed (silt fence, erosion matting, etc.), if necessary.

4.8 DEWATERING

Dewatering may be required for excavations such as bore pits. Castle Rock Solar will develop a Dewatering Plan and provide training to personnel directly involved with discharge activities. Castle Rock Solar shall ensure that on-site personnel directly involved with discharge activities have access to the Dewatering Plan at all times while at the discharge location(s). Dewatering will be performed in accordance with applicable appropriation and discharge permits, and at a minimum, will comply with the following procedures:

- Floats will be placed on pump intakes;
- The excavation will be dewatered into a well-vegetated upland area with an appropriate energy-dissipation device. Whenever possible, the slope at the point of discharge will be away from any streams or wetlands. Soils in the vicinity of the discharge point will be assessed before discharge. Topography between the discharge point and the nearest receiving waters will be evaluated for erosion potential;
- If the flow of a discharge cannot be kept out of streams, wetlands, drainage ditches, etc., the discharge shall be filtered by one of the methods described below. Dewatering discharge will be directed into a sediment filter bag or a straw bale/silt fence dewatering structure which discharges into a vegetated

area to prevent heavily silt-laden water from flowing into wetlands and waterbodies.

- Only non-woven fabric filter bags will be used for dewatering.
- Filter bags and dewatering structures must be maintained in a functional condition throughout dewatering activity (e.g., clogged or ripped bags must be replaced) and will be attended at all times during active pumping. Accumulated sediment from the filter bags shall be spread in an approved upland location.
- Castle Rock Solar will comply with applicable permit requirements, including tracking volumes of water pumped, obtaining water samples (if needed) for testing, and taking necessary measures to meet effluent limitations.

4.9 TEMPORARY CONSTRUCTION MAT SEQUENCE AND TIMING

Construction mats may be used to reduce impacts to wet areas. The use of the construction mats in farmed wetlands will be determined by an examination of site-specific soil stability and moisture content at the time of construction. If this examination determines that there is a potential for rutting, then construction mats will be placed prior to construction activities to prevent rutting. Low ground pressure tracked equipment, or work during frozen soil conditions may be used to minimize surficial wetland impacts, in lieu of construction mats.

4.9.1 Construction Mat Installation and Maintenance

The following practices will be used to minimize impacts to farmed wetland areas during installation and use of construction mats.

- Mats should be in good condition to ensure proper installation, use and removal.
- Construction mats shall not be dragged into position in wetlands.
- Woody vegetation (trees, shrubs, etc.) should be cut at or above ground level and not uprooted in order to prevent disruption to the wetland soil structure and to allow stump sprouts to revegetate the work area;
- Where feasible, mats shall be placed in a location that would minimize the amount needed for the wetlands crossing;
- Erosion and sediment controls shall be installed at approaches to mats to promote a smooth transition to minimize sediment tracking onto mats.
- Construction mats should generally be placed along the travel area so that the individual boards are resting perpendicular to the direction of traffic. No gaps should exist between mats. Mats should be placed far enough on the entrance and exit of the resource area to rest on non-hydric soil;
- Standard construction mat BMP details shall be provided to work crews;
- Mats shall be monitored to assure correct functioning of the mats. Mats shall be inspected during use for any defects or structural problems;

- Mats which become covered with soils or construction debris should be cleaned and the materials removed and disposed of in an upland location. The material should not be scraped and shoveled into the resource area. Mats which become imbedded shall be reset or layered to prevent mud from covering them or water passing over them;
- Operating heavy equipment in wetlands shall be minimized;
- Equipment shall not be stored, maintained, fueled, or repaired in wetlands unless the equipment is broken down and cannot be easily removed; and
- An adequate supply of spill containment equipment shall be maintained on site.

4.9.2 Construction Mat Removal

Restoration within wetland areas will include removal of all construction mats and construction-related materials. Matting should be removed by "backing" out of the site, removing mats one at a time until the upland mats are all that remain. Mats should be cleaned before transport to another wetland location to remove soil and any invasive plant species seed stock or plant material. Cleaning methods may include but are not limited to shaking or dropping mats in a controlled manner with a piece of machinery to knock off attached soil and debris, spraying with water or air, and sweeping.

4.9.3 Construction Mat Area Specific Monitoring And Restoration

Matted wetlands will be inspected after mat removal to document site conditions and then regularly, as necessary. Proposed restoration objectives, along with remedial restoration options, are outlined below.

Once construction mats are removed, the matted area will be restored to pre-existing topography. Areas with ground surface disturbance in wetlands will be repaired using hand tools, back dragging, or other appropriate means to restore topography while minimizing additional disturbance or soil compaction. If soil compaction is observed in wetland areas, soils may be disced to alleviate compaction. The re-compaction of soil will be avoided by avoiding driving in old wheel ruts and repeated traffic.

- Erosion controls will be maintained, and bare soils stabilized to be compliant with the Project's SWMP;
- A temporary cover crop may be installed over disturbed soils following ground disturbance as described in the VMP;
- Wetlands will be seeded as described in the VMP;
- Wetlands will be monitored to document revegetation success and community composition. Sites will be revisited regularly to note vegetative cover response. Corrective actions described in the VMP and reseeding if necessary, shall be conducted to control negative influences that may deter the establishment of permanent planned vegetation.

4.10 TEMPORARY EROSION AND SEDIMENT CONTROL

Castle Rock Solar will prevent excessive soil erosion on lands disturbed by construction by adhering to a SWPPP required under the NPDES permitting requirement that will be administered by the MPCA. Prior to construction, the Project's Engineer of Record will outline the reasonable methods for erosion control and prepare the SWPPP.

These measures would primarily include silt fencing on the downside of all hills and near waterways. This silt fencing would control soil erosion via stormwater. Check dams and straw waddles will also be used to slow water during rain events in areas that have the potential for high volume flow. In addition, the Contractor can use erosion control blankets on any steep slopes, although given the site topography, this BMP will not likely be required. Lastly, as outlined above, topsoil and sub-grade material will be piled and loosely compacted and / or "tracked" while stored. The BMPs employed to mitigate wind and stormwater erosion on these soil stockpiles will include installing silt fence on the downward side of the piles as needed and installation of straw waddles if these spoil piles are located near waterways.

The SWPPP will designate onsite SWPPP inspectors to be employed by the Contractor for routine inspections as well as for inspections after storm events per the plan outlined in the SWPPP. The SWPPP will consider wind erodibility and best practices as such including methods such as wetting exposed soils to minimize dust during construction activity and maintaining good vegetative cover (both cover crops and permanent vegetation).

Engineered SWPPP plans will be submitted to the MPCA prior to construction start and designated onsite SWPPP inspectors will be employed by the Contractor for routine inspections as well as for inspections after storm events per the plan outlined in the SWPPP.

4.11 DRAIN TILE IDENTIFICATION, AVOIDANCE AND REPAIR

Castle Rock Solar or its EPC contractor will work to identify existing drain tile systems within the Project Area and may include the use of local drain tile contractor. Existing tile will be located by analyzing existing documentation, reviewing aerial photography, and interviewing Project participating landowners and adjacent landowners to identify approximate or expected locations of the tile lines. If the location of the existing tile system is not accurately determined, a physical tile location effort will be undertaken. Physical location of tile will be attempted using ground penetrating radar in the areas of suspected tile locations, or GPS-enabled line scope. If visible surface inlets are identified, a tile probe will be used to locate the tile line and determine its direction from the inlet. The tile line will then be mapped with a GPS locator so it can be avoided during construction.

Care will be taken during construction to: a) avoid drain tile locations within the Project Area, b) re-route drain tile away from locations which could be damaged during construction, or c) in the case of fields with pattern tile networks, work with applicable landowners to establish acceptable criteria for rerouting, replacing or abandoning in place drain tile that is within a PV array.

If non-abandoned drain tile is damaged, the damaged segment will be repaired in place or, if necessary, relocated as required by the condition and location of the damaged tile. In the event

drain tile damage becomes apparent after commercial operation of the Project, the drain tile will be repaired in a manner that restores the operating condition of the tile at the point of repair and will have the capacity, depth, and appropriate slope to ensure the new tile line performs adequately for the line it is replacing. All repair, relocation, or rerouting referenced above will be consistent with these policies: a) materials will be of equal or better quality to those removed or damaged; b) work will be completed as soon as practicable, taking into consideration weather and soil conditions; c) work will be performed in accordance with industry-accepted, modern methods; and d) in the event water is flowing through a tile when damage occurs, temporary repairs will be promptly installed and maintained until such time that permanent repairs can be made. Castle Rock Solar will minimize interruption of any drainage on site or on any neighboring properties that may drain through the property.

Repairs or rerouting will be performed using a small to mid-sized excavator. Laser equipment will be used to ensure proper grading of the tile. In the event a line of significant size and length needs to be rerouted or installed; a commercial drainage plow could be used. The drainage plow typically utilizes GPS-grade control to ensure tile is installed to specified slopes. The following considerations will also apply:

- Tiles will be repaired with materials of the same or better quality as that which was damaged.
- Tiles repairs will be conducted in a manner consistent with industry-accepted methods.
- Before completing permanent tile repairs, tiles will be examined within the work area to check for tile that might have been damaged by construction equipment. If tiles are found to be damaged, they will be repaired so they operate as well after construction as before construction began.
- Castle Rock Solar will make efforts to complete permanent tile repairs within a reasonable timeframe, considering weather and soil conditions.

4.12 CENTER-PIVOT IRRIGATION WELL IDENTIFICATION AND AVOIDANCE

If center-pivot irrigation systems are present within the Project Area, the systems and the water/utility lines servicing them within the Project Area will be decommissioned and left in place. If wells are located within the solar array area, they will either be marked with flagging and a five-foot buffer around them will be fenced to protect these structures, or fully decommissioned. If Castle Rock Solar identifies a need for wells during operations, these wells may be uncapped or new wells may be installed.

5.0 VEGETATIVE MANAGEMENT PLAN

Castle Rock Solar is committed to minimizing impacts to soil within the Project Area so that the site may be returned to active agricultural production upon decommissioning. In accordance with the VMP, Castle Rock Solar will establish a permanent vegetative cover throughout the Project Area including areas beneath and around arrays. This will manage erosion by increasing stormwater infiltration and reducing runoff. Stormwater infiltrates soil at a higher rate on perennially vegetated ground cover than on cultivated cropland. The transition to permanent perennial vegetation will manage additional runoff resulting from the solar modules and access roads. Permanent perennial vegetative cover also provides connectivity to existing adjacent wildlife habitats.

6.0 CONTROLING SPREAD OF UNDESIRABLE SPECIES

During construction and operation, appropriate BMPs will be used to manage and limit the spread of invasive and noxious weed species. Invasive and noxious weed control practices to be conducted during pre-construction, construction, and operation phases of the project, and during soil handling and equipment cleaning are described in the VMP.

Equipment will be cleaned before mobilization to the site to prevent introduction of invasive species from off-site sources. The equipment will be manually cleaned of plant materials between work zones within the Project Site. Additionally, any equipment working below the OHWM of waterways will be cleaned using the appropriate BMPs before moving to another location to work below the OHWM.

Project Plan details can be found in the project specific Vegetation Management Plan developed for the Project.

7.0 DECOMMISSIONING

At the end of the Project's useful life, anticipated to be 45 years, Castle Rock Solar will either take necessary steps to continue operation of the Project (such as re-leasing the land, re-permitting and retrofitting) with an opportunity for a project lifetime of 50 years or more, or will decommission the Project and remove facilities. Castle Rock Solar reserves the right to extend operations instead of decommissioning at the end of the site permit term. Refer to the Project's Decommissioning Plan for additional details.

In general, most of the decommissioned equipment and materials will be recycled or sold on the secondary market. Any materials that cannot be recycled will be disposed of at approved facilities. Castle Rock Solar anticipates contracting with the panel manufacturer to accept panels for recycling at their end of life and/or contract recycling services. At or before the end of solar project's operations, Castle Rock Solar will notify Dakota County of its intent to decommission the project. In general, site decommissioning and equipment removal can take 6 to 12 months. Therefore, access roads, fencing, and electrical power facilities will remain in place for use by the decommissioning and restoration workers until no longer needed. Demolition debris will be placed in temporary on-site storage area(s) pending final transportation and disposal/recycling.

7.1 RESTORATION/RECLAMATION OF FACILITY SITE

Once the solar facilities are removed, the site would be restored to agricultural use or to another use if the economic conditions and landowner intentions at that time indicate another use is appropriate for the site. Restoration activities will be conducted in accordance with the Decommissioning Plan and VMP.

The site will be returned to the original topography to the extent practicable and will be restored with either stockpiled soil or by supplemental soil after steel pier foundations, fence posts, concrete foundations, re-claimed access road corridors and other equipment are removed. Grading and other soil disturbance activities conducted during decommissioning will be minimized to the extent necessary to effectively decommission the site and to maintain the soil benefits realized during the long-term operation of the Project. Any decompaction efforts will take place following final site grading if deemed necessary. The method of decompaction will depend on the tested level of compaction present during decommission, but may include deep ripping with a tractor, or a form of discing or plowing.

APPENDIX A

Appendix A

A.1 SITE LOCATION MAP

A.2 USDA NRCS SOIL SURVEY REPORT

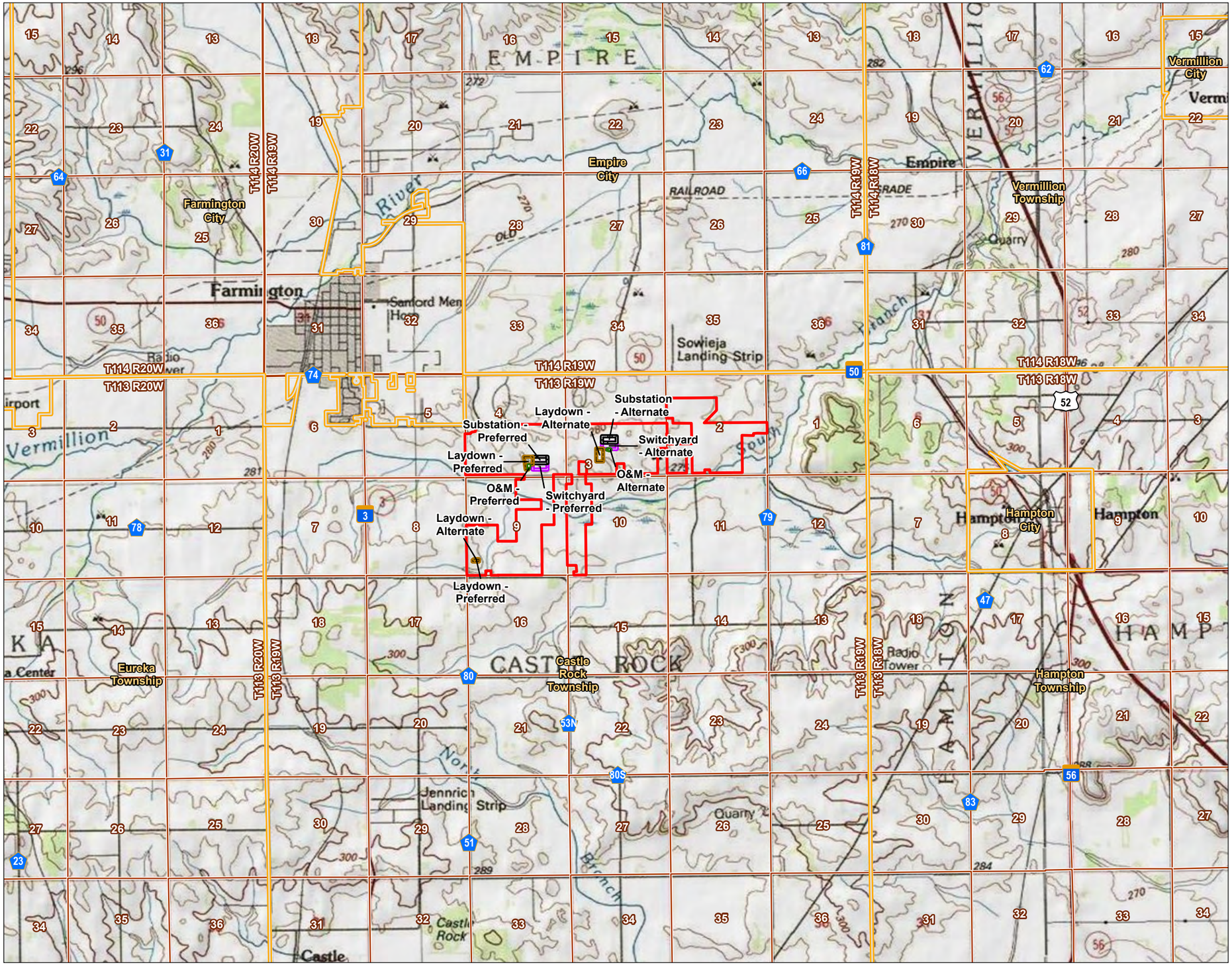


Figure No.
1

Title
Project Location Map

Client/Project 193709215
Castle Rock Solar, LLC
Castle Rock Solar Project
MPUC Site Permit Application

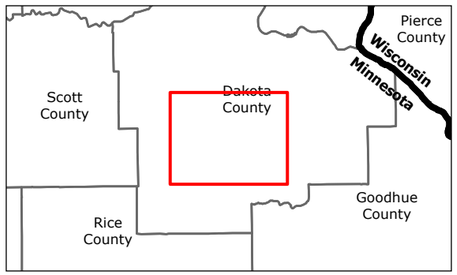
Project Location
Castle Rock Township
Dakota Co., MN

Prepared by KJM on 2024-03-27

N

0 0.5 1 Miles
(At original document size of 11x17)
1:63,360

Legend
- Project Area Boundary
- Proposed O&M Facility
- Proposed Laydown Yard
- Proposed Substation
- Proposed Switchyard
- County Subdivision
- Township, Range & Section Boundary



Notes
1. Coordinate System: NAD 1983 StatePlane Minnesota South FIPS 2203 Feet
2. Data Sources: Stantec, Castle Rock Solar LLC, MnGeo, MnDOT
3. Background: USGS 7.5' Topographic Quadrangles

Stantec

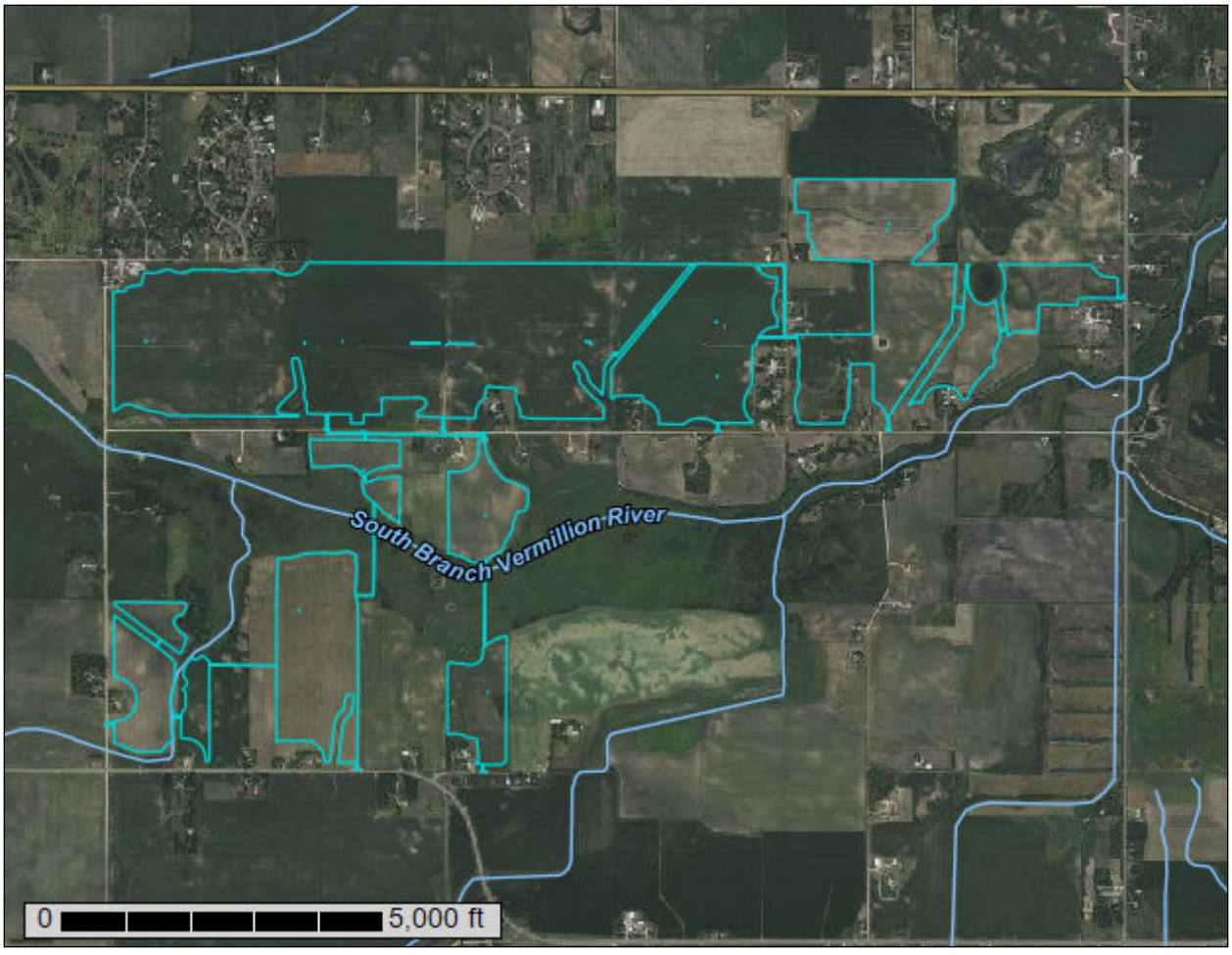
United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Dakota County, Minnesota



August 26, 2024

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

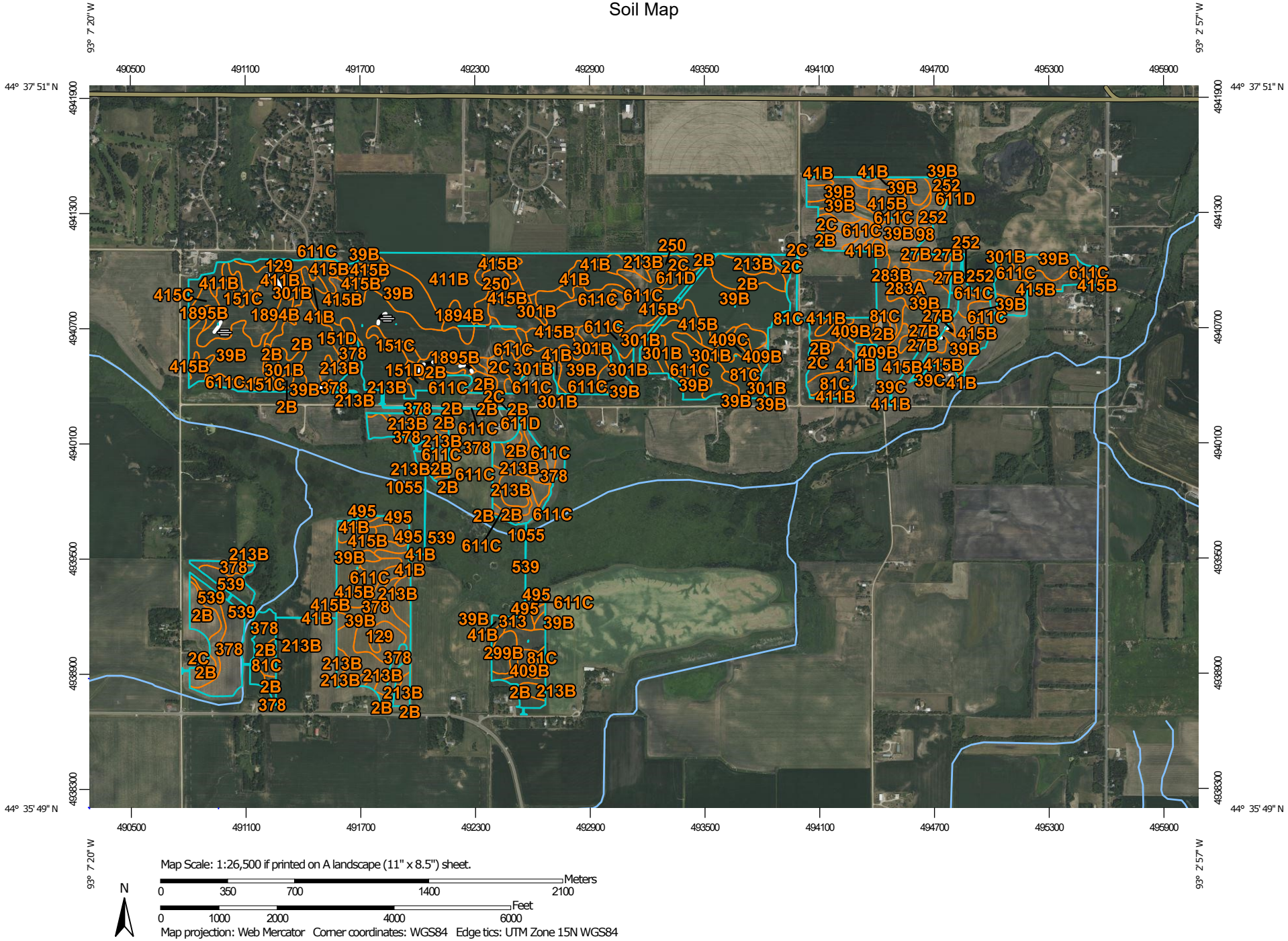
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.


93° 7' 20" W
93° 2' 57" W
44° 37' 51" N
44° 35' 49" N
490500
491100
491700
492300
492900
493500
494100
494700
495300
495900
4941900
4941300
4940700
4940100
4939500
4938900
4938300
Map Scale: 1:26,500 if printed on A landscape (11" x 8.5") sheet.
N
Meters
0 350 700 1400 2100
Feet
0 1000 2000 4000 6000
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 15N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Dakota County, Minnesota
Survey Area Data: Version 19, Sep 9, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 29, 2023—Sep 13, 2023

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
2B	Ostrander loam, 1 to 6 percent slopes	72.8	7.8%
2C	Ostrander loam, 6 to 12 percent slopes	19.4	2.1%
27B	Dickinson sandy loam, 2 to 6 percent slopes	9.5	1.0%
39B	Wadena loam, 2 to 6 percent slopes	208.5	22.3%
39C	Wadena loam, 6 to 12 percent slopes	0.5	0.1%
41B	Estherville sandy loam, 2 to 6 percent slopes	22.2	2.4%
81B	Boone loamy fine sand, 2 to 6 percent slopes	7.7	0.8%
81C	Boone loamy fine sand, 6 to 12 percent slopes	19.6	2.1%
98	Colo silt loam, occasionally flooded	0.8	0.1%
129	Cylinder loam, 0 to 2 percent slopes	21.6	2.3%
151C	Burkhardt sandy loam, 6 to 12 percent slopes	6.1	0.7%
151D	Burkhardt sandy loam, 12 to 18 percent slopes	6.7	0.7%
213B	Klinger silt loam, 1 to 5 percent slopes	55.6	6.0%
250	Kennebec silt loam	5.8	0.6%
252	Marshan silty clay loam	0.8	0.1%
283A	Plainfield loamy sand, 0 to 2 percent slopes	2.7	0.3%
283B	Plainfield loamy sand, 2 to 6 percent slopes	3.5	0.4%
299B	Rockton loam, 2 to 6 percent slopes	5.4	0.6%
301B	Lindstrom silt loam, till plain, 2 to 6 percent slopes	36.7	3.9%
313	Spillville loam, 0 to 2 percent slopes, occasionally flooded	3.9	0.4%
378	Maxfield silty clay loam	63.0	6.7%
409B	Etter fine sandy loam, 2 to 6 percent slopes	11.4	1.2%
409C	Etter fine sandy loam, 6 to 12 percent slopes	6.0	0.6%

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
411B	Waukegan silt loam, 1 to 6 percent slopes	61.1	6.5%
411C	Waukegan silt loam, 6 to 12 percent slopes	2.4	0.3%
415B	Kanaranzi loam, 2 to 6 percent slopes	75.7	8.1%
415C	Kanaranzi loam, 6 to 12 percent slopes	3.2	0.3%
495	Zumbro fine sandy loam	1.4	0.1%
539	Klossner muck, 0 to 1 percent slopes	6.2	0.7%
611C	Hawick gravelly sandy loam, 6 to 12 percent slopes	89.1	9.5%
611D	Hawick gravelly sandy loam, 12 to 20 percent slopes	11.2	1.2%
1055	Aquolls and Histosols, ponded	0.0	0.0%
1078	Anthroportic Udorthents, 2 to 9 percent slopes	1.5	0.2%
1894B	Winnebago loam, 2 to 6 percent slopes	26.5	2.8%
1895B	Carmi loam, 2 to 8 percent slopes	7.1	0.8%
1896B	Ostrander-Carmi loams, 2 to 6 percent slopes	59.1	6.3%
Totals for Area of Interest		**934.4**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties

and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Dakota County, Minnesota

2B—Ostrander loam, 1 to 6 percent slopes

Map Unit Setting

National map unit symbol: f9xz
Elevation: 850 to 1,120 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Ostrander and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ostrander

Setting

Landform: Moraines
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess over till

Typical profile

Ap,A,AB - 0 to 17 inches: loam
2Bw - 17 to 53 inches: loam
2C - 53 to 60 inches: loam

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: High (about 11.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Ecological site: R104XY005IA - Loamy Upland Prairie
Forage suitability group: Sloping Upland, Neutral (G104XN002MN)
Other vegetative classification: Sloping Upland, Neutral (G104XN002MN)
Hydric soil rating: No

Minor Components

Dickinson

Percent of map unit: 8 percent

Hydric soil rating: No

Klinger

Percent of map unit: 7 percent
Hydric soil rating: No

2C—Ostrander loam, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: f9y0
Elevation: 840 to 1,120 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Ostrander and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ostrander

Setting

Landform: Moraines
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess over till

Typical profile

Ap,A - 0 to 13 inches: loam
2Bw - 13 to 53 inches: loam
2C - 53 to 60 inches: loam

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: High (about 11.3 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B

Ecological site: R104XY005IA - Loamy Upland Prairie
Forage suitability group: Sloping Upland, Neutral (G104XN002MN)
Other vegetative classification: Sloping Upland, Neutral (G104XN002MN)
Hydric soil rating: No

Minor Components

Dickinson
Percent of map unit: 8 percent
Hydric soil rating: No

Klinger
Percent of map unit: 7 percent
Hydric soil rating: No

27B—Dickinson sandy loam, 2 to 6 percent slopes

Map Unit Setting
National map unit symbol: f9xn
Elevation: 800 to 1,500 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Dickinson and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Dickinson

Setting
Landform: Outwash plains
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Outwash

Typical profile
Ap,A,AB - 0 to 15 inches: sandy loam
Bw - 15 to 24 inches: sandy loam
BC,C - 24 to 60 inches: sand

Properties and qualities
Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 5.5 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: A
Ecological site: R104XY010IA - Sandy Upland Prairie
Forage suitability group: Sloping Upland, Low AWC, Acid (G091XN008MN)
Other vegetative classification: Sloping Upland, Low AWC, Acid (G091XN008MN)
Hydric soil rating: No

Minor Components

Hubbard

Percent of map unit: 4 percent
Hydric soil rating: No

Sparta

Percent of map unit: 3 percent
Hydric soil rating: No

Zumbro

Percent of map unit: 3 percent
Hydric soil rating: No

39B—Wadena loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 2wd86
Elevation: 690 to 1,840 feet
Mean annual precipitation: 24 to 37 inches
Mean annual air temperature: 43 to 52 degrees F
Frost-free period: 140 to 180 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Wadena and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wadena

Setting

Landform: Outwash plains, terraces
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loamy glaciofluvial deposits over sandy and gravelly outwash

Typical profile

Ap - 0 to 7 inches: loam
A - 7 to 17 inches: loam
Bw - 17 to 30 inches: loam
2C - 30 to 79 inches: gravelly loamy coarse sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 8.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Ecological site: R103XY003MN - Sandy Upland Prairies
Forage suitability group: Sloping Upland, Neutral (G103XS002MN)
Other vegetative classification: Sloping Upland, Neutral (G103XS002MN)
Hydric soil rating: No

Minor Components

Estherville

Percent of map unit: 10 percent
Landform: Outwash plains, terraces
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: R103XY003MN - Sandy Upland Prairies
Other vegetative classification: Sandy (G103XS022MN)
Hydric soil rating: No

Dickinson

Percent of map unit: 5 percent
Landform: Outwash plains, terraces
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: R103XY003MN - Sandy Upland Prairies
Other vegetative classification: Sloping Upland, Neutral (G103XS002MN)
Hydric soil rating: No

39C—Wadena loam, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 2wd87
Elevation: 690 to 1,840 feet
Mean annual precipitation: 24 to 37 inches
Mean annual air temperature: 43 to 52 degrees F
Frost-free period: 140 to 180 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Wadena and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Wadena

Setting

Landform: Outwash plains, terraces
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loamy glaciofluvial deposits over sandy and gravelly outwash

Typical profile

Ap - 0 to 7 inches: loam
A - 7 to 17 inches: loam
Bw - 17 to 30 inches: loam
2C - 30 to 79 inches: gravelly loamy coarse sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 8.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: R103XY003MN - Sandy Upland Prairies
Forage suitability group: Sloping Upland, Neutral (G103XS002MN)

Other vegetative classification: Sloping Upland, Neutral (G103XS002MN)
Hydric soil rating: No

Minor Components

Estherville

Percent of map unit: 10 percent
Landform: Outwash plains, terraces
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: R103XY003MN - Sandy Upland Prairies
Other vegetative classification: Sandy (G103XS022MN)
Hydric soil rating: No

Dickinson

Percent of map unit: 5 percent
Landform: Outwash plains, terraces
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: R103XY003MN - Sandy Upland Prairies
Other vegetative classification: Sloping Upland, Neutral (G103XS002MN)
Hydric soil rating: No

41B—Estherville sandy loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 2tsjp
Elevation: 690 to 1,840 feet
Mean annual precipitation: 24 to 37 inches
Mean annual air temperature: 43 to 52 degrees F
Frost-free period: 140 to 180 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Estherville and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Estherville

Setting

Landform: Outwash plains, terraces
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Linear

Parent material: Loamy glaciofluvial deposits over sandy and gravelly outwash

Typical profile

Ap - 0 to 8 inches: sandy loam
A - 8 to 13 inches: sandy loam
Bw - 13 to 19 inches: sandy loam
2C - 19 to 79 inches: gravelly loamy coarse sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 6.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Ecological site: R103XY003MN - Sandy Upland Prairies
Forage suitability group: Sandy (G103XS022MN)
Other vegetative classification: Sandy (G103XS022MN)
Hydric soil rating: No

Minor Components

Dickinson

Percent of map unit: 8 percent
Landform: Outwash plains, terraces
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: R103XY003MN - Sandy Upland Prairies
Other vegetative classification: Sloping Upland, Neutral (G103XS002MN)
Hydric soil rating: No

Wadena

Percent of map unit: 6 percent
Landform: Outwash plains, terraces
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: R103XY003MN - Sandy Upland Prairies
Other vegetative classification: Sloping Upland, Neutral (G103XS002MN)
Hydric soil rating: No

Biscay

Percent of map unit: 1 percent
Landform: Outwash plains, terraces

Landform position (three-dimensional): Tread, talf
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R103XY007MN - Sandy Wet Prairies
Other vegetative classification: Level Swale, Neutral (G103XS001MN)
Hydric soil rating: Yes

81B—Boone loamy fine sand, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: f9zr
Elevation: 700 to 1,400 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Boone and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Boone

Setting

Landform: Hills
Landform position (two-dimensional): Summit
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Siliceous sandy residuum

Typical profile

A - 0 to 3 inches: loamy fine sand
AC - 3 to 8 inches: loamy fine sand
C - 8 to 24 inches: fine sand
Cr - 24 to 60 inches: weathered bedrock

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s

Hydrologic Soil Group: A
Ecological site: F105XY019WI - Dry Upland
Forage suitability group: Sandy (G104XN022MN)
Other vegetative classification: Sandy (G104XN022MN)
Hydric soil rating: No

Minor Components

Etter
Percent of map unit: 10 percent
Hydric soil rating: No

81C—Boone loamy fine sand, 6 to 12 percent slopes

Map Unit Setting
National map unit symbol: f9zs
Elevation: 700 to 1,400 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition
Boone and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Boone

Setting
Landform: Hills
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Siliceous sandy residuum

Typical profile
A - 0 to 3 inches: loamy fine sand
AC - 3 to 8 inches: loamy fine sand
C - 8 to 24 inches: fine sand
Cr - 24 to 60 inches: weathered bedrock

Properties and qualities
Slope: 6 to 12 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.14 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None

Available water supply, 0 to 60 inches: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: A
Ecological site: F105XY019WI - Dry Upland
Forage suitability group: Sandy (G104XN022MN)
Other vegetative classification: Sandy (G104XN022MN)
Hydric soil rating: No

Minor Components

Etter

Percent of map unit: 10 percent
Hydric soil rating: No

98—Colo silt loam, occasionally flooded

Map Unit Setting

National map unit symbol: fb0m
Elevation: 500 to 1,400 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: Prime farmland if protected from flooding or not frequently flooded during the growing season

Map Unit Composition

Colo, occasionally flooded, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Colo, Occasionally Flooded

Setting

Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

A1,A2 - 0 to 20 inches: silt loam
A3,A4,A5 - 20 to 54 inches: silty clay loam
C - 54 to 60 inches: silty clay loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very high (about 12.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B/D
Ecological site: R108XC527IA - Wet Floodplain Sedge Meadow
Forage suitability group: Level Swale, Neutral (G105XN001MN)
Other vegetative classification: Level Swale, Neutral (G105XN001MN)
Hydric soil rating: Yes

Minor Components

Lawson

Percent of map unit: 5 percent
Hydric soil rating: No

Garwin

Percent of map unit: 5 percent
Landform: Drainageways on moraines
Hydric soil rating: Yes

Maxfield

Percent of map unit: 5 percent
Landform: Drainageways on moraines
Hydric soil rating: Yes

129—Cylinder loam, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: 2wd84
Elevation: 690 to 1,840 feet
Mean annual precipitation: 24 to 37 inches
Mean annual air temperature: 43 to 52 degrees F
Frost-free period: 140 to 180 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Cylinder and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cylinder

Setting

Landform: Outwash plains, terraces

Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Fine-loamy glaciofluvial deposits over sandy and gravelly outwash

Typical profile

Ap - 0 to 8 inches: loam
A - 8 to 19 inches: loam
Bg - 19 to 34 inches: sandy loam
2C - 34 to 79 inches: gravelly loamy coarse sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 12 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2s
Hydrologic Soil Group: B/D
Ecological site: R103XY003MN - Sandy Upland Prairies
Forage suitability group: Level Swale, Neutral (G103XS001MN)
Other vegetative classification: Level Swale, Neutral (G103XS001MN)
Hydric soil rating: No

Minor Components

Biscay

Percent of map unit: 10 percent
Landform: Outwash plains, terraces
Landform position (three-dimensional): Tread, talf
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R103XY007MN - Sandy Wet Prairies
Other vegetative classification: Level Swale, Neutral (G103XS001MN)
Hydric soil rating: Yes

Biscay, depressional

Percent of map unit: 5 percent
Landform: Depressions on outwash plains
Landform position (three-dimensional): Talf
Down-slope shape: Linear, concave
Across-slope shape: Linear, concave
Ecological site: R103XY015MN - Depressional Marsh
Other vegetative classification: Ponded If Not Drained (G103XS013MN)
Hydric soil rating: Yes

151C—Burkhardt sandy loam, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: f9wd
Elevation: 700 to 1,900 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Burkhardt and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Burkhardt

Setting

Landform: Outwash plains
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Outwash

Typical profile

A,AB - 0 to 12 inches: sandy loam
Bw,BC - 12 to 22 inches: sandy loam
2C - 22 to 60 inches: gravelly coarse sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.2 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Ecological site: R104XY010IA - Sandy Upland Prairie
Forage suitability group: Sandy (G104XN022MN)
Other vegetative classification: Sandy (G104XN022MN)
Hydric soil rating: No

Minor Components

Carmi

Percent of map unit: 5 percent
Hydric soil rating: No

151D—Burkhardt sandy loam, 12 to 18 percent slopes

Map Unit Setting

National map unit symbol: f9wf
Elevation: 700 to 1,900 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Burkhardt and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Burkhardt

Setting

Landform: Outwash plains
Landform position (two-dimensional): Shoulder
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Outwash

Typical profile

A,AB - 0 to 12 inches: sandy loam
Bw,BC - 12 to 22 inches: sandy loam
2C - 22 to 60 inches: gravelly coarse sand

Properties and qualities

Slope: 12 to 18 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 4.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A

Ecological site: R104XY010IA - Sandy Upland Prairie
Forage suitability group: Sandy (G104XN022MN)
Other vegetative classification: Sandy (G104XN022MN)
Hydric soil rating: No

Minor Components

Carmi
Percent of map unit: 5 percent
Hydric soil rating: No

213B—Klinger silt loam, 1 to 5 percent slopes

Map Unit Setting
National map unit symbol: f9x8
Elevation: 1,200 to 1,400 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition
Klinger and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Klinger

Setting
Landform: Moraines
Landform position (two-dimensional): Footslope
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Loess over till

Typical profile
Ap,A - 0 to 13 inches: silt loam
Bt - 13 to 28 inches: silt loam
2Bt,2Bw - 28 to 55 inches: loam
2C - 55 to 60 inches: loam

Properties and qualities
Slope: 1 to 5 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 18 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent

Available water supply, 0 to 60 inches: High (about 11.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B/D
Forage suitability group: Sloping Upland, Acid (G104XN006MN)
Other vegetative classification: Sloping Upland, Acid (G104XN006MN)
Hydric soil rating: No

Minor Components

Maxfield

Percent of map unit: 5 percent
Landform: Drainageways on moraines
Hydric soil rating: Yes

Ostrander

Percent of map unit: 5 percent
Hydric soil rating: No

250—Kennebec silt loam

Map Unit Setting

National map unit symbol: f9xc
Elevation: 600 to 1,300 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Kennebec and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kennebec

Setting

Landform: Outwash plains
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

Ap,A1,A2 - 0 to 41 inches: silt loam
C - 41 to 60 inches: silt loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 36 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Very high (about 13.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 1
Hydrologic Soil Group: C
Ecological site: F090AY004WI - Loamy Floodplain
Forage suitability group: Sloping Upland, Acid (G104XN006MN)
Other vegetative classification: Sloping Upland, Acid (G104XN006MN)
Hydric soil rating: No

252—Marshan silty clay loam

Map Unit Setting

National map unit symbol: f9xg
Elevation: 670 to 1,100 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Marshan and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Marshan

Setting

Landform: Flats on stream terraces, flats on outwash plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Glaciolacustrine sediments over outwash

Typical profile

A1,A2 - 0 to 14 inches: silty clay loam
BA,Bg - 14 to 32 inches: loam
2C - 32 to 60 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 inches
Frequency of flooding: None

Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B/D
Ecological site: F090AY006WI - Wet Loamy Lowland
Forage suitability group: Level Swale, Neutral (G104XN001MN)
Other vegetative classification: Level Swale, Neutral (G104XN001MN)
Hydric soil rating: Yes

Minor Components

Cylinder

Percent of map unit: 10 percent
Hydric soil rating: No

283A—Plainfield loamy sand, 0 to 2 percent slopes

Map Unit Setting

National map unit symbol: f9xp
Elevation: 700 to 1,200 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Plainfield and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Plainfield

Setting

Landform: Stream terraces, outwash plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Outwash

Typical profile

A - 0 to 4 inches: loamy sand
Bw,BC,C - 4 to 60 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained

Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F090AY019WI - Dry Sandy Uplands
Forage suitability group: Sandy (G104XN022MN)
Other vegetative classification: Sandy (G104XN022MN)
Hydric soil rating: No

Minor Components

Dickinson

Percent of map unit: 5 percent
Hydric soil rating: No

283B—Plainfield loamy sand, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: f9xq
Elevation: 700 to 1,200 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Plainfield and similar soils: 95 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Plainfield

Setting

Landform: Stream terraces, outwash plains
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Outwash

Typical profile

A - 0 to 4 inches: loamy sand
Bw,BC,C - 4 to 60 inches: sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (5.95 to 19.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Low (about 3.2 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: F090AY019WI - Dry Sandy Uplands
Forage suitability group: Sandy (G091XN022MN)
Other vegetative classification: Sandy (G091XN022MN)
Hydric soil rating: No

Minor Components

Dickinson

Percent of map unit: 5 percent
Hydric soil rating: No

299B—Rockton loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: f9xx
Elevation: 690 to 1,050 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Rockton and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rockton

Setting

Landform: Hills
Landform position (two-dimensional): Summit
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Alluvial sediments over bedrock

Typical profile

A,AB - 0 to 16 inches: loam
Bt - 16 to 35 inches: clay loam
2R - 35 to 60 inches: weathered bedrock

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: 20 to 40 inches to lithic bedrock
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 6.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: C
Ecological site: R104XY002IA - Bedrock Prairie
Forage suitability group: Sloping Upland, Low AWC, Acid (G104XN008MN)
Other vegetative classification: Sloping Upland, Low AWC, Acid (G104XN008MN)
Hydric soil rating: No

301B—Lindstrom silt loam, till plain, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: 2zwnx
Elevation: 520 to 1,310 feet
Mean annual precipitation: 11 to 41 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 155 to 210 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Lindstrom and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Lindstrom

Setting

Landform: Alluvial fans, stream terraces, drainageways
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Silty slope alluvium

Typical profile

Ap - 0 to 9 inches: silt loam

A1 - 9 to 16 inches: silt loam
A2 - 16 to 29 inches: silt loam
Bw - 29 to 60 inches: silt loam
C - 60 to 79 inches: silt loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 1.42 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very high (about 13.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Ecological site: R104XY015IA - Terrace Savanna
Forage suitability group: Sloping Upland, Neutral (G104XS002MN)
Other vegetative classification: Sloping Upland, Neutral (G104XS002MN)
Hydric soil rating: No

Minor Components

Littleton, till substratum

Percent of map unit: 5 percent
Landform: Stream terraces, drainageways
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Concave
Across-slope shape: Linear
Ecological site: R108XC519IA - Wet Upland Drainageway Prairie
Other vegetative classification: Sloping Upland, Neutral (G104XS002MN)
Hydric soil rating: No

Clyde, frequently flooded

Percent of map unit: 5 percent
Landform: Drainageways, alluvial fans, stream terraces
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Concave, convex
Across-slope shape: Concave, linear
Ecological site: R104XY012IA - Wet Upland Drainageway Sedge Meadow
Other vegetative classification: Level Swale, Neutral (G104XS001MN)
Hydric soil rating: Yes

Terril

Percent of map unit: 5 percent
Landform: Alluvial fans, stream terraces, drainageways
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Convex, concave, linear
Across-slope shape: Linear

Ecological site: R104XY015IA - Terrace Savanna
Other vegetative classification: Sloping Upland, Neutral (G104XS002MN)
Hydric soil rating: No

313—Spillville loam, 0 to 2 percent slopes, occasionally flooded

Map Unit Setting

National map unit symbol: 2xl22
Elevation: 520 to 1,310 feet
Mean annual precipitation: 23 to 41 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 155 to 210 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Spillville, occasionally flooded, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Spillville, Occasionally Flooded

Setting

Landform: Flood-plain steps
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Fine-loamy alluvium

Typical profile

Ap - 0 to 8 inches: loam
A - 8 to 54 inches: loam
C - 54 to 79 inches: sandy loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Somewhat poorly drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.14 to 1.42 in/hr)
Depth to water table: About 12 to 42 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Moderate (about 8.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B/D
Ecological site: F104XY020IA - Loamy Floodplain Forest

Hydric soil rating: No

Minor Components

Sigglekov, frequently flooded

Percent of map unit: 5 percent
Landform: Flood plains
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: F104XY021IA - Sandy Floodplain Forest
Hydric soil rating: Yes

Coland, occasionally flooded

Percent of map unit: 5 percent
Landform: Flood-plain steps
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: R104XY018IA - Wet Floodplain Sedge Meadow
Hydric soil rating: Yes

378—Maxfield silty clay loam

Map Unit Setting

National map unit symbol: f9yf
Elevation: 800 to 1,200 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: Prime farmland if drained

Map Unit Composition

Maxfield and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Maxfield

Setting

Landform: Swales on moraines
Down-slope shape: Concave
Across-slope shape: Linear
Parent material: Loess over till

Typical profile

Ap,A,AB - 0 to 21 inches: silty clay loam
Bg - 21 to 27 inches: silty clay loam
2Bg - 27 to 30 inches: loam
2C - 30 to 60 inches: loam

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: About 6 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: High (about 11.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w
Hydrologic Soil Group: B/D
Ecological site: R104XY006IA - Wet Loamy Upland Prairie
Forage suitability group: Level Swale, Neutral (G104XN001MN)
Other vegetative classification: Level Swale, Neutral (G104XN001MN)
Hydric soil rating: Yes

Minor Components

Colo

Percent of map unit: 5 percent
Landform: Flood plains
Hydric soil rating: Yes

Klinger

Percent of map unit: 5 percent
Hydric soil rating: No

409B—Etter fine sandy loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: f9yq
Elevation: 850 to 1,030 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Etter and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Etter

Setting

Landform: Hills
Landform position (two-dimensional): Summit
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Glacial drift over sandy residuum

Typical profile

Ap,A - 0 to 15 inches: fine sandy loam
Bw - 15 to 21 inches: fine sandy loam
2C - 21 to 60 inches: fine sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 6.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: R104XY010IA - Sandy Upland Prairie
Forage suitability group: Sloping Upland, Acid (G104XN006MN)
Other vegetative classification: Sloping Upland, Acid (G104XN006MN)
Hydric soil rating: No

Minor Components

Wadena

Percent of map unit: 10 percent
Hydric soil rating: No

409C—Etter fine sandy loam, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: f9yr
Elevation: 850 to 1,070 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Etter and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Etter

Setting

Landform: Hills
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Glacial drift over sandy residuum

Typical profile

Ap,A - 0 to 15 inches: fine sandy loam
Bw - 15 to 21 inches: fine sandy loam
2C - 21 to 60 inches: fine sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 6.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R104XY010IA - Sandy Upland Prairie
Forage suitability group: Sloping Upland, Acid (G104XN006MN)
Other vegetative classification: Sloping Upland, Acid (G104XN006MN)
Hydric soil rating: No

Minor Components

Wadena

Percent of map unit: 10 percent
Hydric soil rating: No

411B—Waukegan silt loam, 1 to 6 percent slopes

Map Unit Setting

National map unit symbol: f9yt
Elevation: 900 to 1,400 feet

Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Waukegan and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Waukegan

Setting

Landform: Stream terraces, outwash plains
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Glaciofluvial sediments over outwash

Typical profile

Ap,AB - 0 to 13 inches: silt loam
Bt - 13 to 28 inches: silt loam
2BC - 28 to 42 inches: gravelly sand
2C - 42 to 60 inches: gravelly sand

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Available water supply, 0 to 60 inches: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Ecological site: F090AY014WI - Loamy Bedrock Upland
Forage suitability group: Sloping Upland, Acid (G091XN006MN)
Other vegetative classification: Sloping Upland, Acid (G091XN006MN)
Hydric soil rating: No

Minor Components

Estherville

Percent of map unit: 5 percent
Hydric soil rating: No

Kanaranzi

Percent of map unit: 5 percent
Hydric soil rating: No

411C—Waukegan silt loam, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: f9yv
Elevation: 900 to 1,400 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Waukegan and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Waukegan

Setting

Landform: Stream terraces, outwash plains
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Glaciofluvial sediments over outwash

Typical profile

Ap,AB - 0 to 13 inches: silt loam
Bt - 13 to 28 inches: silt loam
2BC - 28 to 42 inches: gravelly sand
2C - 42 to 60 inches: gravelly sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Available water supply, 0 to 60 inches: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: F090AY014WI - Loamy Bedrock Upland
Forage suitability group: Sloping Upland, Acid (G091XN006MN)
Other vegetative classification: Sloping Upland, Acid (G091XN006MN)
Hydric soil rating: No

Minor Components

Kanaranzi

Percent of map unit: 10 percent
Hydric soil rating: No

415B—Kanaranzi loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: f9yy
Elevation: 700 to 1,600 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Kanaranzi and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kanaranzi

Setting

Landform: Outwash plains
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Outwash

Typical profile

Ap - 0 to 9 inches: loam
Bw - 9 to 19 inches: silt loam
2BC - 19 to 23 inches: loamy sand
2C - 23 to 60 inches: coarse sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e

Hydrologic Soil Group: B
Ecological site: R103XY003MN - Sandy Upland Prairies
Forage suitability group: Sloping Upland, Low AWC, Acid (G104XN008MN)
Other vegetative classification: Sloping Upland, Low AWC, Acid (G104XN008MN)
Hydric soil rating: No

415C—Kanaranzi loam, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: f9yz
Elevation: 700 to 1,600 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Kanaranzi and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Kanaranzi

Setting

Landform: Outwash plains
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Outwash

Typical profile

Ap - 0 to 9 inches: loam
Bw - 9 to 19 inches: silt loam
2BC - 19 to 23 inches: loamy sand
2C - 23 to 60 inches: coarse sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 20 percent
Available water supply, 0 to 60 inches: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: R103XY003MN - Sandy Upland Prairies

Forage suitability group: Sloping Upland, Low AWC, Acid (G104XN008MN)
Other vegetative classification: Sloping Upland, Low AWC, Acid (G104XN008MN)
Hydric soil rating: No

495—Zumbro fine sandy loam

Map Unit Setting

National map unit symbol: f9z9
Elevation: 680 to 1,570 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Zumbro and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Zumbro

Setting

Landform: Flood plains, outwash plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium

Typical profile

Ap,A1 - 0 to 18 inches: fine sandy loam
A2,A3 - 18 to 56 inches: loamy fine sand
Bw - 56 to 60 inches: fine sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (1.98 to 5.95 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum content: 5 percent
Available water supply, 0 to 60 inches: Moderate (about 7.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3s
Hydrologic Soil Group: A
Ecological site: F090AY003WI - Sandy Floodplain
Forage suitability group: Sloping Upland, Low AWC, Neutral (G104XN004MN)
Other vegetative classification: Sloping Upland, Low AWC, Neutral (G104XN004MN)
Hydric soil rating: No

539—Klossner muck, 0 to 1 percent slopes

Map Unit Setting

National map unit symbol: 2s8wz
Elevation: 690 to 1,840 feet
Mean annual precipitation: 24 to 37 inches
Mean annual air temperature: 43 to 52 degrees F
Frost-free period: 140 to 180 days
Farmland classification: Farmland of statewide importance

Map Unit Composition

Klossner, drained, and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Klossner, Drained

Setting

Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Organic material over alluvium

Typical profile

Oap - 0 to 9 inches: muck
Oa - 9 to 27 inches: muck
2A - 27 to 46 inches: silty clay loam
2Cg - 46 to 79 inches: silty clay loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to high (0.06 to 2.00 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: None
Frequency of ponding: Occasional
Calcium carbonate, maximum content: 20 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Very high (about 17.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3w
Hydrologic Soil Group: C/D
Ecological site: R103XY016MN - Organic Marsh
Forage suitability group: Organic (G103XS014MN)
Other vegetative classification: Organic (G103XS014MN)
Hydric soil rating: Yes

Minor Components

Canisteo

Percent of map unit: 5 percent
Landform: Rims on depressions, ground moraines
Landform position (three-dimensional): Talf
Down-slope shape: Concave, linear
Across-slope shape: Linear
Ecological site: R103XY001MN - Loamy Wet Prairies
Other vegetative classification: Level Swale, Calcareous (G103XS009MN)
Hydric soil rating: Yes

Okoboji

Percent of map unit: 5 percent
Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Ecological site: R103XY015MN - Depressional Marsh
Other vegetative classification: Ponded If Not Drained (G103XS013MN)
Hydric soil rating: Yes

611C—Hawick gravelly sandy loam, 6 to 12 percent slopes

Map Unit Setting

National map unit symbol: 2wd89
Elevation: 690 to 1,840 feet
Mean annual precipitation: 24 to 37 inches
Mean annual air temperature: 43 to 52 degrees F
Frost-free period: 140 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Hawick and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hawick

Setting

Landform: Outwash plains, terraces
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loamy glaciofluvial deposits over sandy and gravelly outwash

Typical profile

Ap - 0 to 7 inches: gravelly sandy loam
Bw - 7 to 11 inches: gravelly loamy coarse sand
C - 11 to 79 inches: gravelly coarse sand

Properties and qualities

Slope: 6 to 12 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (2.00 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4s
Hydrologic Soil Group: A
Ecological site: R103XY003MN - Sandy Upland Prairies
Forage suitability group: Sandy (G103XS022MN)
Other vegetative classification: Sandy (G103XS022MN)
Hydric soil rating: No

Minor Components

Estherville

Percent of map unit: 10 percent
Landform: Outwash plains, terraces
Landform position (two-dimensional): Backslope, shoulder, summit
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: R103XY003MN - Sandy Upland Prairies
Other vegetative classification: Sandy (G103XS022MN)
Hydric soil rating: No

611D—Hawick gravelly sandy loam, 12 to 20 percent slopes

Map Unit Setting

National map unit symbol: 2wd8b
Elevation: 690 to 1,840 feet
Mean annual precipitation: 24 to 37 inches
Mean annual air temperature: 43 to 52 degrees F
Frost-free period: 140 to 180 days
Farmland classification: Not prime farmland

Map Unit Composition

Hawick and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hawick

Setting

Landform: Outwash plains, terraces
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Linear
Parent material: Loamy glaciofluvial deposits over sandy and gravelly outwash

Typical profile

Ap - 0 to 7 inches: gravelly sandy loam
Bw - 7 to 11 inches: gravelly loamy coarse sand
C - 11 to 79 inches: gravelly coarse sand

Properties and qualities

Slope: 12 to 20 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Capacity of the most limiting layer to transmit water (Ksat): High to very high (2.00 to 99.90 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 30 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Ecological site: R103XY003MN - Sandy Upland Prairies
Forage suitability group: Sandy (G103XS022MN)
Other vegetative classification: Sandy (G103XS022MN)
Hydric soil rating: No

Minor Components

Estherville

Percent of map unit: 10 percent
Landform: Outwash plains, terraces
Landform position (two-dimensional): Summit, shoulder, backslope
Landform position (three-dimensional): Tread, rise
Down-slope shape: Convex
Across-slope shape: Linear
Ecological site: R103XY003MN - Sandy Upland Prairies
Other vegetative classification: Sandy (G103XS022MN)
Hydric soil rating: No

1055—Aquolls and Histosols, ponded

Map Unit Setting

National map unit symbol: f9w0
Elevation: 670 to 1,030 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: Not prime farmland

Map Unit Composition

Aquolls, ponded, and similar soils: 55 percent
Histosols, ponded, and similar soils: 45 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Aquolls, Ponded

Setting

Landform: Depressions on moraines
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Mineral sediments

Typical profile

A - 0 to 42 inches: silty clay loam
Bg - 42 to 50 inches: clay loam
Cg - 50 to 60 inches: loam

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.20 to 2.00 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Calcium carbonate, maximum content: 20 percent
Gypsum, maximum content: 1 percent
Available water supply, 0 to 60 inches: High (about 11.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8w
Hydrologic Soil Group: B/D
Ecological site: R103XY015MN - Depressional Marsh
Forage suitability group: Not Suited (G104XN024MN)
Other vegetative classification: Not Suited (G104XN024MN)
Hydric soil rating: Yes

Description of Histosols, Ponded

Setting

Landform: Depressions on moraines
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Organic material

Typical profile

Oa1 - 0 to 8 inches: muck
Oa2 - 8 to 60 inches: muck

Properties and qualities

Slope: 0 to 1 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Very poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Available water supply, 0 to 60 inches: Very high (about 23.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8w
Hydrologic Soil Group: A/D
Ecological site: R103XY016MN - Organic Marsh
Forage suitability group: Not Suited (G104XN024MN)
Other vegetative classification: Not Suited (G104XN024MN)
Hydric soil rating: Yes

1078—Anthroportic Udorthents, 2 to 9 percent slopes

Map Unit Setting

National map unit symbol: 2xm97
Elevation: 520 to 1,310 feet
Mean annual precipitation: 23 to 41 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 155 to 210 days
Farmland classification: Not prime farmland

Map Unit Composition

Anthroportic udorthents and similar soils: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Anthroportic Udorthents

Setting

Down-slope shape: Linear

Across-slope shape: Linear
Parent material: Human-transported material

Typical profile

^A - 0 to 6 inches: loam
^C - 6 to 79 inches: loam

Properties and qualities

Slope: 2 to 9 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 1.42 in/hr)
Depth to water table: About 48 to 72 inches
Frequency of flooding: None
Frequency of ponding: None
Maximum salinity: Nonsaline to slightly saline (1.0 to 4.0 mmhos/cm)
Available water supply, 0 to 60 inches: High (about 12.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: C
Hydric soil rating: Unranked

1894B—Winnebago loam, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: f9x1
Elevation: 680 to 1,360 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Winnebago and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Winnebago

Setting

Landform: Moraines
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess over till

Typical profile

Ap,A - 0 to 15 inches: loam
2Bt,2BC - 15 to 44 inches: sandy clay loam

2C - 44 to 60 inches: sandy loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Available water supply, 0 to 60 inches: High (about 10.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Forage suitability group: Sloping Upland, Acid (G104XN006MN)
Other vegetative classification: Sloping Upland, Acid (G104XN006MN)
Hydric soil rating: No

Minor Components

Carmi

Percent of map unit: 5 percent
Hydric soil rating: No

Burkhardt

Percent of map unit: 5 percent
Hydric soil rating: No

1895B—Carmi loam, 2 to 8 percent slopes

Map Unit Setting

National map unit symbol: f9x2
Elevation: 340 to 1,300 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Carmi and similar soils: 90 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Carmi

Setting

Landform: Moraines

Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Glaciofluvial sediments

Typical profile

Ap,A - 0 to 13 inches: loam
Bw,Bt - 13 to 25 inches: sandy loam
2Bw - 25 to 48 inches: gravelly sandy loam
2C - 48 to 60 inches: gravelly loamy sand

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 6.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 3e
Hydrologic Soil Group: B
Ecological site: R104XY010IA - Sandy Upland Prairie
Forage suitability group: Sloping Upland, Low AWC, Acid (G104XN008MN)
Other vegetative classification: Sloping Upland, Low AWC, Acid (G104XN008MN)
Hydric soil rating: No

Minor Components

Winnebago

Percent of map unit: 5 percent
Hydric soil rating: Yes

Burkhardt

Percent of map unit: 5 percent
Hydric soil rating: No

1896B—Ostrander-Carmi loams, 2 to 6 percent slopes

Map Unit Setting

National map unit symbol: f9x3
Elevation: 340 to 1,300 feet
Mean annual precipitation: 23 to 35 inches
Mean annual air temperature: 43 to 50 degrees F
Frost-free period: 155 to 200 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Ostrander and similar soils: 55 percent
Carmi and similar soils: 35 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ostrander

Setting

Landform: Moraines
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Loess over till

Typical profile

Ap,A,AB - 0 to 17 inches: loam
2Bw - 17 to 53 inches: loam
2C - 53 to 60 inches: loam

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 25 percent
Available water supply, 0 to 60 inches: High (about 11.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Ecological site: R104XY005IA - Loamy Upland Prairie
Forage suitability group: Sloping Upland, Neutral (G104XN002MN)
Other vegetative classification: Sloping Upland, Neutral (G104XN002MN)
Hydric soil rating: No

Description of Carmi

Setting

Landform: Moraines
Landform position (two-dimensional): Backslope
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Glaciofluvial sediments

Typical profile

Ap,A - 0 to 13 inches: loam
Bw,Bt - 13 to 25 inches: sandy loam
2Bw - 25 to 48 inches: gravelly sandy loam
2C - 48 to 60 inches: gravelly loamy sand

Properties and qualities

Slope: 2 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water supply, 0 to 60 inches: Moderate (about 6.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2e
Hydrologic Soil Group: B
Ecological site: R104XY010IA - Sandy Upland Prairie
Forage suitability group: Sloping Upland, Neutral (G104XN002MN)
Other vegetative classification: Sloping Upland, Neutral (G104XN002MN)
Hydric soil rating: No

Minor Components

Klinger

Percent of map unit: 5 percent
Hydric soil rating: No

Dickinson

Percent of map unit: 5 percent
Hydric soil rating: No

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