Appendix J

Preliminary Drainage Report

Hayward Solar LLC
Docket No. IP-7053/GS-21-113
May 2021

PRELIMINARY STORMWATER MANAGEMENT REPORT

Hayward Solar Project

Freeborn County, MN

MARCH 2021

PREPARED FOR:

CapitalDynamics

PREPARED BY:

Westwood

Preliminary Stormwater Management Report

Hayward Solar Project

Freeborn County, MN

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Westwood

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Introduction

The purpose of this report is to summarize the proposed stormwater management for the Hayward Solar Project ("the project"). This report was prepared to meet local and state requirements and is intended for submittal to these agencies for permitting review and approval.

The project site is proposed on approximately 1,274 acres and is located approximately 1.5 miles east of the town of Hayward in Freeborn County, Minnesota. The site's current use is agricultural row crops along with a small number of residential homes and roads.

The proposed use of the site will be a solar facility consisting of 285 acres of solar modules and 31 acres of the new impervious surface including gravel access roads and associated solar infrastructure. The proposed site under the solar modules will be converted to meadow conditions within the fenced boundary around the proposed impervious surfaces. Although the area beneath the panels is vegetated, the MPCA considers a portion of the solar array as impervious for runoff treatment. The amount of treatment needed is calculated using the MPCA solar panel spreadsheet.

Minimal grading will be proposed on site and existing drainage patterns will be maintained. Stormwater management practices including wet sedimentation basins are proposed on site to meet the requirements of the MPCA and Shell Rock River Watershed. Other stormwater measures are proposed on site to route water through the site including culverts and low water crossings.

Data Sources

TABLE 1: DATA SOURCES

Task	Format	Source	Use
Elevation	1-meter DEM	MnTOPO	Model Elevations
Crop Data	Shapefile	USDA 2013 Crop Data Layer	Landcover
Soils	Shapefile	USGS SSURGO Dataset	Curve Numbers
Precipitation	PDF File	Shell Rock River Watershed District	Design Storms
Site Boundary	Hayward.kmz	Midwest Solar DevCO CEI, LLC	Define Model Extents
2014 Aerial Photography	ArcGIS Map Service	USDA FSA	Reference

Site Conditions

Site Location

The project area is located approximately 1.5 miles east of the town of Hayward in Freeborn County, Minnesota.

Historical Use

A review of aerial photographs shows that the site is currently used and has historically been used for agricultural row crops.

Topography Description

The existing topographic information used in this analysis was obtained from USGS. In general, the site is very flat with slopes of less than 1% though there are a few locations where the slopes reach roughly 4%. There are also several county ditches with steeper slopes that run through and around the site outside of the proposed improvement areas.

Drainage Patterns

Onsite runoff is split into 8 drainage areas based on discharge locations and existing low areas. Several drainage areas do not discharge all runoff and the runoff stays in existing low areas. Drainage areas are shown in Exhibits 5 and 6.

Discharge Locations

Each drainage area discharges in separate directions and locations. Discharge locations are shown in Exhibits 5 and 6.

Soils

Soils data was downloaded from SSURGO and can be found in Exhibit 3. The soils data was reviewed and incorporated into the analysis.

The site consists primarily of Hydrologic Soil Group (HSG) B/D and C/D soils. Type D soils have high runoff potential and low infiltration rates.

Stormwater Management Requirements

Stormwater management for the project falls under the jurisdiction of Shell Rock River Watershed District, (http://shellrockriver.govoffice3.com/vertical/sites/%7B9804AD9D-40CA-46B1-8F91-CC0257E7304A%7D/uploads/Shell_Rock_River_Watershed_District_Rules.pdf). The following requirements need to be met for the project:

Rate Control

Stormwater rate control must be provided so that the proposed conditions peak runoff rates must not increase from existing conditions. The 2-year (2.9”), 10-year (4.4”), and 100-year (6.3”) 24-hour stormwater events must meet these requirements. In addition, pond outlet structures, emergency overflow structures, and drainage routes must be designed for a 100-yr 24-hour storm event.

Water Quality

The project needs to treat 1.0” of runoff from the new impervious surfaces, which consist of the proposed roads and inverter pads, along with a portion of the proposed solar arrays determined

by the MPCA spreadsheet. In addition, discharge for the 1.25 inch event must be limited to 5.66 cfs/acre or provide NURP volume for ponds.

Drainage Improvements

Proposed culverts and low water crossings will be sized for the 10-year 24-hour stormwater event per Shell Rock River Watershed District.

Methodology

Existing and proposed conditions are modeled in HydroCAD software. HydroCAD is a widely accepted hydrologic and hydraulic modeling package based on TR-20 unit hydrograph equations. It models stormwater runoff discharge rates and velocities from ponds, culverts, outlet control structures, and stream reaches.

Hydrology

Curve Number Methodology, based on the NRCS-TR 55 method, was used in the modeling for predicting direct runoff. Curve numbers were assigned by reviewing the soil and landcover for each drainage area.

Time of concentrations were calculated for each drainage area in HydroCAD using the lag method. The lag method uses the hydraulic length (distance traveled by a drop of water from the most distant part of the subcatchment to the outlet point) and the average land slope (average slope of entire watershed). The overall curve number for the site along with the lag information is used to get the time of concentration for the site.

Rainfall data from Shell Rock River Watershed District for the 2-year, 10-year, and 100-year 24-hour storm events were used as input for the analysis.

Hydraulics

Culvert sizing was completed using HydroCAD and contributing watershed properties to find runoff to the anticipated culvert locations. CulvertMaster is then used to size the culverts assuming 1' allowable headwater and manning's number of 0.025 for corrugated metal culverts. CulvertMaster uses the methodologies outlined in Hydraulic Design Series Number 5 from the U.S. Federal Highway Administration to calculate capacities and end conditions.

Existing Conditions

The existing site consists of row crops and wooded areas. Cover for the analysis was determined using the USDA 2013 Crop Data Layer and aerial photos. Curve numbers were assigned based on the land cover and soil types, see table below for summary.

TABLE 2: EXISTING CONDITIONS COVER

Cover	CN	Area [ac]
Row Crops, HSG B	78	4.90
Row Crops, HSG D	89	1,269.50
Total		1,274.40

Proposed Conditions

The use of the site will be a solar plant. The site will consist of approximately 285 acres of solar modules mounted above grade on a racking system and 31 acres of gravel access roads, electrical equipment, and a substation. The solar modules will be located above grade with meadow grass below the proposed array.

The proposed substation will be a raised pad and runoff from this area will sheet flow over proposed meadow grasses before reaching the county ditch system and leaving the site.

Minimal grading is proposed to meet the tolerances of the proposed solar array. Drainage patterns will remain the same as existing with the addition of wet sedimentation basins that outlet to the adjacent county ditches or similar to existing conditions. Wet sedimentation basins are proposed to provide treatment and rate control for the site. Culverts and low water crossings are proposed to route water through the site.

TABLE 3: PROPOSED CONDITIONS COVER

Cover	CN	Area [ac]
Roads/Inverters/Substation	98	30.90
Meadow Grass with Solar Above, HSG B	58	4.90
Meadow Grass with Solar Above, HSG D	78	1,238.60
Total		1,274.40

Proposed Stormwater Management

A solar project differs greatly from other commercial or residential developments. When constructed, a solar project will include solar panels, at-grade gravel access roads, and other electrical equipment. The panels will be mounted a minimum of 18" above the ground with a low maintenance perennial meadow grass growing under the panels. While solar projects may require grading, the existing terrain is smoothed to accommodate array installation, rather than significant changes to grades or slopes, and the grading is designed to maintain existing drainage patterns. Access roads are installed at grade and allow for runoff to sheet flow through the proposed meadow cover which provides treatment and reduction in runoff. The proposed vegetation slows the runoff and allows for water to filter into the soils for treatment. Runoff is actually reduced over existing conditions by converting from a row crop land cover.

Water quality is not a concern and is actually improved over pre-development conditions due to the land cover's conversion from a higher runoff rate row-crop field to a lower runoff rate meadow grass. Water quality concerns are also minimized due to the low percentage of impervious surfaces and the fact that runoff from these surfaces filters through the meadow grasses on site prior to discharging.

As described in the Minnesota Stormwater Manual, better site design techniques have been incorporated to ensure a site where all impervious surfaces are fully disconnected and routed over grass prior to leaving the site. (http://stormwater.pca.state.mn.us/index.php/Better_site_design). The MPCA has developed a

spreadsheet tool to calculate the volume of the stormwater that must be treated on site from solar installations (Appendix C).

Wet sedimentation basins are proposed where infiltration and filtration basins are not allowed due to soil conditions and/or site constraints. They provide rate control and treatment as needed to meet the requirements of the state and watershed. Wet basins have "dead" and "live" storage requirements set by the state. The "dead" storage is the storage below the outlet that will provide treatment for the site. The "live" storage is the storage above the outlet culvert that stores the water quality volume and bounces to meet the runoff requirements of the site.

In addition to these stormwater management BMPs, the recommended approach for solar projects includes the following: limit the amount of impervious surfaces to reduce runoff, minimize the amount of grading to promote sheet flow, and the planting of the meadow grass on the majority of the site to provide both runoff reduction and treatment.

Water Quantity/Runoff Analysis

Stormwater quantity calculations for the site were prepared using HydroCAD. The proposed site meets the rate control requirements of Shell Rock River Watershed. Table 4 and 5 show a summary of the runoff rates and volumes for each event at the site discharge locations. Calculations are included in Appendices A and B.

TABLE 4: RUNOFF RATE SUMMARY

Location	2-year Runoff (cfs)		10-year Runoff (cfs)		100-year Runoff (cfs)	
	Existing	Proposed	Existing	Proposed	Existing	Proposed
1	194.44	87.42	342.46	187.37	530.99	326.17
2	81.52	32.99	144.10	72.12	224.40	127.73
3	82.62	33.06	145.60	72.97	226.67	129.60
4	119.33	53.86	209.87	115.49	325.31	200.91
5	174.46	73.87	305.47	162.33	471.93	285.65
6	39.43	16.35	69.31	36.06	107.29	63.55
7	103.02	41.67	181.60	91.31	282.55	161.90
8	66.53	32.75	115.51	69.28	177.52	119.40

TABLE 5: RUNOFF VOLUME SUMMARY

Location	2-year Runoff (ac-ft)		10-year Runoff (ac-ft)		100-year Runoff (ac-ft)	
	Existing	Proposed	Existing	Proposed	Existing	Proposed
1	35.33	21.79	62.49	44.77	98.14	77.10
2	42.29	24.73	74.78	51.65	117.45	89.85
3	31.43	18.38	55.58	38.39	87.29	66.78
4	20.24	12.48	35.79	25.64	56.21	44.16
5	18.93	11.07	33.47	23.12	52.57	40.21
6	5.64	3.30	9.97	6.89	15.67	11.98
7	33.68	19.69	59.55	41.13	93.53	71.55
8	4.66	2.87	8.24	5.90	12.94	10.17

Water Quality Analysis

Treatment of the stormwater quality volume for the site will be provided for each discharge location with the proposed basins. The basins have been sized to detain the required 1" of runoff over the proposed impervious surfaces and the required volume from the MPCA panel calculator. Table 6 shows the required and provided storage volumes for each discharge location. Calculations can be found in Appendix C.

TABLE 6: BASIN STORAGE SUMMARY

Basin	Required Water Quality Volume (ac-ft)	Provided Live Storage Volume (ac-ft)	Required Dead Storage Volume (ac-ft)	Provided Dead Storage Volume (ac-ft)
1a/1b	2.77	2.90	9.61	11.70
2	2.86	3.47	11.50	11.99
3a/3b	2.10	2.63	8.54	8.89
4	1.50	1.68	5.50	5.66
5	1.32	1.32	5.15	5.72
6	0.36	0.39	1.53	1.85
7	2.12	2.94	9.16	10.77
8	0.43	0.48	1.27	1.71

Stormwater Management Practices

Basin Calculations

Wet sedimentation basins are provided at critical locations in the site to capture runoff to slow release rates and provide treatment for the site. The results of the MPCA spreadsheet show that most of the site is meeting the requirements based on the solar panels being allowed to sheet flow over the pervious ground. Small basins are also provided to make up the remainder of the volume required and they exceed the required volume. Table 7 summarizes the proposed basins on site. Calculations can be found in Appendix B.

TABLE 7: PROPOSED BASIN SUMMARY

Basin	Bottom Elevation	NWL/Outlet Elevation	Emergency Overflow Elev.	100-yr HWL	Top Elevation
1a	1238.00	1243.00	1244.00	1244.36	1245.00
1b	1238.00	1243.00	1244.00	1244.68	1245.00
2	1235.00	1243.00	1243.70	1244.60	1245.00
3a	1238.00	1242.00	1243.00	1243.70	1244.00
3b	1238.00	1242.00	1243.00	1244.31	1245.00
4	1239.00	1245.00	1246.25	1246.48	1247.00
5	1238.00	1245.00	1246.00	1246.73	1247.00
6	1242.00	1245.00	1245.50	1246.36	1246.50
7	1239.00	1243.00	1244.00	1244.89	1245.00
8	1241.00	1246.00	1247.00	1247.06	1248.00

Culvert Sizing

Culverts are proposed below new access roads to maintain existing drainage patterns through the proposed site. Entrance culverts EC-01 and EC-02 have negligible drainage areas flowing to each crossing so the minimum culvert size is proposed for both culverts. Table 9 summarizes the proposed culverts on site, see civil plans for culvert locations.

TABLE 9: CULVERT SUMMARY

Culvert ID	Size	Material
EC-01	18”	CMP
EC-02	18”	CMP

Low Water Crossing

Low water crossings are proposed where concentrated flows cross the access roads. Crossings are sized to withstand the shear stress caused by flow during the 10-year 24-hour rainfall event. FLO2D models were created and analyzed to determine the shear stresses and lengths. The combination of crossing depths and the slope of the flow path at each crossing location were multiplied by the density of water to determine the expected shear stress. Table 10 provides a summary of the proposed low water crossing on site. Calculations can be found in Appendix D. See civil plan set for the crossing location.

TABLE 10: LOW WATER CROSSING SUMMARY

Low Water Crossing ID	Type	Length
LWC-01	Standard Duty	30’

Construction Conditions

During construction conditions, higher runoff rates and volumes can be expected than the fully vegetated final condition. To account for this, dewatering should be anticipated as needed until vegetation has fully established on the site. This may include pumping of temporary swales and diversions. Once the site has been stabilized, sediment will need to be removed from any permanent basins on site. Using temporary seed/mulch at the onset of construction can greatly reduce the amount of erosion and rework on solar sites. As the project progresses to construction a separate stormwater pollution prevention plan will be prepared to account for these concerns in greater detail.

Conclusion

The proposed site was designed to meet the requirements of the MPCA and Shell Rock River Watershed for stormwater management. The proposed site consists of proposed basins and crossings in order to maintain existing drainage patterns, reduce runoff rates, and provide required treatment volumes.

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National Engineering Handbook, Part 630 Hydrology. Chapter 9 Hydrologic Soil-Cover Complexes. USDA. NRCS. 210-VI-NEH, July 2004

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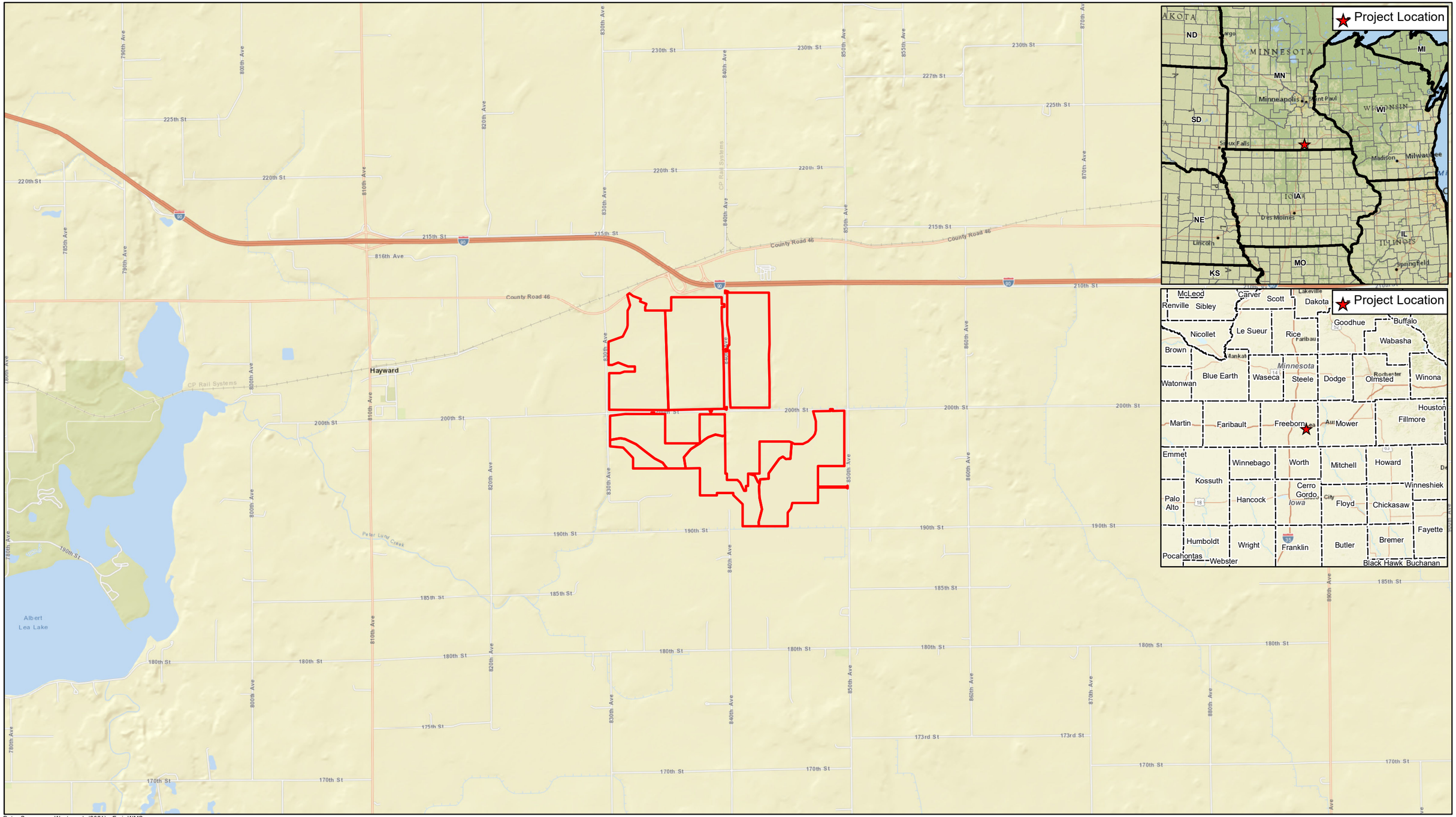
Exhibits



Data Sources: Westwood (2021); Esri WMS Basemap Imagery (Accessed 2021); USGS (2021); FEMA (2021); USDA (2021)

Legend

- Project Boundary
- County Boundary

Westwood
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Westwood Professional Services, Inc.

N

0 4,000 Feet

Hayward Solar Project

Freeborn County, Minnesota

Exhibit 1: Location Map

March 19, 2021

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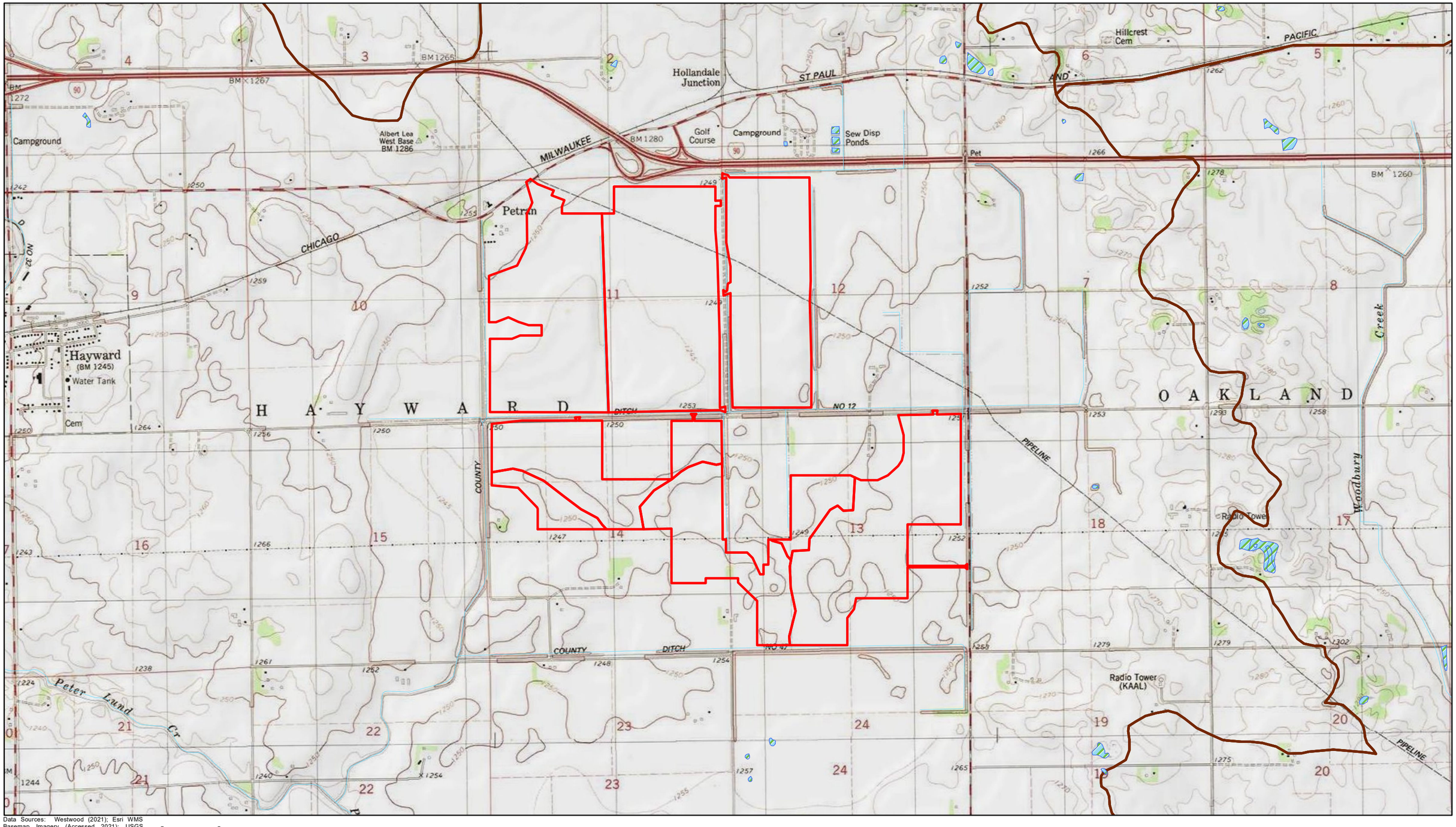

Data Sources: Westwood (2021); Esri WMS Basemap Imagery (Accessed 2021); USGS (2021); FEMA (2021); USDA (2021)

Legend

- Project Boundary
- County Boundary
- NHD Flowline
- HUC 12 Boundary
- NWI Wetlands

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N

0 Feet 2,000

Hayward Solar Project

Freeborn County, Minnesota

Exhibit 2: Base Map

March 19, 2021

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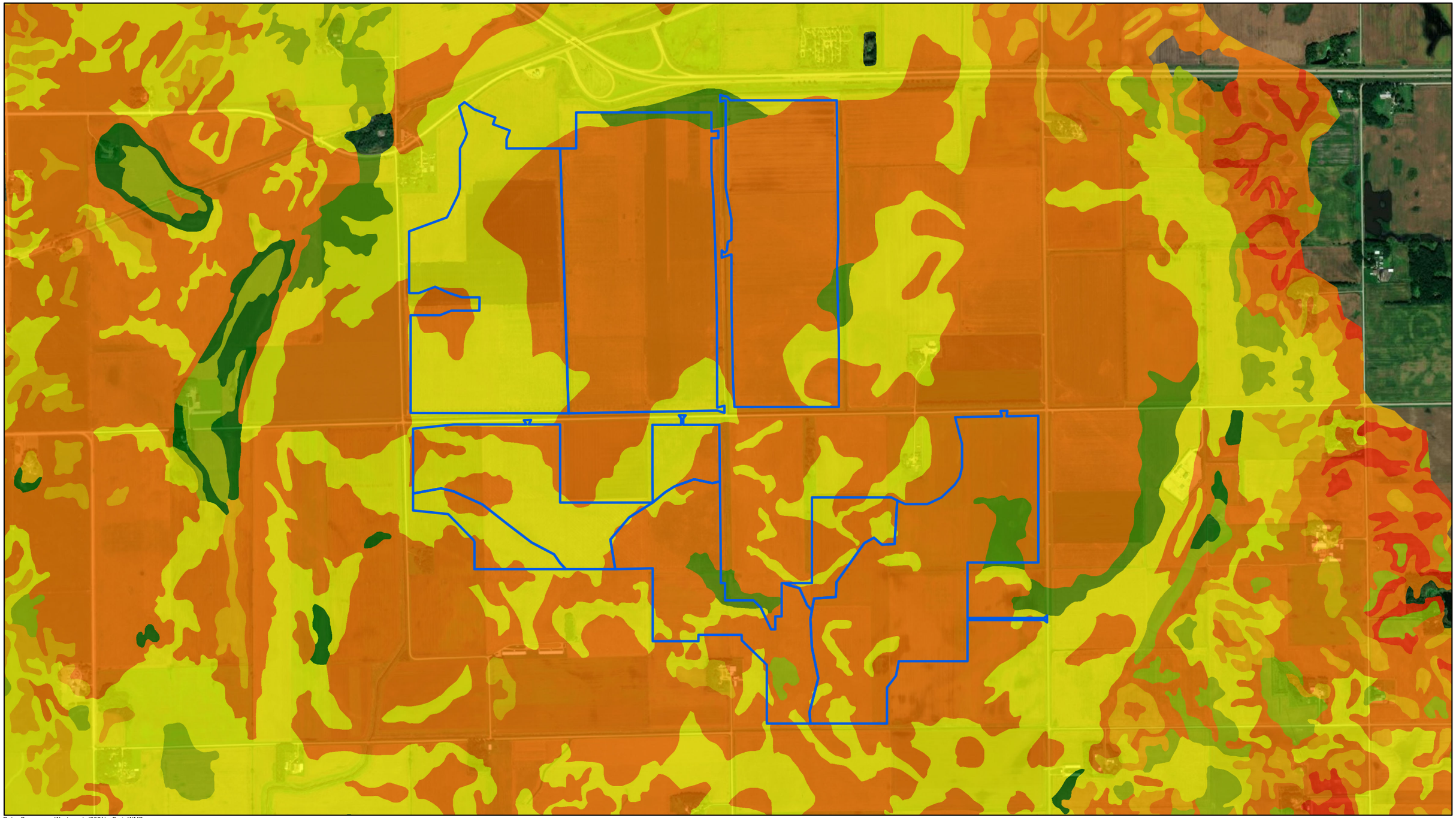

Data Sources: Westwood (2021); Esri WMS Basemap Imagery (Accessed 2021); USGS (2021); FEMA (2021); USDA (2021)

Legend

Project Boundary

Hydrologic Soils Group

- A
- A/D
- B
- B/D
- C
- C/D
- D

N

0 Feet 1,500

Hayward Solar Project

Freeborn County, Minnesota

Exhibit 3: Soils Map

March 19, 2021

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Map Document: N:\0026599.00\GIS\Hydro Exhibits\SWMP Exhibits\Hayward_Ex3_SoilsMap.mxd LJBASSETTE 3/19/2021 2:58:16 PM

Data Sources: Westwood (2021); Esri WMS Basemap Imagery (Accessed 2021); USGS (2021); FEMA (2021); USDA (2021)

Legend

Project Boundary

Land Cover

- Miscellaneous Crops
- Corn
- Deciduous Forest
- Developed
- Grassland/Pasture
- Herbaceous Wetlands
- Open Water
- Peas
- Soybeans
- Sweet Corn
- Woody Wetlands

N

0 Feet 1,500

Hayward Solar Project

Freeborn County, Minnesota

Exhibit 4: Land Cover Map

March 19, 2021

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Map Document: N:\0026599.00\GIS\Hydro Exhibits\SWMP Exhibits\Hayward_Ex4_LandcoverMap.mxd LJBASSETTE 3/19/2021 2:58:39 PM