Memorandum

To: Wareham PV I, LLC Solar Project File

Date: June 30, 2022

Project #: 15225.02

From: Meddie J. Perry, CGWP Certified Groundwater Professional #3106689

RE: 0 Route 25 Wareham, MA Solar Project, Groundwater Hydrology Assessment

At the request of Wareham PV I, LLC, VHB prepared this Groundwater Hydrology Assessment Memorandum for the planned development of the 0 Route 25 Wareham, MA Solar Project (the "Project"). This assessment was designed to determine the potential for the Project to impact groundwater hydrology on and surrounding the Project site (0 Route 25; Assessor's Map 115, Lot 1000) (the "Project Site"). This assessment is based on a desktop review of the Project Site, site features, and surrounding water resource, soil, geology, and documented environmental hazards.

SITE DESCRIPTION

The Project Site currently consists of an approximately 24-acre property containing approximately 14 acres of woods in the southern portion, while the northern portion has been cleared. Abutting properties consists of woods, cranberry bogs, and the Wareham Municipal Maintenance Facility.

Site topography is gently sloping with the highest terrain approximately 45 feet above mean sea level ("msl," NAVD 88) and the lowest areas approximately 20 feet msl based on a topographic survey performed by VHB. A local high point is present at the adjacent Wareham Municipal Maintenance Facility, which is situated along a long, low ridge running from the north-northeast to the south-southwest. Lower terrain to the east, south, and west holds cranberry bogs, and a network of streams interconnecting the bogs generally flows southwards towards the Atlantic Ocean.

PROJECT DESCRIPTION

The Project proposed by the Applicant is a 3.5-megawatt (AC) ground-mounted PV array on a fixed racking system. In addition to the PV array, small concrete pads will be created in the central and southern portions of the Project Site to support the electrical equipment in those areas. To accommodate the change in cover type, two stormwater basins will be constructed at the southern end of the parcel. Additional work includes improvements to utility infrastructure, new and modified existing access roads, and a 7-foot chain link fence around the entire Project Site. The gravel access road will be 20 feet wide and will provide vehicular access throughout the entire length of the Project Site. The racking system will be constructed of galvanized steel racks and either pile-driven or screw-type anchors; the anchors are typically galvanized steel installed 5 to 9 feet into the ground to develop the structural rigidity required primarily due to frost heave considerations.

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SITE GEOLOGY

Surficial geology of the Project Site and surrounding area is mapped as coarse glacial stratified deposits (USGS, 2015; see attached Figure 1 - Geologic Resources).

Based on a review of the National Resource Conservation Service ("NRCS," 2021) soil survey mapping within and surrounding the Project Site, site soils are identified as loamy sands (see attached Figure 2 - NRCS Soils Map). Test pits conducted by VHB in the southeast portion of the Project Site indicated loamy sands and fine sands. A site investigation at the adjacent Wareham Municipal Maintenance Facility during 2001 associated with the removal and replacement of underground storage tanks ("USTs") (MA DEP Release Tracking Number ("RTN") 4-0016168) reported "well-graded fine to medium sands, with intermittent stingers of clay," and characterized the materials as glacial outwash deposits (Coler & Colantonio, 2001).

Bedrock at and surrounding the Project Site is mapped as the Avalon Granite formation (USGS, 2014).

SITE HYDROLOGY

Observations from VHB's on-site test pits indicate a depth to the seasonal high groundwater table of approximately 44 to 50 inches below the ground surface. Where the ground elevation at these test pits is approximately 21 feet msl, the seasonal high groundwater table elevation is estimated at 17.2 feet msl. The seasonal high water table typically occurs in March or April, and lower water-table elevations are present at other times of year.

Comparable estimates of the groundwater elevations were made at the adjacent Wareham Municipal Maintenance Facility during the 2001 site investigation (Coler & Colantonio, 2001). At this location, where the ground elevation is approximately 50 feet msl, excavation to a depth of 20 feet below grade did not encounter groundwater during April (a month when seasonal high groundwater levels typically occur). This information suggests a seasonal high groundwater table elevation of 30 feet msl or lower.

Most likely, given the consistent granular glacial outwash deposits at and surrounding the Project Site, groundwater in the Project vicinity flows from the areas of higher topography towards local groundwater discharge zones along the cranberry bogs and streams in the lower elevations. The regional low-elevation zone at approximately 12 to 14 feet msl is along the stream and wetlands east and southeast of the Project (2-foot contour elevations are shown on the attached Figure 6 – Topography Map, indicating the elevations at the Project Site, cranberry bogs, wetlands, and streams). Higher-elevation terrain along Charge Pond Road appears to function as a groundwater flow divide, with groundwater flowing westward from the area west of the road, and flowing south and eastward from the area east of the road. More specifically, in the vicinity of the Project Site, groundwater originates as precipitation which infiltrates

the ground surface and forms the water table, which flows southeastward from the higher terrain along Charge Pond Road and the Municipal Maintenance Facility, toward the bogs and streams bordering the Project Site on the east (see attached Figure 3 - Water Resources Map).

WATER SUPPLY ASSESSMENT

The Wareham Fire District provides municipal water service in the area. Adjacent to the Project Site, a municipal water main is present along Charge Pond Road (Kleinfelder, 2018).

The Wareham Fire District obtains water from a series of wells located at least 1.4 miles north and northeast from the Project Site (Kleinfelder, 2018). Wellhead Protection Areas have been delineated for the wells and approved by the MA DEP. The Wellhead Protection Areas represent the land area from where water is likely to enter these public wells (MassGIS, 2022). The Project Site is located at least 0.75 miles distant from the nearest edge of any of the Wareham Fire District Wellhead Protection Areas, and groundwater from the Project Site flows away from the municipal wells (see attached Figure 3 - Water Resources Map).

GROUNDWATER HYDROLOGY ASSESSMENT

As is the case presently, snowmelt and rain falling on the Project Site will seep into the site soils and recharge the groundwater, thus preserving existing groundwater flows and quantities. Precipitation falling on the proposed solar panels will run onto and seep into the ground, and stormwater will be infiltrated via constructed infiltration basins, with the result that the overall amount of groundwater flow and recharge will be maintained after Project construction. Groundwater flow directions will not be altered and groundwater will continue to flow from the higher terrain north and west of the Project Site (from the Municipal Maintenance Facility and adjacent areas) towards the cranberry bogs, wetlands, and stream along the east side of the Project Site.

Scientific studies have determined that solar farms do not have adverse hydrologic impacts if a well-maintained grass cover is maintained beneath the panels and in the spacer section, or if a buffer section or a detention basin is added (Cook and McCuen, 2013). The Project will involve both of these measures.

The pile-driven posts which will support the PV array would not affect the flow of groundwater because the posts are very small in area and spaced sufficiently far apart so that groundwater would flow unimpeded around them. The galvanized steel posts are composed of materials that are accepted for construction of water piping, and that will not contaminate or alter the chemistry of the groundwater.

No Project components would withdraw or divert the flow of groundwater. At most, any impact to groundwater would be negligible and would consist of no more than a few inches rise in water table elevations if the infiltration of stormwater from the developed site were to increase recharge compared to the current partially-forested condition[1]. A rise in the water table of this magnitude is insignificant and is much less than natural seasonal changes, which are typically a few feet. Moreover, such a hypothetical rise in the water table would be limited to the small area between the Project Site and the bogs and stream along the eastern border of the Project Site. Therefore the Project will not affect groundwater resources of off-site properties (including the Municipal Maintenance Facility property) or public water supplies.

ENVIRONMENTAL HAZARDS

A search of public records indicates that two underground storage tanks ("UST") are present at the Municipal Maintenance Facility. Two 5,000-gallon USTs (one gasoline, one diesel) were in place from 1975 to 2001. Two new tanks (both 5,000 gallons, one gasoline, one diesel) were installed in 1997 and are still in place currently (see attached Figure 4 – Environmental Hazards Map).

In April 2001, a release of gasoline and diesel fuel on the Municipal Maintenance Facility property was reported to MA DEP (RTN 4-0016168). As noted above, a site investigation determined that the release was from the former USTs at the Municipal Maintenance Facility (Coler & Colantonio, Inc., 2001). To remediate this release, 200 cubic yards of soil were excavated and removed from the site for off-site treatment. The Town's environmental consultant subsequently determined that following the soil excavation and removal, no detectable petroleum compounds were detected in soil remaining on-site, and groundwater was not at risk of contamination. Based on this determination, and given that, as discussed above, the Project would not affect groundwater levels, no risk of affecting groundwater contamination or quality is posed by the Project.

[1] A Hydrogeologic and Hydrologic Study prepared in connection with the site plan review application submitted for the 91 & 101 Fearing Hill Road solar project concluded that on that project site, during a 100-year storm groundwater levels would experience "*relatively minor total increases in elevation of less than two inches at neighboring properties, relative to existing conditions*" (Horsley Witten, 2022). The predicted groundwater rise was associated with tree clearing, which reduces water loss via transpiration, resulting in more infiltration to groundwater. Here, the Project has a similar acreage and similar sandy loam soils as the Fearing Hill solar project site but involves significantly less tree clearing (14 acres compared to 26.5 acres at the Fearing Hill site). Given this, the Project is expected to have a similar or, more likely, a lesser effect on groundwater levels than would the Fearing Hill solar project.

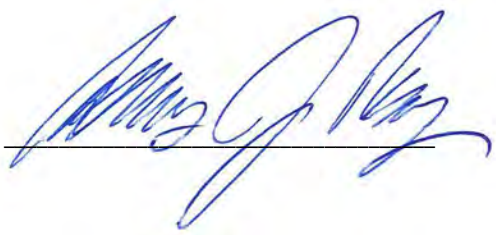
CONCLUSIONS

The Project would not adversely affect groundwater. No Project components would withdraw or divert the flow of groundwater. Because of the consistent granular glacial outwash soils at and surrounding the Project Site, precipitation and snowmelt on the Project Site will seep into the site soils and recharge the groundwater, preserving existing groundwater flows and quantities. Groundwater flow directions will not be altered and groundwater will continue to flow from the higher terrain north and west of the Project Site (from the Municipal Maintenance Facility and adjacent areas), towards the cranberry bogs and stream along the east side of the Project Site. At most, any impact to groundwater would be negligible and would consist of no more than a few inches rise in water table elevations; such a rise in the water table would be limited to the small area between the Project Site and the bogs, wetlands, and stream along the east border of the Project Site. In sum, the Project will not affect groundwater resources of off-site properties (including the Municipal Maintenance Facility property) or public water supplies.

Municipal water supplies the area surrounding the Project, and the Project Site is located at least 0.75 miles distant from the nearest edge of any of the Wareham Fire District Wellhead Protection Areas. Groundwater from the Project Site flows to the southeast, away from the municipal wells.

CERTIFICATION

I, Meddie J. Perry, Certified Ground Water Professional #3106689, do hereby certify, in the exercise of my professional judgement, the information and opinions presented in this memorandum are true and accurate with reasonable scientific certainty.



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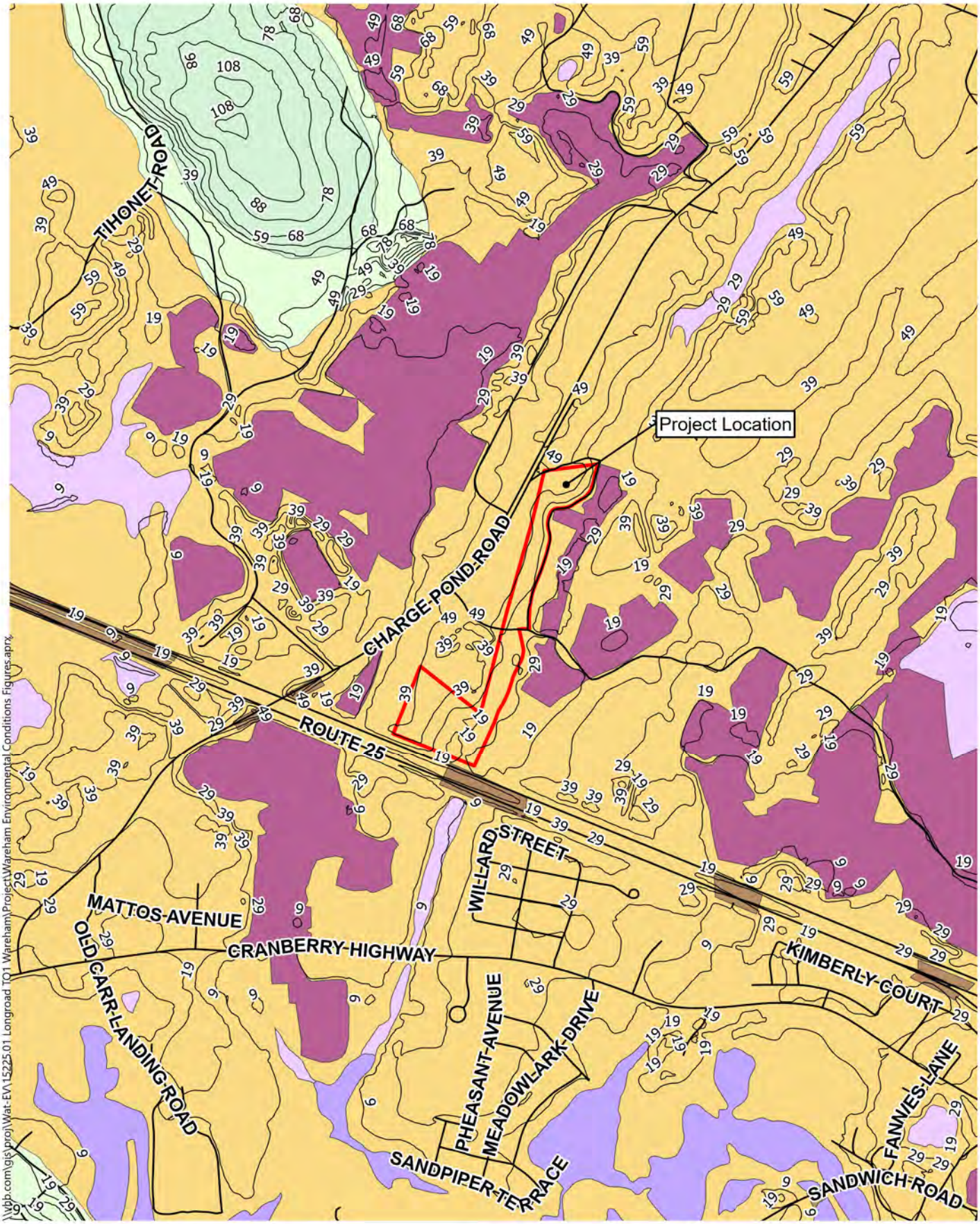
ATTACHMENT



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0 1000 2000 4000 Feet

Proposed Wareham Solar | Wareham, MA

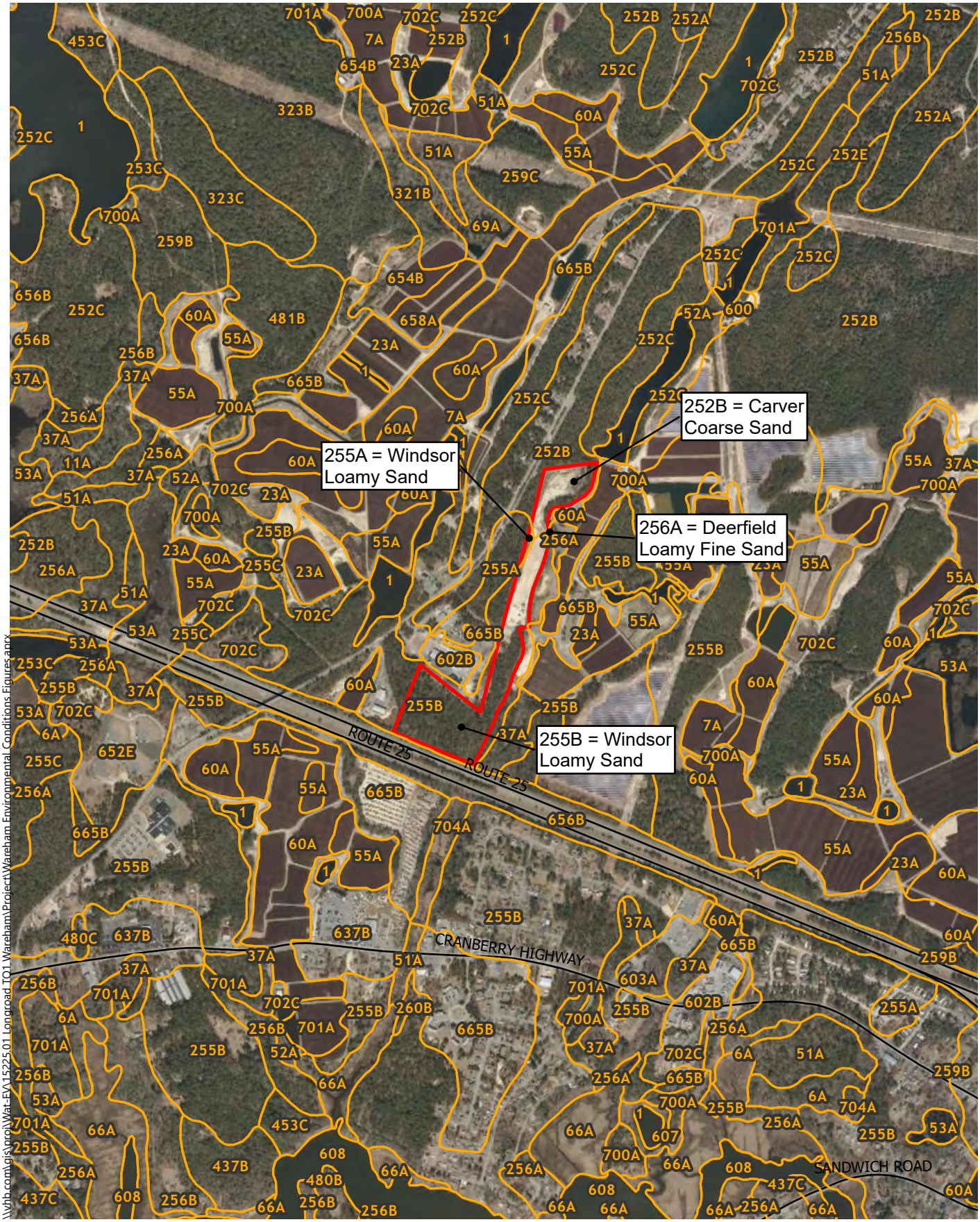
Legend

- Project Location
- **Postglacial Deposits**
  - Artificial Fill
- **Postglacial Deposits**
  - Cranberry Bog
- Salt Marsh Deposits
- Swamp and Marsh Deposits
- **Glacial Stratified Deposits**
  - Coarse
- **Thick Till and Moraine**
  - Thick Till
- **Bedrock Outcrops and Thin Till**
  - Thin Till

*All bedrock within map extent is Avalon Granite

Figure 1 - Geologic Resources

Source Info: USGS, MassGIS, VHB



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Proposed Wareham Solar | Wareham, MA

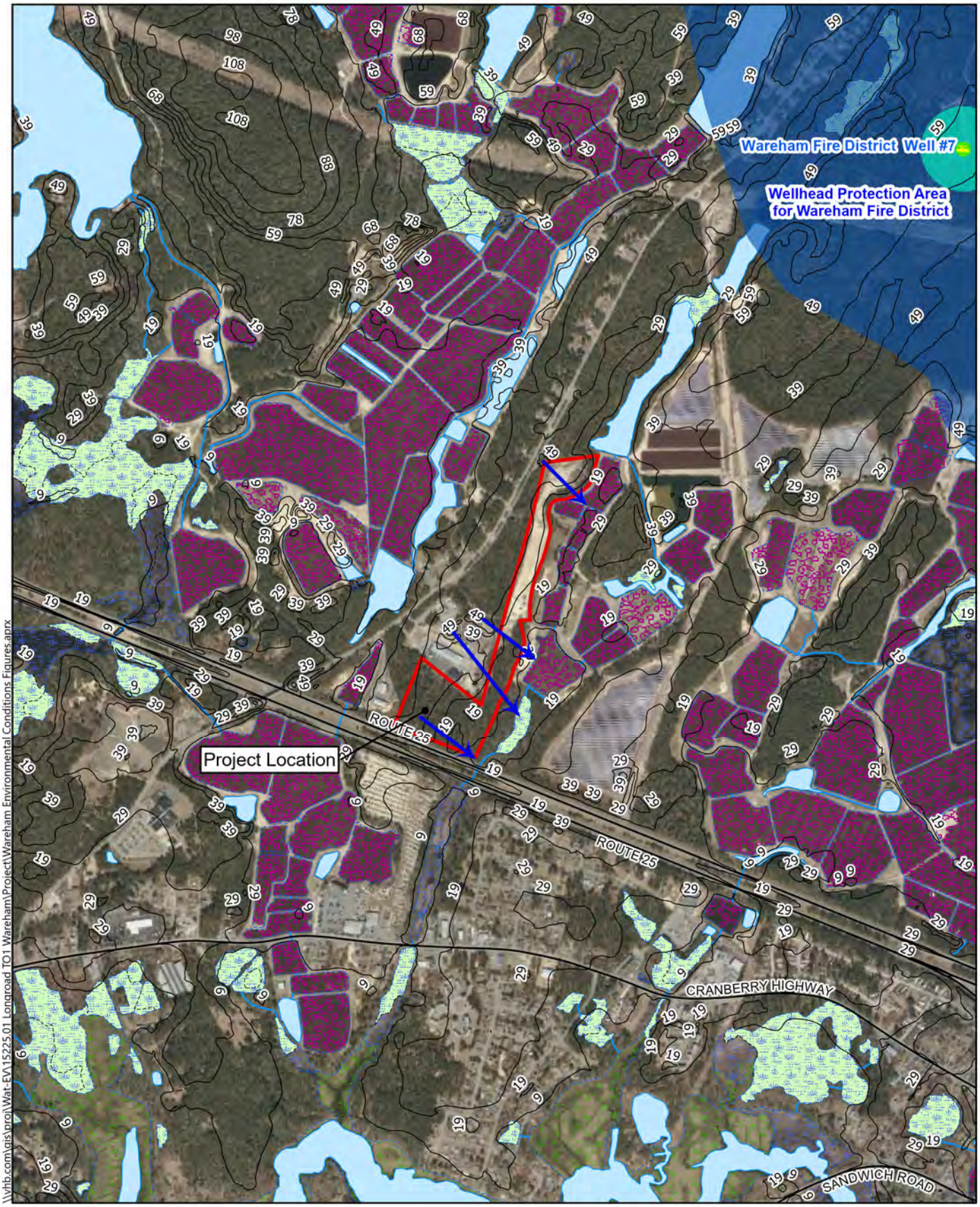
Legend

Project Location

NRCS Soil Types

Figure 2 - NRCS Soils Map

Source Info: USGS, MassGIS, VHB



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Proposed Wareham Solar | Wareham, MA

Legend

- Project Location
- Topography - 10 ft Contours

Public Water Supplies

- Community Groundwater Source
- Zone 1 Wellhead Protection Areas
- Zone 2 Wellhead Protection Areas

Linear Features

- Shoreline
- Hydrologic Connection
- Wetland Limit
- Closure Line

Polygons

- Marsh/Bog
- Wooded marsh
- Cranberry Bog
- Salt Marsh
- Open Water
- Inferred groundwater flow direction

Figure 3 - Water Resources Map

Source Info: USGS, MassGIS, VHB

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Proposed Wareham Solar | Wareham, MA

Figure 4 - Environmental Hazards Map

Source Info: USGS, MassGIS, VHB

Legend

- Project Location
- Landfills
- MassDEP CERO Brownfields - None Present
- Bureau of Waste Prevention - Underground Storage Tank
- Activity Use Limitation Sites - None Present

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0 1000 2000 4000 Feet

Proposed Wareham Solar | Wareham, MA

Legend

- Project Location
- **FEMA Flood Zone Designations**
- A: 1% Annual Chance of Flooding, no BFE
- AE: 1% Annual Chance of Flooding, with BFE
- X: 0.2% Annual Chance of Flooding

Figure 5 - FEMA Map
Source Info: USGS, MassGIS, VHB

0 300 600 1200 Feet

Proposed Wareham Solar | Wareham, MA

Legend

- Project Location
- 10-ft Contours
- 2-ft Contours
- Shoreline
- Hydrologic Connection
- Wetland Limit
- Marsh/Bog
- Wooded marsh
- Cranberry Bog

Figure 6 - Topography Map

Source Info: USGS, MassGIS, VHB