To: Brad Parsons

Date: June 10, 2022

Project #: 42889.00

From: Eric Olson, PWS
Jeffrey Shamas, CSS, CE, SPWS

Re: Vernal Pool Investigation
Verogy
North Haven Solar One Project
700 Middletown Avenue
North Haven, Connecticut

During delineation of wetlands on the above-referenced site in December 2021, Wetland 1 was identified as potentially containing cryptic vernal pool breeding habitat. Connecticut's municipal inland wetlands agencies regulate any activities that are likely to impact or affect vernal pools. Therefore, in consideration of the proposed Site development, VHB conducted a seasonally appropriate investigation the property located at 700 Middletown Avenue, North Haven, Connecticut for vernal pools during spring 2022. This memorandum provides a summary of site conditions, criteria for identifying vernal pools, and the findings of VHB's investigation.

Site Description

The 10-acre Project Site is located in the northeastern corner of a larger (124-acre) property located at 700 Middletown Avenue, Parcel ID No. 009 (Figure 1). The Project Site is a mix of active agricultural field and undeveloped woodland, which is bound to the north by residential properties, to the west by Mill Road, to the south by undeveloped woodland and to the east by an active agricultural field and the Muddy River.

Much of the Project Site consists of active agricultural fields, located primarily in the northcentral portion of the Site with fingers extending to both the southeast and southwest. Undisturbed forested areas within the Project Site are located in the northwest, along the eastern boundary and in the majority of the southern and southwestern portions of the Site.

Topography onsite is split into two main sections: the majority of the Project Site generally slopes to the southeast from the north and west towards the Muddy River (Figure 2); while the northeast portion of the Site slopes to the west. Elevations range from 88 feet in the southern-central portion of the Site to 32 feet in the far southeastern corner of the Site. Surficial geology consists of a mix of sandy loam and outcrop complexes.

Agricultural Fields

As noted above, the northcentral portion of the Site contains agricultural fields with fingers extending to both the southeast and southwest. While no direct activity was observed within the field during the December 2021 delineation or the Spring 2022 vernal pool investigation, evidence of corn crop harvesting from the 2021 season were visible via cut corn stalks (see Photo 10).

Wetlands

Three separate wetland areas, each containing similar physical properties and vegetation compositions, were identified during VHB's 2022 wetland delineation.

Wetland 1

Wetland 1 consists of a freshwater palustrine forested slope wetland system (USFWS Class: PFO1E). This groundwater slope wetland is located along the northeastern side of the property, which is where the topography slopes to the west. The wetland is on a mild incline and drains into a ~12" corrugated metal culvert located in the far southwestern corner, which flows to the west under Mill Road. Note that the culvert is perched above the ground level by about 12", which allows for standing water to remain within the southern portion of the wetland (see Photo 5). A stormwater drainage ditch is located at the southwestern corner of the wetland and appears to drain stormwater surface flow from the portion of the adjacent farm field located to the southeast. This wetland is fed by groundwater discharge

100 Great Meadow Road
Suite 200
Wethersfield, CT 06109-2377
P 860.807.4300

and surface runoff from the farm field located to the east, the residential properties to the north and from Mill Road to the west. Dominant vegetation within Wetland 1 is predominantly woody and includes red maple (*Acer rubrum*), swamp white oak (*Quercus bicolor*), northern spicebush (*Lindera benzoin*), silky dogwood (*Cornus amomum*), skunk cabbage (*Symplocarpus foetidus*), and sensitive fern (*Onoclea sensibilis*).

Wetland 2

Wetland 2 consists of a freshwater palustrine forested slope wetland system (USFWS Class: PFO1E). This groundwater slope wetland is located at the southeastern corner of the property, which is where the topography slopes to the south and east. The wetland is on a mild incline and drains to the south into the Muddy River located outside of the Project area. This wetland is fed by groundwater discharge and surface runoff from upland forested areas to the northwest and the farm field located to the north. Dominant vegetation within Wetland 2 is predominantly woody and includes red maple (*Acer rubrum*), northern spicebush (*Lindera benzoin*), silky dogwood (*Cornus amomum*), skunk cabbage (*Symplocarpus foetidus*), and sensitive fern (*Onoclea sensibilis*).

Wetland 3

Wetland 3 consists of a freshwater palustrine forested slope wetland system (USFWS Class: PFO1E). This groundwater slope wetland is located along the northeastern side of the property, which is where the topography slopes to the south and east. The wetland is on a moderate incline and drains into the southeastern corner of the wetland where it discharges to a farm field and access road outside of the Project area. There is no evidence of a stream channel inside Wetland 3 but the discharge does appear to concentrate and form a stream immediately offsite to the southeast. The flow appears to continue to the southeast where it ultimately drains into the Muddy River. This wetland is fed by groundwater discharge and surface runoff from the farm field to the west and forested areas to the north. Dominant vegetation within Wetland 3 is predominantly woody and includes red maple (*Acer rubrum*), swamp white oak (*Quercus bicolor*), northern spicebush (*Lindera benzoin*), and sensitive fern (*Onoclea sensibilis*).

Surrounding Land Use

Land use surrounding the Site includes residential properties and roadway to the east, residential properties to the north, active agricultural fields to the east and undeveloped woodland to the south. The Muddy River is located offsite approximately 300 feet to the south and 700 feet to the southeast of the Site.

Vernal Pool Identification and Assessment

Although Connecticut's municipal inland wetlands agencies regulate vernal pools, the Connecticut Department of Energy and Environmental Protection (CT DEEP) does not provide a formal definition of vernal pool (CT DEEP 2020). Acknowledging the lack of an official definition for vernal pools in Connecticut, in a technical paper addressing vernal pool considerations for site development, Calhoun and Klemens (2002) note that vernal pools generally occupy less than 2 acres and recommend following guidance provided by Donahue (1996), which is includes the following factors:

a) presence of one or more obligate species,
b) water for approximately 2 months during the growing season,
c) a confined depression that lacks a permanent outlet stream,
d) no fish, and
e) dries out in most years.

In addition, the Connecticut Association of Wetland Scientist (CAWS) Vernal Pool Monitoring webpage (CAWS 2020) cites the following vernal pool definition:

> *Vernal pool means a seasonal watercourse in a defined depression or basin, that lacks a fish population and supports or is capable of supporting breeding and development of amphibian or invertebrate species recognized as obligate to such watercourses. These species include spotted salamander, Jefferson salamander complex, marbled salamander, wood frog, and fairy shrimp.*

These criteria are similar, although the CAWS do not require the pool to dry in most years. The common and specific names for Connecticut species considered by Calhoun and Klemens (2002) to be obligate biological indicators of vernal pool habitat are listed within Table 1.

Table 1 Obligate Vernal Pool Species

Common Name	Scientific name
Jefferson Salamander	*Ambystoma jeffersonianum*
Blue-spotted Salamander complex	*Ambystoma laterale*
Spotted Salamander	*Ambystoma maculatum*
Marbled Salamander	*Ambystoma opacum*
Wood Frog	*Lithobates sylvaticus*
Eastern Spadefoot Toad	*Scaphiopus holbrookii*
Fairy Shrimp	*Eubranchipus spp.*

Furthermore, because vernal pool-breeding amphibians depend on terrestrial habitats as well as aquatic breeding habitats for survival, Calhoun and Klemens (2002) emphasize the importance of considering the surrounding upland areas, up to 750 feet from breeding pools. One hundred feet from the edge of the pool is considered the "vernal pool envelope" and the zone between 100 feet to 750 feet has been termed "critical upland habitat." The authors go on to provide a ranking methodology to assess the quality of each breeding area based on biological indicators and surrounding land use. This tool- a one-page form titled "Vernal Pool Assessment Sheet"- is specifically intended to be used for development planning purposes. Therefore, the purview of Connecticut's municipal inland wetlands agencies encompasses wetland vernal pool habitat and surrounding upland areas.

Survey Methodology

One VHB biologist investigated the property for vernal pool indicators on April 20, 2020. During the investigation, the biologist targeted the are within Wetland 1, which was previously identified during the delineation of wetlands on the Site in December 2021. A wading survey was conducted within the inundated depression within Wetland 1 while wearing polarized glasses. A dip net was used to sample for biological indicators within the inundated area as well. Discretion was used during dipnet sweeps, such that small, shallow areas containing obligate vernal pool indicators were not substantially disrupted (i.e., silting up of areas containing egg masses or spermatophores). Field notes and supporting photographs were taken for areas that were found to meet the vernal pool criteria presented above. Blue plastic flags were hung around the extents of onsite vernal pool-breeding habit based on the maximum observed extent of flooding. Flag locations were recorded using a global positioning device. Subsequently, a Vernal Pool Assessment Sheet (Calhoun and Klemens 2002) was prepared for the vernal pool area (see Attachment 2). Geographic information system (GIS) tools and aerial imagery were used to determine land use surrounding breeding areas and calculate percentages of functional habitat.

Survey Findings

Wetland 1 was found to contain one (1) cryptic vernal pool breeding area (see Figure 2), which was delineated in the field with blue flagging labeled PVP-1-100 to PVP-1-120. Observed obligate vernal pool species included wood frog tadpoles (see Photo 6). No fairy shrimp, marbled salamander, or state-listed vernal pool breeding amphibians were observed. The vernal pool area exhibits a soft, leafy, silty bottom and flood depths within the breeding area at approximately 10-12 inches. The vernal pool (VP) 1 breeding area was a long and broad pool located within the southern portion of Wetland 1 (see Photos 1 through 4). The pool is approximately 230 long and 80-feet wide at the northern extent, tapering down to approximately 40 feet wide at the southern extent.

The pool contained a moderate amount of woody debris and snags throughout. Herbaceous hydrophytic vegetation was present throughout the pool, of which there of which the majority have an obligate (OBL) wetland indicator status, which thrive in inundated conditions, including blue flag Iris (*Iris versicolor*), northern arrowhead (*Sagittaria cuneata*) and fowl manna grass (*Glyceria striata*). The pool also contained creeping yellow-loosestrife (*Lysimachia nummularia*), which has a wetland indicator status of FACW and more often grows in wet soil as opposed to within standing water. An estimated 100+ wood frog tadpoles were observed but the pool likely contained more given that the herbaceous vegetation impaired the ability to observe some portions of the pool. From the 100s of wood frog tadpoles observed, it is estimated that there were at least 5 wood frog egg masses deposited within the vernal pool. Table 2 summarizes obligate indicators observed within each vernal pool.

While VP-1 does contain a permanent culverted outlet, it is a restricted outlet in that the culvert is perched above the ground by approximately 12-inches, which allows for the presence of standing water. Based on the depth of the pool, and the presence of a mix of OBL and FACW species, it is not clear if the pool completely dries out on an annual basis. Given the strong presence of OBL plant species, it appears likely that the pool may occasionally dry down completely, but likely experiences only partial drying during most years (i.e., semi-permanent).

Table 2 Obligate Vernal Pool Species Indicators and Observations

Cryptic VP ID	Wood Frog Egg Masses*	Total Egg Mass Count	Wood Frog Larvae**	Other amphibians
VP 1	0	0	100-200	-

Notes:

**** The VP assessment was conducted at a time when the wood frogs egg masses were hatched and no longer present or visible for observation.***

***** The overall amount of wood frog larvae is estimated.***

Terrestrial Vernal Pool Habitat

Figure 2 shows 100-foot "vernal pool envelope" and 750-feet "critical upland habitat" surrounding vernal pool breeding area. GIS aerial imagery were used to determine the land uses surrounding the breeding areas and GIS analysis were used to quantify potential habitat areas within 750 feet of the pool. Table 3 presents land use percentages for each habitat zone. Overall, suitable terrestrial habitat is somewhat limited.

Upland forest totals are only 28 percent of the 100-foot vernal pool envelope. Although, substantial portions of the vernal envelope are "undeveloped", there is a limited amount of actual suitable/preferred upland habitat; the surrounding cover includes palustrine forest (hydric marginal/ non-habitat), agricultural field (corn field, i.e., non-habitat), impervious surfaces and developed residential areas.

While upland forest totals 43 percent of the 750-foot critical upland habitat for the identified breeding area, much of that forested area is separated from the vernal pool by Mill Road,and developed residential property to the west and agricultural fields to the east and southeast.

The observation of over 100 wood frog tadpoles within Wetland 1, coupled with the surrounding non-exemplary terrestrial habitat appears to indicate habitat suitable for more edge or generalist species. For example, wood frogs have been known to breed in tire ruts that are not vernal pools but can pond water during the breeding season. The regularly plowed agricultural fields do not offer suitable habitat for wood frogs. It is therefore expected that actual habitat use is presumed to be limited to the drier areas of Wetland 1, a narrow strip of upland forest along the eastern side of Wetland 1, the forested area north of Wetland 1, and upland forested areas located across the agricultural field to the southwest and northeast of Wetland 1.

The attached Vernal Pool Assessment Sheet (Calhoun and Klemens 2002) present biological values, habitat conditions, and tier rankings for VP 1. Table 4 below, lists square footage for the breeding area and summarizes vernal pool criteria for VP 1 and tier rankings according to the Calhoun and Klemens (2002) Vernal Pool Assessment Sheet. Based on the sheet, VP 1 is a Tier III breeding area.

Conclusions

During April 2022, VHB identified one (1) vernal pool on the Site, which occupies less than a quarter acre (10,565 square feet) and:

- was documented as providing breeding habitat for one obligate vernal pool species,
- appeared to exhibit suitable hydrology for full larval development and metamorphosis of obligate vernal pool-breeding species,
- lacked a permanent stream outlet, in that the current outlet is restricted (i.e., perched above the ground), which allows for the ponding of water within Wetland 1,
- does not contain fish, and
- appears to partially dry down each year.

The land uses surrounding Wetland 1 indicate that the Site and surrounding areas do not provide exemplary habitat for obligate vernal pool species. Actual habitat use is presumed to be limited to the drier areas of Wetland 1, a narrow strip of upland forest along the eastern side of Wetland 1, the forested area north of Wetland 1, and upland forest located across the farm field to the southwest of Wetland 1.

Table 3 Upland Vernal Pool Habitat Percentages

Habitat Zone	Development Category	VP 1
Vernal Pool Envelope (0-100 ft)	Mixed Forest (upland)	28%
	Palustrine Forested Wetland	28%
	Developed Open Space (Residential)	17%
	Cultivated Land (active agriculture)	15%
	Impervious Surfaces (roadways)	12%
Critical Terrestrial Habitat (100-750 ft)	Mixed Forest (upland)	43%
	Developed Open Space (Residential)	20%
	Cultivated Land (active agriculture)	17%
	Impervious Surfaces (roadways)	13%
	Palustrine Forested Wetland	4%
	Bare Land	1%
	Scrub Shrub	1%
	Open Water	<1%
	Palustrine Aquatic Bed	<1%

Table 4 Summary of Onsite Vernal Pool Indicators

Pool ID	Approximate Breeding Area (Ft^2)	Permanent Outlet *	Hydrology	Obligate Species	Fish Present	Vernal Pool Classification	Tier Rating**
VP 1	10,565	restricted outlet	temporary	wood frog	no	cryptic	III

Notes:

** There is a permanent 12-inch culvert located at the southern end of the vernal pool, however, it is perched about 12-inches above the ground level, which allows for the continued presence of standing water.*

***Tier ratings determined via completing Vernal Pool Assessment Sheets (Calhoun and Klemens 2002), however, Tier ratings do not accurately reflect habitat conditions (see Terrestrial Vernal Pool Habitat Section).*

References:

Calhoun, A. J. K. and M. W. Klemens. 2002. Best development practices: Conserving pool-breeding amphibians in residential and commercial developments in the northeastern United States. MCA Technical Paper No. 5, Metropolitan Conservation Alliance, Wildlife Conservation Society, Bronx, New York.

Connecticut Association of Wetland Scientists (CAWS). 2020. Vernal Pool Monitoring webpage: http://www.ctwetlands.org/vpmonitoring.html; last accessed 4/23/2020.

Connecticut Department of Energy and Environmental Protection (CT DEEP). 2020. Vernal Pools webpage: https://portal.ct.gov/DEEP/Water/Wetlands/Vernal-Pools; last accessed 4/23/2020.

Donahue, D. F. 1996. A guide to the identification and protection of vernal pool wetlands in Connecticut. University of Connecticut Cooperative Extension Program.

Klemens, M. W. 1993. Amphibians and reptiles of Connecticut and adjacent regions. State Geological and Natural History Survey of Connecticut, Bulletin No. 112, Connecticut Department of Environmental Protection, Hartford, CT.

Figures

Figure 1 Site Locus
Figure 2 Vernal Pool Habitat Assessment Map

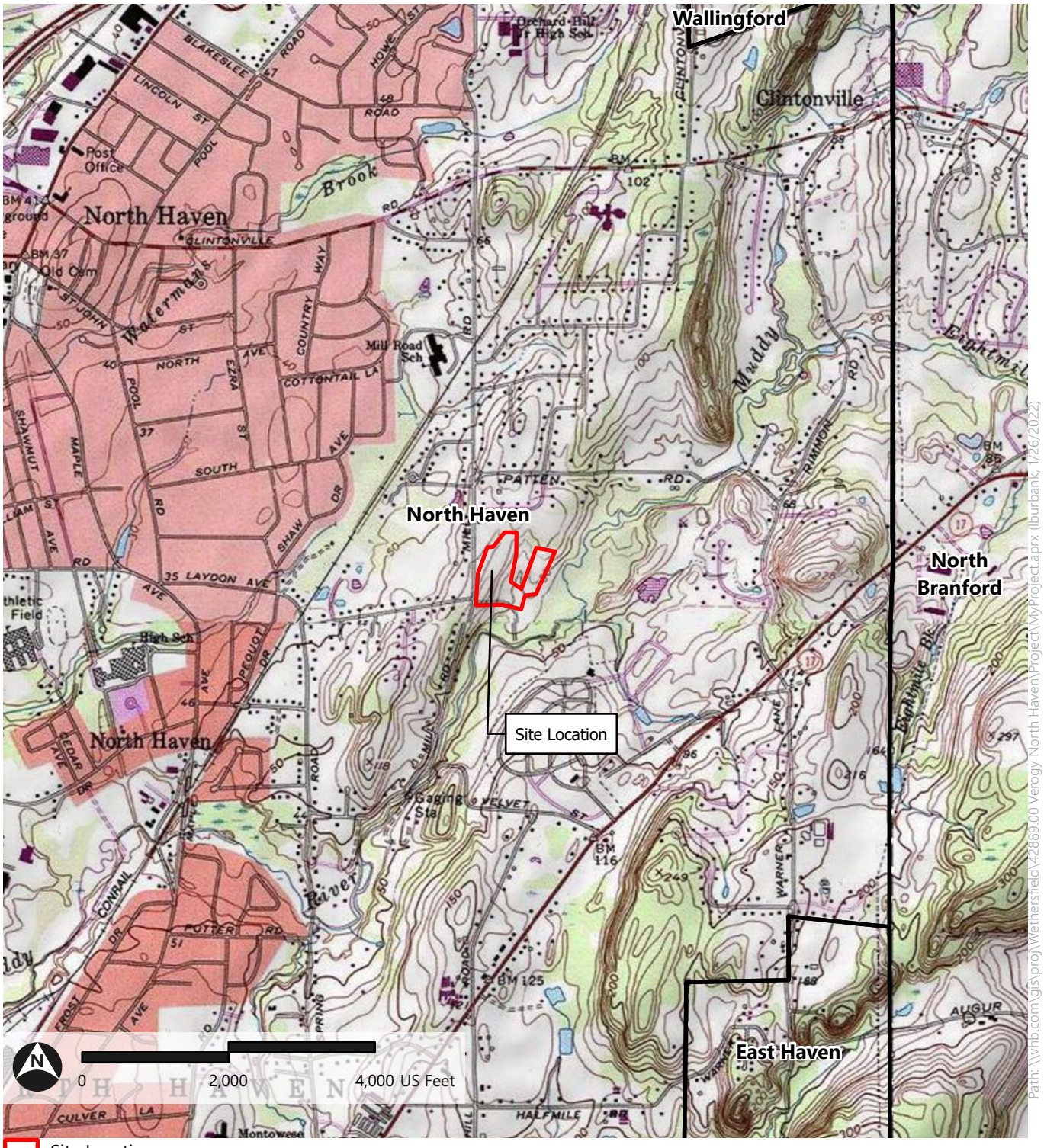
Attachments

Attachment 1 Vernal Pool Evaluation Photographs
Attachment 2 Vernal Pool Assessment Sheet (Calhoun and Klemens 2002)

2022 Vernal Pool Investigation
700 Middletown Avenue, North Haven, CT

Figure 1 Site Locus

Figure 1: USGS Map
Verogy North Haven | North Haven, CT



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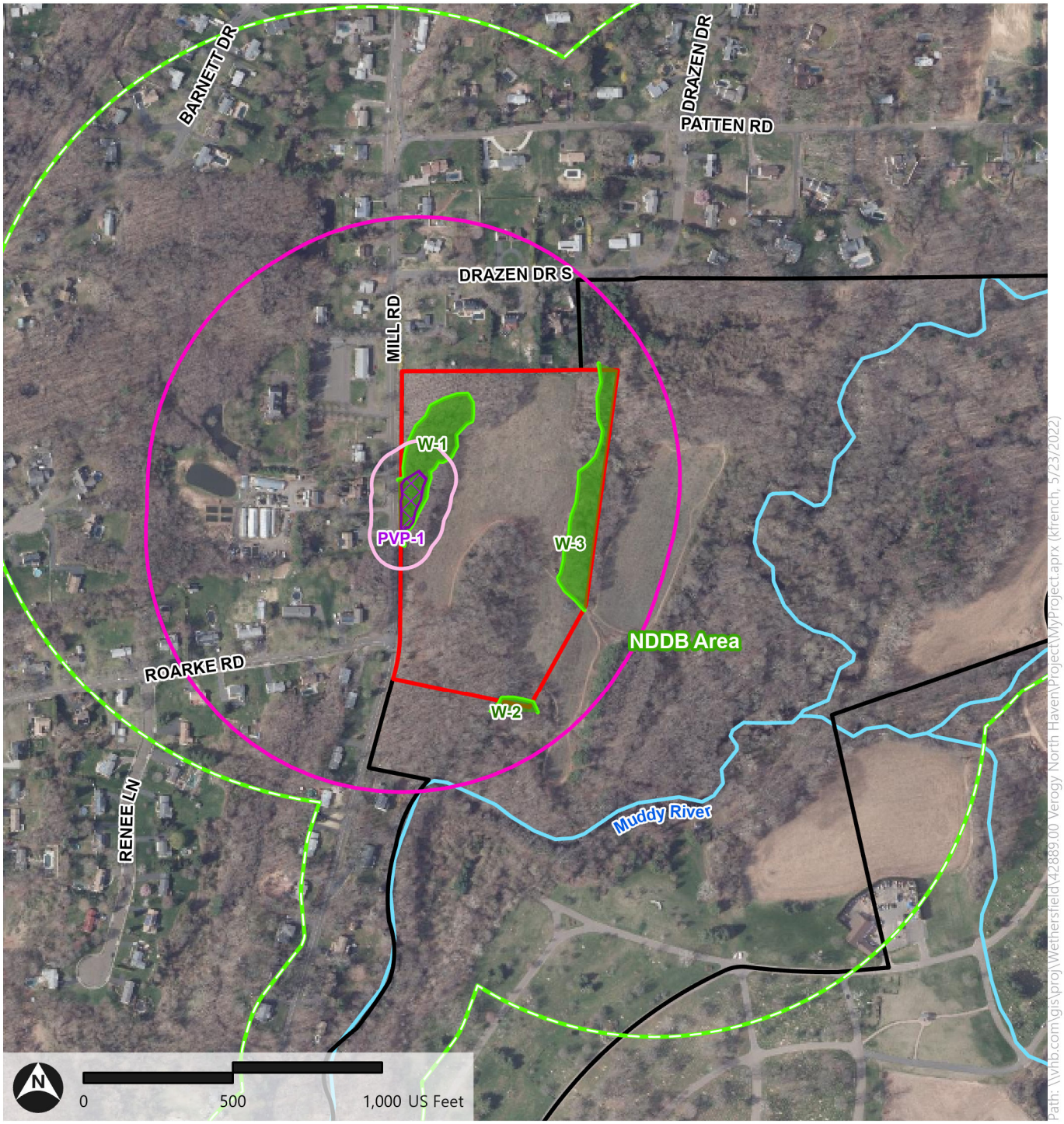
Source: USGS

Figure 2

Vernal Pool Habitat Assessment Map

Figure 2: Vernal Pool Habitat Assessment Map

Verogy North Haven | North Haven, CT



Source: VHB, ArcGIS Online

Attachment 1

Vernal Pool Evaluation Photographs

vhb Engineers | Scientists | Planners | Designers

PHOTOGRAPHIC LOG

Client Name:	**Site Location:** 700 Middletown Avenue, North Haven, CT	**Project No**: 42889.00

Photo No.: 1 **Date:** 12/23/21

Description:

View facing southwest of PVP-1, located within Wetland 1. Mill Road and residential properties in background of photo, located within the 100-foot vernal pool envelope (100-ft. VPE) and 750-foot critical terrrestrial habitat zone (750-ft. CTHZ).

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PHOTOGRAPHIC LOG

Client Name: North Haven Solar One	**Site Location:** 700 Middletown Avenue, North Haven, CT	**Project No**: 42889.00

Photo No.: 2 **Date:** 12/23/21

Description:

View facing northwest of PVP-1, located within Wetland 1. Mill Road and residential properties in the background, located within the 100-ft. VPE750-ft. CTHZ.

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PHOTOGRAPHIC LOG

Client Name: North Haven Solar One	**Site Location:** 700 Middletown Avenue, North Haven, CT	**Project No**: 42889.00

Photo No.: 3 **Date:** 04/20/22

Description:
View facing north from within VP-1.

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PHOTOGRAPHIC LOG

Client Name: North Haven Solar One	**Site Location:** 700 Middletown Avenue, North Haven, CT	**Project No**: 42889.00

Photo No.: 4 **Date:** 04/20/22

Description:
View facing southwest from within VP-1 with Mill Road in background.

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PHOTOGRAPHIC LOG

Client Name: North Haven Solar One | **Site Location:** 700 Middletown Avenue, North Haven, CT | **Project No**: 42889.00

Photo No.: 5 | **Date:** 12/23/21

Description:

View facing southwest of the restricted permanent outlet located at the far southwestern corner of Wetland 1 and VP-1, which flows under Mill Road to the west.

The corrugated metal outlet pipe is perched above the current water level.

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PHOTOGRAPHIC LOG

Client Name: North Haven Solar One | **Site Location:** 700 Middletown Avenue, North Haven, CT | **Project No**: 42889.00

Photo No.: 6 | **Date:** 04/20/22

Description:

Wood frog tadpole found in VP-1, which is an obligate vernal pool species.

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PHOTOGRAPHIC LOG

Client Name: North Haven Solar One | **Site Location:** 700 Middletown Avenue, North Haven, CT | **Project No**: 42889.00

Photo No.: 7 | **Date:** 12/23/21

Description:

View facing southwest from within Wetland 1 inside the 100-ft. VPE, located north of VP-1.

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PHOTOGRAPHIC LOG

Client Name: North Haven Solar One | **Site Location:** 700 Middletown Avenue, North Haven, CT | **Project No**: 42889.00

Photo No.: 8 | **Date:** 12/23/21

Description:

View facing north from within Wetland 1 at the approximately boundary of the 100-ft. VPE. The 750-ft. CTHZ is in the background.

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PHOTOGRAPHIC LOG

Client Name: North Haven Solar One | **Site Location:** 700 Middletown Avenue, North Haven, CT | **Project No**: 42889.00

Photo No.: 9 | **Date:** 12/23/21

Description:

View facing east from within Wetland 1, located within the 100-ft. VPE north of VP-1. Agricultural field in background.

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PHOTOGRAPHIC LOG

Client Name: North Haven Solar One | **Site Location:** 700 Middletown Avenue, North Haven, CT | **Project No**: 42889.00

Photo No.: 10 | **Date:** 12/23/21

Description:

View facing north from within the agricultural field located eeast of VP-1, which is within the 750-ft. CTHZ.

Attachment 2

Vernal Pool Assessment Sheet

(Calhoun and Klemens 2002)

VERNAL POOL ASSESSMENT SHEET

A. Biological Value of the Vernal Pool

(1) Are there *any* state-listed species (Endangered, Threatened, or Special Concern) present or breeding in the pool?
Yes_____ No__X__

(2) Are there two or more vernal pool indicator species breeding (i.e., evidence of egg masses, spermatophores [sperm packets], mating, larvae) in the pool?
Yes_____ No__X__

(3) Are there 25 or more egg masses (regardless of species) present in the pool by the conclusion of the breeding season?
Yes_____ No__X__

B. Condition of the Critical Terrestrial Habitat

(1) Is at least 75% of the vernal pool envelope (100 feet from pool) undeveloped?
Yes_____ No__X__

(2) Is at least 50% of the critical terrestrial habitat (100-750 feet) undeveloped?
Yes__X__ No_____

NOTE: For these purposes, "undeveloped" means open land largely free of roads, structures, and other infrastructure. It can be forested, partially forested, or open agricultural land.

Cumulative Assessment

Number of questions answered YES in category A	Number of questions answered YES in category B	Tier Rating
1-3	2	Tier I
1-3	1	Tier II
0	1-2	Tier III
1-3	0	Tier III

CAUTION! *This rating system is designed strictly as a planning tool, not as an official assessment tool.* It will enable you to determine the relative ecological value of pools within your community. A Tier I rating—which will most likely apply to only a minority of sites—denotes exemplary pools; Management Recommendations should be applied at these sites. For pools rated as Tier II, proceed with care; you need more information! Tier II pools will probably constitute the majority of your vernal pool resources; Management Recommendations should be applied at these sites to the maximum extent practicable. Tier II pools might also be likely candidates for restoration efforts (e.g., reforestation of the critical terrestrial habitat).