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Exhibit D

Stormwater Engineering Concept Report

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Stormwater Engineering Concept Report

Pawcatuck Solar Center

Ella Wheeler Road
North Stonington, CT 06359

Prepared For:

CORONAL ENERGY™
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Prepared By:

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Revision	Date	Description
-	March 6, 2018	CT Siting Council

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Introduction:

The purpose of this design concept report is to demonstrate compliance intent with stormwater management requirements for the Pawcatuck Solar Center development.

The Pawcatuck Solar Center Project is located off Ella Wheeler Road in North Stonington within the County of New London in the State of Connecticut. This is approximately 3 miles north of the Town of Westerly, Rhode Island. The project will consist of installing solar panels on steel pile foundations, electrical equipment pads, and gravel access roads over the project site. The entire site will be surrounded by a barbed wire topped chainlink fence. This report presents project design concepts and stormwater treatment practices to satisfy the stormwater quality and quantity requirements for post-development and construction phases.

The project area existing conditions is primarily row crops and forested areas. Within the project area, wetlands, a vernal pool, and a spadefoot toad population and associated habitat have been identified by the project environmental consultant. In addition, the entire project discharges stormwater runoff to the Pawcatuck River, which is listed as a 305 impaired stream. To build the project 27% of the total parcel area will need to be cleared of trees and environmental items listed above are planned to be protected and mitigated.

The Connecticut Department of Energy and Environmental Protection (CT DEEP) stormwater regulations require site planning that strives to preserve pre-development hydrologic conditions. Pre-development runoff volume and rate, groundwater recharge, stream baseflow, and runoff water quality are primary areas the CT DEEP design methodology addresses. Concepts such as designing the development to fit the terrain, limiting land disturbance activities, providing setbacks and vegetated buffers, and maintaining pre-development vegetation shall be utilized to the maximum extent practicable to preserve pre-development hydrologic conditions. Utilizing sizing criterion, and design concepts identified within this report, the projects watersheds are analyzed hydrologically in order to provide preliminary site stormwater management design including permanent stormwater management facilities to meet CT DEEP requirements.

Methodology and Criteria:

The methodology for analyzing the onsite stormwater for this project will be in conformance with the referenced documents listed on page 4 of this report, and involve analysis of the hydrology for the pre- and post-development conditions. The Data generated will be used to size stormwater management features onsite in order to meet CT DEEP requirements.

Watershed delineations are based on CT DEEP 2016 Lidar topography data and constraints provided by All Points Technology and the rest of the Coronal Energy Team. These watersheds depict the tributary areas with points of analysis typically located at outfall locations. This is done for pre-development and post-development conditions. Hydrologic data is based on NOAA Atlas 14 for 2, 10, 25, and 100-year, 24-hour storms. The United States Department of Agriculture (USDA) TR-55, Urban Hydrology for Small Watersheds method is utilized for the watershed analysis. A variety of factors such as land cover, rainfall, time of concentration, and drainage area are taken into consideration for the existing and post- development conditions to determine the projects hydrology to yield peak design discharges and hydrographs of the various storm frequencies at the project concentration points and outfalls. A HEC-HMS model was created utilizing the TR-55 outputs to develop hydrographs and analyze storm routing through the basin, determine detention volumes and outlet sizing.

Utilizing the data and referenced methodologies the stormwater treatment and stormwater conveyance facilities throughout the project will be preliminarily identified in this report and preliminary plans with final stormwater management facilities incorporated into the developments of the final design drawings. Design criteria from the 2004 Connecticut Stormwater Quality Manual will be adhered to as described below:

- **Water Quality Volume (WQV)** will be minimal for this project due to minimal impervious cover onsite and infrequent travel along the access roads onsite. Meadow grass cover planted onsite should offset any pollutant removal required.

- Storage onsite will have capacity to retain the **Groundwater Recharge Volume (GRV)** to the maximum extent practicable.

- **Stream Channel Protection** does not apply to the project because the impervious cover is less than one-acre.

- Onsite drainage **Conveyance Protection** for passing the 10-year, 24-hour storm will be satisfied.

- **Peak Runoff Attenuation** will be satisfied by controlling the post-development 10, 25, and 100-year 24-hour storm peak discharge rates from exceeding the pre-development peak discharge rates.

- **Emergency Outlet Sizing** to safely convey the 100-year, 24-hour storm event will be incorporated as required.

Analysis:

Peak Flow Comparison & Stormwater Engineering Design Intent

The included calculations provide a preliminary analysis of the pre-development conditions and post-development conditions including peak flows for the 2, 10, 25, and 100-year frequency storm events. Grading intent and goal is to mimic existing conditions with the same drainage areas for pre and post-development flow calculations. The preliminary grading design indicates minimal grade changes required to install the tracker system across the majority of the site. Changes in peak flow for the post-construction are the result to changes in the weighted curve numbers to represent final conditions.

CT DEEP unified stormwater sizing criteria with permanent extended detention at the lower end of the drainage basins will be implemented on the eastern side of the Northeast Site Location in order to meet Groundwater Recharge Volume, and Peak Runoff attenuation requirements. The rest of the drainage areas onsite meet Peak Runoff attenuation requirements because the existing condition cover type is row crops, and the proposed cover condition is meadow that has a lower curve number. See weighted runoff curve number tables in calculations.

Watershed ID	Peak Discharge Pre-Construction (cfs)				Peak Discharge Post-Construction (cfs) (Prior to Addition of Stormwater Management Facilities)				Peak Discharge Post-Construction (cfs) (with Stormwater Management Facilities)			
	2yr	10yr	25yr	100yr	2yr	10yr	25yr	100yr	2yr	10yr	25yr	100yr
North East Area												
NE1	1	6	9	15	2	8	13	21	0	2	6	15
NE2	3	14	23	39	6	21	33	54	2	9	13	39
NE3	1	7	11	18	3	10	15	25	0	2	5	17
NE4	0	2	3	5	1	3	5	7	0	1	3	5
NE5	1	4	7	12	2	6	10	16	0	2	6	12
North West Area												
NW1	2	3	4	5	1	2	2	3	N/A			
NW2	2	3	4	5	1	2	2	3	N/A			
NW3	2	3	4	5	1	2	2	3	N/A			
NW4	2	3	4	5	1	2	2	3	N/A			
NW5	2	3	4	5	1	2	2	4	N/A			
NW6	2	3	4	5	1	2	2	4	N/A			
NW7	7	13	16	22	3	7	10	14	N/A			
NW8	7	13	17	23	3	7	10	15	N/A			
NW9	7	13	17	23	3	7	10	15	N/A			
NW10	0	1	1	1	0	0	1	1	N/A			
NW11	1	2	3	4	1	1	2	2	N/A			
NW12	1	2	3	4	1	1	2	2	N/A			
NW13	5	9	12	16	2	5	7	10	N/A			
NW14	7	12	16	21	3	7	9	14	N/A			
NW15	2	3	4	5	1	2	2	3	N/A			
South Area												
S1	1	2	3	4	0	1	1	2	N/A			
S2	1	2	2	4	0	1	1	2	N/A			
S3	1	2	2	4	0	1	1	2	N/A			
S4	3	6	9	12	1	3	5	7	N/A			
S5	0	1	2	3	0	1	1	2	N/A			
S6	0	1	2	3	0	1	1	2	N/A			
S7	5	10	13	19	1	4	6	10	N/A			
S8	1	3	4	5	0	1	1	2	N/A			
S9	1	2	3	4	0	1	1	2	N/A			
S10	8	18	25	36	2	9	14	22	N/A			
S11	6	13	17	24	1	5	8	12	N/A			
S12	6	12	17	23	1	5	7	12	N/A			
S13	9	19	26	38	2	8	12	20	N/A			
S14	0	1	1	2	0	1	1	2	N/A			
S15	0	1	1	2	0	1	1	2	N/A			
S16	5	11	15	21	1	4	7	11	N/A			

Summary of Sizing Criteria and Proposed Treatment Practices

The table below is a summary of the drainage areas requiring stormwater management utilizing the CT DEEP unified stormwater sizing criteria. Max Conveyance Protection and Max Peak Runoff peak flows were evaluated to determine storage required to attenuate watershed outflows to below pre-development conditions. The peak flow attenuation shown for the 10-year, 25-year, and 100-year storms are indicative if storage alone is utilized to mitigate the peak flow. Where downstream retention is proposed to meet the design requirements, each basin has been sized with an outlet structure capable of controlling and safely conveying the 100-yr, 24-hr peak flow. It has been determined a 20ft long broad crested weir located 1 foot from the top of the basin on each of the basins should be sufficient to safely pass the 100-year, 24-hr peak flow. A single 12 or 18 inch diameter corrugated metal pipe riser culvert is proposed in each of the basins to pass the lower frequency storm events.

The Northeast Site Location will require permanent detention basins due to the significant increases in peak flow post-development in these areas. Upstream treatment facilities may be incorporated into the final design of these areas, which may decrease the ultimate size of the detention basins.

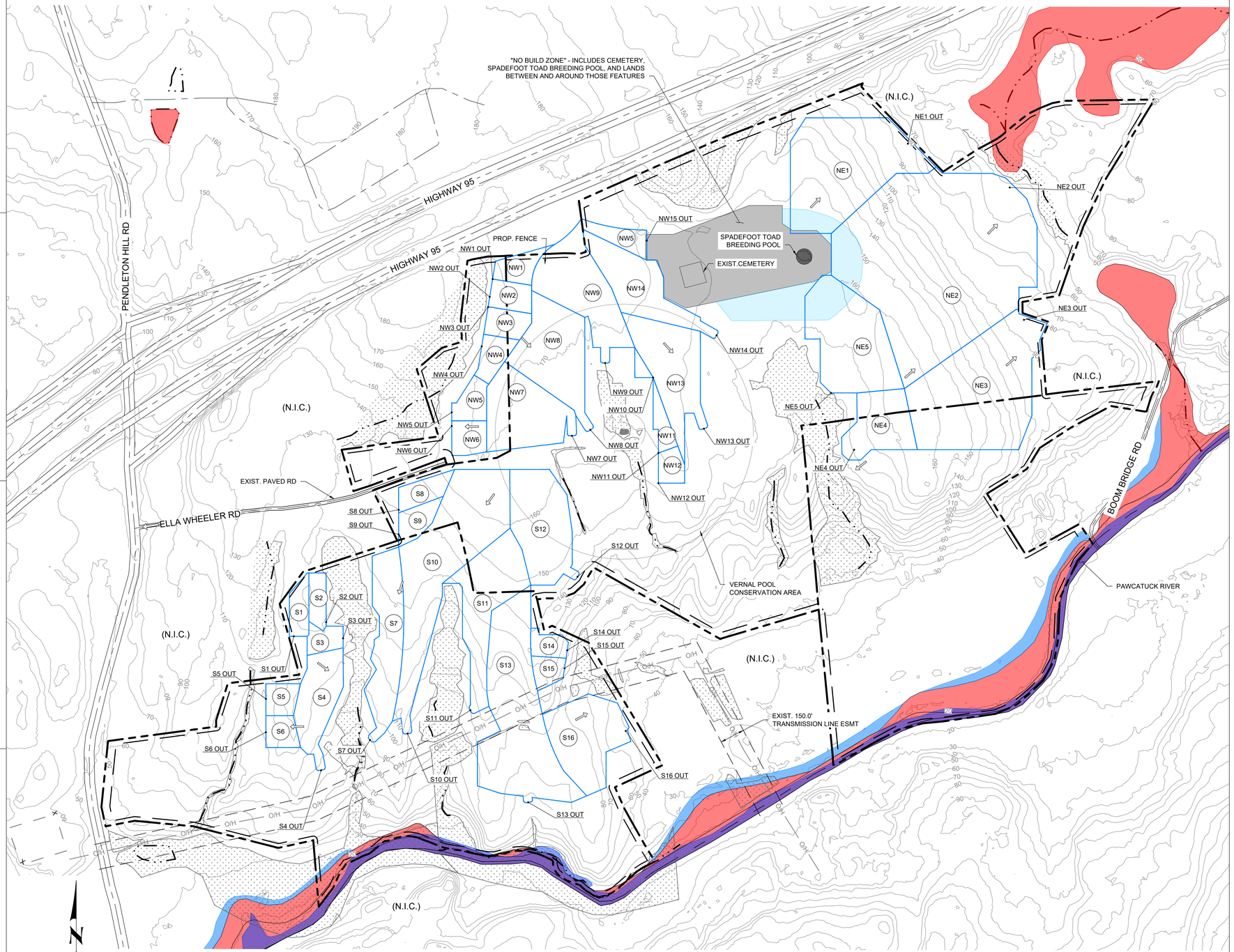
Basin Sizing Summary								
Watershed ID	Max Conveyance Protection (cfs) 10yr		Max Peak Runoff (cfs) 25yr		Max Peak Runoff (cfs) 100yr		Permanent Storage (cy)	Proposed Primary Treatment Practice
	Pre	Post	Pre	Post	Pre	Post		
NE1	6	2	9	6	15	15	**990**	**Basin**
NE2	14	9	23	13	39	39	**2250**	**Basin**
NE3	7	2	11	5	18	17	**1250**	**Basin**
NE4	2	1	3	3	5	5	**330**	**Basin**
NE5	4	2	7	6	12	12	**720**	**Basin**

Conclusion

The project stormwater engineering design intent is to mimic existing conditions of the historic drainage patterns as much as possible and to limit environmental impact to wetlands, streams, and habitat. Post-Construction a native seed mix will be installed and once stabilized temporary erosion and sediment control structures will be removed. Sediment Basins located on the Northeast Site Location will be converted into permanent structures to provide peak flow attenuation post-development per these calculations. Per this hydrology analysis, the rest of the project post construction conditions will have no need for permanent stormwater controls due to natural attenuation caused by changing the existing cover type from row crops to a meadow condition of the proposed solar farm.

References:

- *2000 Connecticut DOT Drainage Manual*
- *2004 Connecticut Stormwater Quality Manual*



LEGEND

- PROPERTY LINE
- SETBACK
- STREAM
- WETLAND DELINEATION BY ALL POINTS TECHNOLOGY
- EXIST. MAJOR CONTOUR
- NO BUILD ZONE
- WIDE ARRAY SPACING ZONE
- EXIST. PAVED ROAD
- 100-YR FLOODPLAIN
- EXIST. TRANSMISSION LINE
- EXIST. TRANSMISSION LINE ESMT
- DIRECTION OF STORM RUNOFF
- PROP. MAJOR CONTOUR
- WATERSHED AREA BOUNDARY
- OUTFALL LOCATION
- WATERSHED AREA ID

PRE-CONTRUCTION WATERSHED

SITE LOCATION	ID	AREA (AC)	CN	Tc (hr)
NORTHEAST	NE1	8.80	55	0.35
	NE2	24.10	55	0.43
	NE3	10.60	55	0.38
	NE4	2.90	55	0.28
	NE5	6.70	55	0.34
NORTHWEST	NW1	0.99	85	0.24
	NW2	0.98	85	0.23
	NW3	0.98	85	0.22
	NW4	0.98	85	0.21
	NW5	0.98	85	0.20
	NW6	0.98	85	0.21
	NW7	4.55	85	0.31
	NW8	4.99	85	0.35
	NW9	4.99	85	0.35
	NW10	0.23	85	0.17
	NW11	0.69	85	0.19
	NW12	0.70	85	0.21
	NW13	4.63	85	0.36
	NW14	4.00	85	0.43
	NW15	0.97	85	0.25
SOUTH	S1	0.87	78	0.16
	S2	0.76	76	0.16
	S3	0.74	76	0.14
	S4	3.01	72	0.17
	S5	0.82	60	0.11
	S6	0.82	60	0.11
	S7	4.18	76	0.18
	S8	1.00	78	0.16
	S9	1.00	73	0.16
	S10	9.60	71	0.21
	S11	5.00	78	0.18
	S12	4.95	78	0.21
	S13	9.53	75	0.27
	S14	0.71	60	0.10
	S15	0.72	60	0.10
	S16	4.53	76	0.16

Know what's **below.** **Call** before you dig.

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-	03.29.18	JT	CT SITING COUNCIL
	04/06/2018	PRINTED	

PROJECT:
PAWCATUCK SOLAR CENTER
ELLA WHEELER ROAD
NORTH STONINGTON, CT 06359

DRAWING TITLE:
PRE-CONSTRUCTION WATERSHED PLAN

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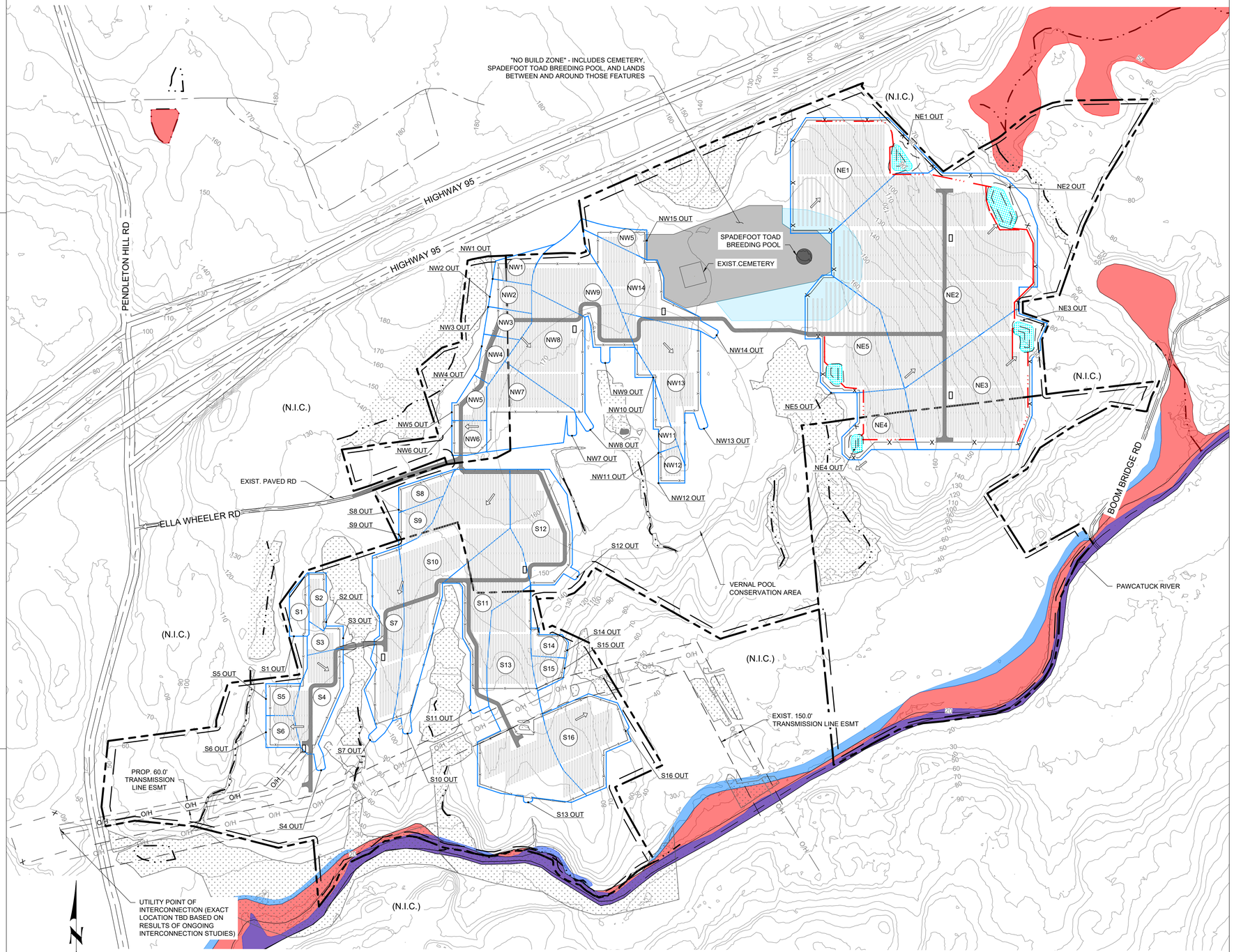

LEGEND

- PROPERTY LINE
- SETBACK
- STREAM
- WETLAND DELINEATION BY ALL POINTS TECHNOLOGY
- EXIST. MAJOR CONTOUR
- NO BUILD ZONE
- WIDE ARRAY SPACING ZONE
- EXIST. PAVED ROAD
- 100-YR FLOODPLAIN
- EXIST. TRANSMISSION LINE
- EXIST. TRANSMISSION LINE ESMT
- PROP. SOLAR TRACKER
- PROP. ACCESS ROAD
- PROP. FENCE
- PROP. SWALE
- DIRECTION OF STORM RUNOFF
- WATERSHED AREA BOUNDARY
- XXX OUT — OUTFALL LOCATION
- XXX — WATERSHED AREA ID

POST-CONSTRUCTION WATERSHED

SITE LOCATION	ID	AREA (AC)	CN	Tc (hr)
NORTHEAST	NE1	8.80	59	0.24
	NE2	24.10	59	0.30
	NE3	10.60	59	0.27
	NE4	2.90	59	0.19
	NE5	6.70	59	0.23
NORTHWEST	NW1	0.99	72	0.31
	NW2	0.98	72	0.30
	NW3	0.98	72	0.28
	NW4	0.98	72	0.27
	NW5	0.98	72	0.26
	NW6	0.98	72	0.27
	NW7	4.55	72	0.41
	NW8	4.99	72	0.46
	NW9	4.99	72	0.46
	NW10	0.23	72	0.23
	NW11	0.69	72	0.25
	NW12	0.70	72	0.27
	NW13	4.63	72	0.47
	NW14	4.00	72	0.55
	NW15	0.97	72	0.32
SOUTH	S1	0.87	59	0.21
	S2	0.76	59	0.21
	S3	0.74	59	0.18
	S4	3.01	59	0.22
	S5	0.82	59	0.15
	S6	0.82	59	0.22
	S7	4.18	59	0.29
	S8	1.00	59	0.21
	S9	1.00	59	0.20
	S10	9.60	59	0.27
	S11	5.00	59	0.23
	S12	4.95	59	0.27
	S13	9.53	59	0.34
	S14	0.71	59	0.13
	S15	0.72	59	0.13
	S16	4.53	59	0.21

Know what's **below.** **Call** before you dig.

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CHK'D: JB
P.M.: KLB
PROJECT #: CORI 16.005
FILE NAME: C801.dwg
DATE: 03.29.18 BY: JT
PRINTED: 04/06/2018

-	CT SITING COUNCIL	03.29.18	JT
	DESCRIPTION:	DATE:	BY:

PROJECT:
PAWCATUCK SOLAR CENTER
ELLA WHEELER ROAD
NORTH STONINGTON, CT 06359

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TR-55 Runoff Curve Number Pre-Construction Condition

Project: Pawcatuck

Engineer: Lukas Klavins

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1. CN are per table 2-2a, 2-2b, 2-2c, and 2-23 from TR-55
2. Hydrologic Soil Group determinations are from USDA Web Soil Survey
3. Drainage Area Determined from watershed delineations located on the plans

Runoff Curve Number Pre-Construction Condition													
Watershed ID	HSG (%)				% Total Area					Weighted CN	Drainage Area (ft^2)	Drainage Area (mi^2)	S
	A	B	C	D	Woods	Meadow	Impervious	Row Crop	Gravel Road				
CN HSG A					30	30	98	67	76				
CN HSG B					55	58	98	78	85				
CN HSG C					70	71	98	85	89				
CN HSG D					77	78	98	89	91				
North East Area													
NE1	0	100	0	0	100	0	0	0	0	55	383328	0.01375	8.18
NE2	0	100	0	0	85	15	0	0	0	55	1049796	0.03766	8.18
NE3	0	100	0	0	100	0	0	0	0	55	461736	0.01656	8.18
NE4	0	100	0	0	100	0	0	0	0	55	126324	0.00453	8.18
NE5	0	100	0	0	100	0	0	0	0	55	291852	0.01047	8.18
North West Area													
NW1	0	0	100	0	0	0	0	100	0	85	43124	0.00155	1.76
NW2	0	0	100	0	0	0	0	100	0	85	42689	0.00153	1.76
NW3	0	0	100	0	0	0	0	100	0	85	42689	0.00153	1.76
NW4	0	0	100	0	0	0	0	100	0	85	42689	0.00153	1.76
NW5	0	0	100	0	0	0	0	100	0	85	42689	0.00153	1.76
NW6	0	0	100	0	0	0	0	100	0	85	42689	0.00153	1.76
NW7	0	0	100	0	0	0	0	100	0	85	198198	0.00711	1.76
NW8	0	0	100	0	0	0	0	100	0	85	217364	0.00780	1.76
NW9	0	0	100	0	0	0	0	100	0	85	217364	0.00780	1.76
NW10	0	0	100	0	0	0	0	100	0	85	10019	0.00036	1.76
NW11	0	0	100	0	0	0	0	100	0	85	30056	0.00108	1.76
NW12	0	0	100	0	0	0	0	100	0	85	30492	0.00109	1.76
NW13	0	0	100	0	0	0	0	100	0	85	155509	0.00558	1.76
NW14	0	0	100	0	0	0	0	100	0	85	217800	0.00781	1.76
NW15	0	0	100	0	0	0	0	100	0	85	42253	0.00152	1.76
South Area													
S1	0	100	0	0	0	0	0	100	0	78	37897	0.00136	2.82
S2	0	100	0	0	10	0	0	90	0	76	33106	0.00119	3.16
S3	0	100	0	0	10	0	0	90	0	76	32234	0.00116	3.16
S4	0	100	0	0	25	0	0	75	0	72	131116	0.00470	3.89
S5	0	100	0	0	80	0	0	20	0	60	35719	0.00128	6.67
S6	0	100	0	0	80	0	0	20	0	60	35719	0.00128	6.67
S7	0	100	0	0	10	0	0	90	0	76	182081	0.00653	3.16
S8	0	100	0	0	0	0	0	100	0	78	43560	0.00156	2.82
S9	0	100	0	0	20	0	0	80	0	73	43560	0.00156	3.70
S10	0	100	0	0	30	0	0	70	0	71	418176	0.01500	4.08
S11	0	100	0	0	0	0	0	100	0	78	217800	0.00781	2.82
S12	0	100	0	0	0	0	0	100	0	78	215622	0.00773	2.82
S13	0	100	0	0	15	0	0	85	0	75	415127	0.01489	3.33
S14	0	100	0	0	80	0	0	20	0	60	30928	0.00111	6.67
S15	0	100	0	0	80	0	0	20	0	60	31363	0.00112	6.67
S16	0	100	0	0	10	0	0	90	0	76	197327	0.00708	3.16

TR-55 Runoff Pre-Construction Condition

Project: Pawcatuck

Engineer: Lukas Klavins

1. Rainfall data source: NOAA Atlas 14

Runoff Pre-Construction Condition								
Watershed ID	P (in) (24-hour)				Q (in)			
	2yr	10yr	25yr	100yr	2yr	10yr	25yr	100yr
North East Area								
NE1	3.42	5.08	6.11	7.7	0.3	1.0	1.6	2.6
NE2	3.42	5.08	6.11	7.7	0.3	1.0	1.6	2.6
NE3	3.42	5.08	6.11	7.7	0.3	1.0	1.6	2.6
NE4	3.42	5.08	6.11	7.7	0.3	1.0	1.6	2.6
NE5	3.42	5.08	6.11	7.7	0.3	1.0	1.6	2.6
North West Area								
NW1	3.42	5.08	6.11	7.7	1.9	3.4	4.4	5.9
NW2	3.42	5.08	6.11	7.7	1.9	3.4	4.4	5.9
NW3	3.42	5.08	6.11	7.7	1.9	3.4	4.4	5.9
NW4	3.42	5.08	6.11	7.7	1.9	3.4	4.4	5.9
NW5	3.42	5.08	6.11	7.7	1.9	3.4	4.4	5.9
NW6	3.42	5.08	6.11	7.7	1.9	3.4	4.4	5.9
NW7	3.42	5.08	6.11	7.7	1.9	3.4	4.4	5.9
NW8	3.42	5.08	6.11	7.7	1.9	3.4	4.4	5.9
NW9	3.42	5.08	6.11	7.7	1.9	3.4	4.4	5.9
NW10	3.42	5.08	6.11	7.7	1.9	3.4	4.4	5.9
NW11	3.42	5.08	6.11	7.7	1.9	3.4	4.4	5.9
NW12	3.42	5.08	6.11	7.7	1.9	3.4	4.4	5.9
NW13	3.42	5.08	6.11	7.7	1.9	3.4	4.4	5.9
NW14	3.42	5.08	6.11	7.7	1.9	3.4	4.4	5.9
NW15	3.42	5.08	6.11	7.7	1.9	3.4	4.4	5.9
South Area								
S1	3.42	5.08	6.11	7.7	1.44	2.78	3.68	5.11
S2	3.42	5.08	6.11	7.7	1.31	2.60	3.48	4.89
S3	3.42	5.08	6.11	7.7	1.31	2.60	3.48	4.89
S4	3.42	5.08	6.11	7.7	1.07	2.26	3.08	4.43
S5	3.42	5.08	6.11	7.7	0.50	1.35	1.99	3.11
S6	3.42	5.08	6.11	7.7	0.50	1.35	1.99	3.11
S7	3.42	5.08	6.11	7.7	1.31	2.60	3.48	4.89
S8	3.42	5.08	6.11	7.7	1.44	2.78	3.68	5.11
S9	3.42	5.08	6.11	7.7	1.13	2.34	3.18	4.55
S10	3.42	5.08	6.11	7.7	1.01	2.18	2.99	4.32
S11	3.42	5.08	6.11	7.7	1.44	2.78	3.68	5.11
S12	3.42	5.08	6.11	7.7	1.44	2.78	3.68	5.11
S13	3.42	5.08	6.11	7.7	1.25	2.51	3.38	4.77
S14	3.42	5.08	6.11	7.7	0.50	1.35	1.99	3.11
S15	3.42	5.08	6.11	7.7	0.50	1.35	1.99	3.11
S16	3.42	5.08	6.11	7.7	1.31	2.60	3.48	4.89

TR-55 Time of Concentration Pre-Construction Condition

Project: Pawcatuck

Engineer: Lukas Klavins

CORONAL ENERGY powered by Panasonic

Time of Concentration											
Watershed ID	Sheet Flow						Shallow Concentrated				Tc
	Surface Description	Manning's Roughness Coefficient	Flow Length (ft)	2-year, 24-hour rainfall (in)	Land Slope (ft/ft)	Tsf (hrs)	Flow Length (ft)	Land Slope (ft/ft)	Velocity (ft/s)	Tsc (hr)	
North East Area											
NE1	Woods, Light	0.400	100	3.42	0.080	0.20	775	0.080	1.42	0.15	0.35
NE2	Woods, Light	0.400	100	3.42	0.086	0.19	1275	0.086	1.48	0.24	0.43
NE3	Woods, Light	0.400	100	3.42	0.082	0.20	975	0.082	1.44	0.19	0.38
NE4	Woods, Light	0.400	100	3.42	0.075	0.20	400	0.075	1.38	0.08	0.28
NE5	Woods, Light	0.400	100	3.42	0.060	0.22	500	0.060	1.23	0.11	0.34
North West Area											
NW1	Row Crops	0.170	100	3.42	0.020	0.17	300	0.020	1.24	0.07	0.24
NW2	Row Crops	0.170	100	3.42	0.016	0.19	150	0.016	1.11	0.04	0.23
NW3	Row Crops	0.170	100	3.42	0.018	0.18	150	0.018	1.18	0.04	0.22
NW4	Row Crops	0.170	100	3.42	0.020	0.17	150	0.020	1.24	0.03	0.21
NW5	Row Crops	0.170	100	3.42	0.020	0.17	100	0.020	1.24	0.02	0.20
NW6	Row Crops	0.170	100	3.42	0.018	0.18	100	0.018	1.18	0.02	0.21
NW7	Row Crops	0.170	100	3.42	0.017	0.19	525	0.017	1.14	0.13	0.31
NW8	Row Crops	0.170	100	3.42	0.020	0.17	800	0.020	1.24	0.18	0.35
NW9	Row Crops	0.170	100	3.42	0.020	0.17	800	0.020	1.24	0.18	0.35
NW10	Row Crops	0.170	100	3.42	0.020	0.17	0	0.020	1.24	0.00	0.17
NW11	Row Crops	0.170	100	3.42	0.018	0.18	25	0.018	1.18	0.01	0.19
NW12	Row Crops	0.170	100	3.42	0.018	0.18	100	0.018	1.18	0.02	0.21
NW13	Row Crops	0.170	100	3.42	0.015	0.20	650	0.015	1.07	0.17	0.36
NW14	Row Crops	0.170	100	3.42	0.017	0.19	1000	0.017	1.14	0.24	0.43
NW15	Row Crops	0.170	100	3.42	0.020	0.17	325	0.020	1.24	0.07	0.25
South Area											
S1	Row Crops	0.170	100	3.42	0.050	0.12	300	0.050	1.96	0.04	0.16
S2	Row Crops	0.170	100	3.42	0.054	0.12	300	0.054	2.04	0.04	0.16
S3	Row Crops	0.170	100	3.42	0.060	0.11	200	0.060	2.15	0.03	0.14
S4	Row Crops	0.170	100	3.42	0.062	0.11	450	0.062	2.18	0.06	0.17
S5	Row Crops	0.170	100	3.42	0.080	0.10	100	0.080	2.48	0.01	0.11
S6	Row Crops	0.170	100	3.42	0.080	0.10	100	0.080	2.48	0.01	0.11
S7	Row Crops	0.170	100	3.42	0.050	0.12	400	0.050	1.96	0.06	0.18
S8	Row Crops	0.170	100	3.42	0.050	0.12	300	0.050	1.96	0.04	0.16
S9	Row Crops	0.170	100	3.42	0.050	0.12	250	0.050	1.96	0.04	0.16
S10	Row Crops	0.170	100	3.42	0.070	0.11	850	0.070	2.32	0.10	0.21
S11	Row Crops	0.170	100	3.42	0.070	0.11	600	0.070	2.32	0.07	0.18
S12	Row Crops	0.170	100	3.42	0.050	0.12	600	0.050	1.96	0.09	0.21
S13	Row Crops	0.170	100	3.42	0.060	0.11	1200	0.060	2.15	0.16	0.27
S14	Row Crops	0.170	100	3.42	0.120	0.09	150	0.120	3.04	0.01	0.10
S15	Row Crops	0.170	100	3.42	0.110	0.09	150	0.110	2.91	0.01	0.10
S16	Row Crops	0.170	100	3.42	0.060	0.11	350	0.060	2.15	0.05	0.16

TR-55 Graphical Peak Discharge Method Pre-Construction Condition

Project: Pawcatuck

Engineer: Lukas Klavins

CORONAL ENERGY powered by Panasonic

1. Pond and Swamp Fp factor from TR-55 Table 4-2

Graphical Peak Discharge Method														
Data		Initial Abstraction Ia	Compute Ia/P				Unit Peak Discharge, qu (csm/in)				Peak Discharge			
Watershed ID	Rainfall Distribution		2yr	10yr	25yr	100yr	2yr	10yr	25yr	100yr	2yr	10yr	25yr	100yr
North East Area														
NE1	III	1.636	0.48	0.32	0.27	0.21	259	400	417	435	**1.14**	**5.61**	**9.07**	**15.42**
NE2	III	1.636	0.48	0.32	0.27	0.21	242	367	383	400	**2.91**	**14.10**	**22.82**	**38.86**
NE3	III	1.636	0.48	0.32	0.27	0.21	251	385	402	419	**1.33**	**6.51**	**10.53**	**17.92**
NE4	III	1.636	0.48	0.32	0.27	0.21	275	433	450	469	**0.40**	**2.00**	**3.23**	**5.48**
NE5	III	1.636	0.48	0.32	0.27	0.21	262	407	424	441	**0.88**	**4.34**	**7.01**	**11.93**
North West Area														
NW1	III	0.353	0.10	0.07	0.06	0.05	534	555	555	555	**1.61**	**2.96**	**3.78**	**5.09**
NW2	III	0.353	0.10	0.07	0.06	0.05	544	565	565	565	**1.62**	**2.98**	**3.81**	**5.12**
NW3	III	0.353	0.10	0.07	0.06	0.05	552	572	572	572	**1.64**	**3.02**	**3.86**	**5.19**
NW4	III	0.353	0.10	0.07	0.06	0.05	559	579	579	579	**1.67**	**3.05**	**3.91**	**5.26**
NW5	III	0.353	0.10	0.07	0.06	0.05	567	588	588	588	**1.69**	**3.10**	**3.97**	**5.34**
NW6	III	0.353	0.10	0.07	0.06	0.05	561	581	581	581	**1.67**	**3.06**	**3.92**	**5.27**
NW7	III	0.353	0.10	0.07	0.06	0.05	491	511	511	511	**6.79**	**12.50**	**16.01**	**21.52**
NW8	III	0.353	0.10	0.07	0.06	0.05	470	490	490	490	**7.14**	**13.15**	**16.84**	**22.64**
NW9	III	0.353	0.10	0.07	0.06	0.05	470	490	490	490	**7.14**	**13.15**	**16.84**	**22.64**
NW10	III	0.353	0.10	0.07	0.06	0.05	586	607	607	607	**0.41**	**0.75**	**0.96**	**1.29**
NW11	III	0.353	0.10	0.07	0.06	0.05	575	595	595	595	**1.21**	**2.21**	**2.83**	**3.80**
NW12	III	0.353	0.10	0.07	0.06	0.05	561	581	581	581	**1.19**	**2.19**	**2.80**	**3.77**
NW13	III	0.353	0.10	0.07	0.06	0.05	465	485	485	485	**5.05**	**9.31**	**11.92**	**16.03**
NW14	III	0.353	0.10	0.07	0.06	0.05	437	456	456	456	**6.65**	**12.26**	**15.70**	**21.11**
NW15	III	0.353	0.10	0.07	0.06	0.05	531	551	551	551	**1.57**	**2.88**	**3.68**	**4.95**
South Area														
S1	III	0.564	0.16	0.11	0.09	0.07	576	596	616	616	**1.13**	**2.25**	**3.08**	**4.28**
S2	III	0.632	0.18	0.12	0.10	0.08	581	601	601	621	**0.90**	**1.86**	**2.48**	**3.60**
S3	III	0.632	0.18	0.12	0.10	0.08	601	620	620	640	**0.91**	**1.87**	**2.49**	**3.61**
S4	III	0.778	0.23	0.15	0.13	0.10	553	572	592	592	**2.78**	**6.08**	**8.58**	**12.33**
S5	III	1.333	0.39	0.26	0.22	0.17	525	597	614	631	**0.33**	**1.03**	**1.57**	**2.51**
S6	III	1.333	0.39	0.26	0.22	0.17	525	597	614	631	**0.33**	**1.03**	**1.57**	**2.51**
S7	III	0.632	0.18	0.12	0.10	0.08	564	583	583	604	**4.81**	**9.91**	**13.24**	**19.27**
S8	III	0.564	0.16	0.11	0.09	0.07	576	596	616	616	**1.29**	**2.59**	**3.54**	**4.93**
S9	III	0.740	0.22	0.15	0.12	0.10	564	603	603	623	**0.99**	**2.21**	**2.99**	**4.42**
S10	III	0.817	0.24	0.16	0.13	0.11	520	539	559	559	**7.90**	**17.61**	**25.06**	**36.23**
S11	III	0.564	0.16	0.11	0.09	0.07	564	583	604	604	**6.33**	**12.67**	**17.35**	**24.14**
S12	III	0.564	0.16	0.11	0.09	0.07	540	560	581	581	**6.00**	**12.05**	**16.52**	**22.99**
S13	III	0.667	0.19	0.13	0.11	0.09	498	517	517	538	**9.23**	**19.37**	**26.01**	**38.24**
S14	III	1.333	0.39	0.26	0.22	0.17	541	614	630	646	**0.30**	**0.92**	**1.39**	**2.23**
S15	III	1.333	0.39	0.26	0.22	0.17	536	609	625	642	**0.30**	**0.92**	**1.40**	**2.25**
S16	III	0.632	0.18	0.12	0.10	0.08	582	601	601	621	**5.38**	**11.07**	**14.79**	**21.49**

TR-55 Runoff Curve Number Post-Construction Condition

Project: Pawcatuck

Engineer: Lukas Klavins

CORONAL ENERGY™ powered by Panasonic

1. CN are per table 2-2a, 2-2b, 2-2c, and 2-23 from TR-55
2. Hydrologic Soil Group determinations are from USDA Web Soil Survey
3. Drainage Area Determined from watershed delineations located on the plans

Runoff Curve Number Pre-Construction Condition													
Watershed ID	HSG (%)				% Total Area					Weighted CN	Drainage Area (ft^2)	Drainage Area (mi^2)	S
	A	B	C	D	Woods	Meadow	Impervious	Row Crop	Gravel Road				
CN HSG A					30	30	98	67	76				
CN HSG B					55	58	98	78	85				
CN HSG C					70	71	98	85	89				
CN HSG D					77	78	98	89	91				
North East Area													
NE1	0	100	0	0	0	95	1	0	4	59	383328	0.01375	6.95
NE2	0	100	0	0	0	95	1	0	4	59	1049796	0.03766	6.95
NE3	0	100	0	0	0	95	1	0	4	59	461736	0.01656	6.95
NE4	0	100	0	0	0	95	1	0	4	59	126324	0.00453	6.95
NE5	0	100	0	0	0	95	1	0	4	59	291852	0.01047	6.95
North West Area													
NW1	0	0	100	0	0	99	1	0	0	71	43124.4	0.00155	4.08
NW2	0	0	100	0	0	99	1	0	0	71	42688.8	0.00153	4.08
NW3	0	0	100	0	0	95	1	0	4	72	42688.8	0.00153	3.89
NW4	0	0	100	0	0	95	1	0	4	72	42688.8	0.00153	3.89
NW5	0	0	100	0	0	95	1	0	4	72	42688.8	0.00153	3.89
NW6	0	0	100	0	0	95	1	0	4	72	42688.8	0.00153	3.89
NW7	0	0	100	0	0	95	1	0	4	72	198198	0.00711	3.89
NW8	0	0	100	0	0	95	1	0	4	72	217364.4	0.00780	3.89
NW9	0	0	100	0	0	95	1	0	4	72	217364.4	0.00780	3.89
NW10	0	0	100	0	0	99	1	0	0	71	10018.8	0.00036	4.08
NW11	0	0	100	0	0	99	1	0	0	71	30056.4	0.00108	4.08
NW12	0	0	100	0	0	99	1	0	0	71	30492	0.00109	4.08
NW13	0	0	100	0	0	95	1	0	4	72	155509.2	0.00558	3.89
NW14	0	0	100	0	0	95	1	0	4	72	217800	0.00781	3.89
NW15	0	0	100	0	0	99	1	0	0	71	42253.2	0.00152	4.08
South Area													
S1	0	100	0	0	0	99	1	0	0	58	37897.2	0.00136	7.24
S2	0	100	0	0	0	99	1	0	0	58	33105.6	0.00119	7.24
S3	0	100	0	0	0	95	1	0	4	59	32234.4	0.00116	6.95
S4	0	100	0	0	0	95	1	0	4	59	131115.6	0.00470	6.95
S5	0	100	0	0	0	99	1	0	0	58	35719.2	0.00128	7.24
S6	0	100	0	0	0	99	1	0	0	58	35719.2	0.00128	7.24
S7	0	100	0	0	0	95	1	0	4	59	182080.8	0.00653	6.95
S8	0	100	0	0	0	99	1	0	0	58	43560	0.00156	7.24
S9	0	100	0	0	0	99	1	0	0	58	43560	0.00156	7.24
S10	0	100	0	0	0	95	1	0	4	59	418176	0.01500	6.95
S11	0	100	0	0	0	95	1	0	4	59	217800	0.00781	6.95
S12	0	100	0	0	0	95	1	0	4	59	215622	0.00773	6.95
S13	0	100	0	0	0	95	1	0	4	59	415126.8	0.01489	6.95
S14	0	100	0	0	0	99	1	0	0	58	30927.6	0.00111	7.24
S15	0	100	0	0	0	99	1	0	0	58	31363.2	0.00112	7.24
S16	0	100	0	0	0	99	1	0	0	58	197326.8	0.00708	7.24

TR-55 Runoff Post-Construction Condition

Project: Pawcatuck

Engineer: Lukas Klavins

1. Rainfall data source: NOAA Atlas 14

Runoff Post-Construction Condition								
Watershed ID	P (in) (24-hour)				Q (in)			
	2yr	10yr	25yr	100yr	2yr	10yr	25yr	100yr
North East Area								
NE1	3.42	5.08	6.11	7.7	0.5	1.3	1.9	3.0
NE2	3.42	5.08	6.11	7.7	0.5	1.3	1.9	3.0
NE3	3.42	5.08	6.11	7.7	0.5	1.3	1.9	3.0
NE4	3.42	5.08	6.11	7.7	0.5	1.3	1.9	3.0
NE5	3.42	5.08	6.11	7.7	0.5	1.3	1.9	3.0
North West Area								
NW1	3.42	5.08	6.11	7.7	1.0	2.2	3.0	4.3
NW2	3.42	5.08	6.11	7.7	1.0	2.2	3.0	4.3
NW3	3.42	5.08	6.11	7.7	1.1	2.3	3.1	4.4
NW4	3.42	5.08	6.11	7.7	1.1	2.3	3.1	4.4
NW5	3.42	5.08	6.11	7.7	1.1	2.3	3.1	4.4
NW6	3.42	5.08	6.11	7.7	1.1	2.3	3.1	4.4
NW7	3.42	5.08	6.11	7.7	1.1	2.3	3.1	4.4
NW8	3.42	5.08	6.11	7.7	1.1	2.3	3.1	4.4
NW9	3.42	5.08	6.11	7.7	1.1	2.3	3.1	4.4
NW10	3.42	5.08	6.11	7.7	1.0	2.2	3.0	4.3
NW11	3.42	5.08	6.11	7.7	1.0	2.2	3.0	4.3
NW12	3.42	5.08	6.11	7.7	1.0	2.2	3.0	4.3
NW13	3.42	5.08	6.11	7.7	1.1	2.3	3.1	4.4
NW14	3.42	5.08	6.11	7.7	1.1	2.3	3.1	4.4
NW15	3.42	5.08	6.11	7.7	1.0	2.2	3.0	4.3
South Area								
S1	3.42	5.08	6.11	7.7	0.4	1.2	1.8	2.9
S2	3.42	5.08	6.11	7.7	0.4	1.2	1.8	2.9
S3	3.42	5.08	6.11	7.7	0.5	1.3	1.9	3.0
S4	3.42	5.08	6.11	7.7	0.5	1.3	1.9	3.0
S5	3.42	5.08	6.11	7.7	0.4	1.2	1.8	2.9
S6	3.42	5.08	6.11	7.7	0.4	1.2	1.8	2.9
S7	3.42	5.08	6.11	7.7	0.5	1.3	1.9	3.0
S8	3.42	5.08	6.11	7.7	0.4	1.2	1.8	2.9
S9	3.42	5.08	6.11	7.7	0.4	1.2	1.8	2.9
S10	3.42	5.08	6.11	7.7	0.5	1.3	1.9	3.0
S11	3.42	5.08	6.11	7.7	0.5	1.3	1.9	3.0
S12	3.42	5.08	6.11	7.7	0.5	1.3	1.9	3.0
S13	3.42	5.08	6.11	7.7	0.5	1.3	1.9	3.0
S14	3.42	5.08	6.11	7.7	0.4	1.2	1.8	2.9
S15	3.42	5.08	6.11	7.7	0.4	1.2	1.8	2.9
S16	3.42	5.08	6.11	7.7	0.4	1.2	1.8	2.9

TR-55 Time of Concentration Post-Construction Condition

Project: Pawcatuck

Engineer: Lukas Klavins

CORONAL ENERGY powered by Panasonic

Time of Concentration											
Watershed ID	Sheet Flow						Shallow Concentrated				Tc
	Surface Description	Manning's Roughness Coefficient	Flow Length (ft)	2-year, 24-hour rainfall (in)	Land Slope (ft/ft)	Tsf (hrs)	Flow Length (ft)	Land Slope (ft/ft)	Velocity (ft/s)	Tsc (hr)	
North East Area											
NE1	Dense Grass	0.24	100	3.42	0.080	0.13	775	0.080	1.97	0.11	0.24
NE2	Dense Grass	0.24	100	3.42	0.086	0.13	1275	0.086	2.04	0.17	0.30
NE3	Dense Grass	0.24	100	3.42	0.082	0.13	975	0.082	1.99	0.14	0.27
NE4	Dense Grass	0.24	100	3.42	0.075	0.14	400	0.075	1.91	0.06	0.19
NE5	Dense Grass	0.24	100	3.42	0.060	0.15	500	0.060	1.71	0.08	0.23
North West Area											
NW1	Dense Grass	0.24	100	3.42	0.020	0.23	300	0.020	0.98	0.08	0.31
NW2	Dense Grass	0.24	100	3.42	0.016	0.25	150	0.016	0.88	0.05	0.30
NW3	Dense Grass	0.24	100	3.42	0.018	0.24	150	0.018	0.93	0.04	0.28
NW4	Dense Grass	0.24	100	3.42	0.020	0.23	150	0.020	0.98	0.04	0.27
NW5	Dense Grass	0.24	100	3.42	0.020	0.23	100	0.020	0.98	0.03	0.26
NW6	Dense Grass	0.24	100	3.42	0.018	0.24	100	0.018	0.93	0.03	0.27
NW7	Dense Grass	0.24	100	3.42	0.017	0.25	525	0.017	0.91	0.16	0.41
NW8	Dense Grass	0.24	100	3.42	0.020	0.23	800	0.020	0.98	0.23	0.46
NW9	Dense Grass	0.24	100	3.42	0.020	0.23	800	0.020	0.98	0.23	0.46
NW10	Dense Grass	0.24	100	3.42	0.020	0.23	0	0.020	0.98	0.00	0.23
NW11	Dense Grass	0.24	100	3.42	0.018	0.24	25	0.018	0.93	0.01	0.25
NW12	Dense Grass	0.24	100	3.42	0.018	0.24	100	0.018	0.93	0.03	0.27
NW13	Dense Grass	0.24	100	3.42	0.015	0.26	650	0.015	0.85	0.21	0.47
NW14	Dense Grass	0.24	100	3.42	0.017	0.25	1000	0.017	0.91	0.31	0.55
NW15	Dense Grass	0.24	100	3.42	0.020	0.23	325	0.020	0.98	0.09	0.32
South Area											
S1	Dense Grass	0.24	100	3.42	0.050	0.16	300	0.050	1.56	0.05	0.21
S2	Dense Grass	0.24	100	3.42	0.054	0.15	300	0.054	1.62	0.05	0.21
S3	Dense Grass	0.24	100	3.42	0.060	0.15	200	0.060	1.71	0.03	0.18
S4	Dense Grass	0.24	100	3.42	0.062	0.15	450	0.062	1.73	0.07	0.22
S5	Dense Grass	0.24	100	3.42	0.080	0.13	100	0.080	1.97	0.01	0.15
S6	Dense Grass	0.24	100	3.42	0.030	0.20	100	0.030	1.21	0.02	0.22
S7	Dense Grass	0.24	100	3.42	0.030	0.20	400	0.030	1.21	0.09	0.29
S8	Dense Grass	0.24	100	3.42	0.050	0.16	300	0.050	1.56	0.05	0.21
S9	Dense Grass	0.24	100	3.42	0.050	0.16	250	0.050	1.56	0.04	0.20
S10	Dense Grass	0.24	100	3.42	0.070	0.14	850	0.070	1.84	0.13	0.27
S11	Dense Grass	0.24	100	3.42	0.070	0.14	600	0.070	1.84	0.09	0.23
S12	Dense Grass	0.24	100	3.42	0.050	0.16	600	0.050	1.56	0.11	0.27
S13	Dense Grass	0.24	100	3.42	0.060	0.15	1200	0.060	1.71	0.20	0.34
S14	Dense Grass	0.24	100	3.42	0.120	0.11	150	0.120	2.41	0.02	0.13
S15	Dense Grass	0.24	100	3.42	0.110	0.12	150	0.110	2.31	0.02	0.13
S16	Dense Grass	0.24	100	3.42	0.060	0.15	350	0.060	1.71	0.06	0.21

TR-55 Graphical Peak Discharge Method Post-Construction Condition

Project: Pawcatuck

Engineer: Lukas Klavins

CORONAL ENERGY powered by Panasonic

1. Pond and Swamp Fp factor from TR-55 Table 4-2

Graphical Peak Discharge Method														
Data		Initial Abstraction Ia	Compute Ia/P				Unit Peak Discharge, qu (csm/in)				Peak Discharge			
Watershed ID	Rainfall Distribution		2yr	10yr	25yr	100yr	2yr	10yr	25yr	100yr	2yr	10yr	25yr	100yr
North East Area														
NE1	III	1.390	0.41	0.27	0.23	0.18	357	477	495	515	**2.25**	**8.39**	**13.01**	**21.25**
NE2	III	1.390	0.41	0.27	0.23	0.18	331	441	459	478	**5.71**	**21.25**	**32.99**	**54.03**
NE3	III	1.390	0.41	0.27	0.23	0.18	345	461	479	498	**2.62**	**9.77**	**15.15**	**24.79**
NE4	III	1.390	0.41	0.27	0.23	0.18	382	512	531	550	**0.80**	**2.97**	**4.59**	**7.48**
NE5	III	1.390	0.41	0.27	0.23	0.18	363	485	504	523	**1.74**	**6.50**	**10.06**	**16.44**
North West Area														
NW1	III	0.817	0.24	0.16	0.13	0.11	452	471	490	490	**0.71**	**1.59**	**2.27**	**3.28**
NW2	III	0.817	0.24	0.16	0.13	0.11	461	479	499	499	**0.71**	**1.60**	**2.28**	**3.30**
NW3	III	0.778	0.23	0.15	0.13	0.10	469	488	507	507	**0.77**	**1.69**	**2.40**	**3.44**
NW4	III	0.778	0.23	0.15	0.13	0.10	476	495	515	515	**0.78**	**1.71**	**2.43**	**3.49**
NW5	III	0.778	0.23	0.15	0.13	0.10	484	504	524	524	**0.79**	**1.74**	**2.47**	**3.55**
NW6	III	0.778	0.23	0.15	0.13	0.10	477	496	516	516	**0.78**	**1.72**	**2.44**	**3.50**
NW7	III	0.778	0.23	0.15	0.13	0.10	410	428	447	447	**3.12**	**6.88**	**9.79**	**14.07**
NW8	III	0.778	0.23	0.15	0.13	0.10	392	409	427	427	**3.26**	**7.20**	**10.26**	**14.75**
NW9	III	0.778	0.23	0.15	0.13	0.10	392	409	427	427	**3.26**	**7.20**	**10.26**	**14.75**
NW10	III	0.817	0.24	0.16	0.13	0.11	503	523	543	543	**0.18**	**0.41**	**0.58**	**0.84**
NW11	III	0.817	0.24	0.16	0.13	0.11	491	511	531	531	**0.54**	**1.20**	**1.71**	**2.47**
NW12	III	0.817	0.24	0.16	0.13	0.11	477	496	516	516	**0.53**	**1.18**	**1.69**	**2.44**
NW13	III	0.778	0.23	0.15	0.13	0.10	387	404	422	422	**2.31**	**5.09**	**7.25**	**10.42**
NW14	III	0.778	0.23	0.15	0.13	0.10	361	377	394	394	**3.02**	**6.66**	**9.50**	**13.65**
NW15	III	0.817	0.24	0.16	0.13	0.11	448	467	486	486	**0.69**	**1.54**	**2.20**	**3.19**
South Area														
S1	III	1.448	0.42	0.29	0.24	0.19	371	497	516	535	**0.21**	**0.82**	**1.28**	**2.11**
S2	III	1.448	0.42	0.29	0.24	0.19	375	502	521	540	**0.19**	**0.72**	**1.13**	**1.86**
S3	III	1.390	0.41	0.27	0.23	0.18	391	523	542	561	**0.21**	**0.77**	**1.20**	**1.95**
S4	III	1.390	0.41	0.27	0.23	0.18	368	493	512	531	**0.80**	**2.97**	**4.59**	**7.50**
S5	III	1.448	0.42	0.29	0.24	0.19	415	556	574	593	**0.22**	**0.86**	**1.34**	**2.20**
S6	III	1.448	0.42	0.29	0.24	0.19	368	493	511	531	**0.20**	**0.77**	**1.20**	**1.97**
S7	III	1.390	0.41	0.27	0.23	0.18	336	449	467	486	**1.01**	**3.75**	**5.82**	**9.53**
S8	III	1.448	0.42	0.29	0.24	0.19	371	497	516	535	**0.24**	**0.94**	**1.47**	**2.42**
S9	III	1.448	0.42	0.29	0.24	0.19	376	504	523	542	**0.25**	**0.96**	**1.49**	**2.45**
S10	III	1.390	0.41	0.27	0.23	0.18	345	460	479	498	**2.37**	**8.84**	**13.71**	**22.42**
S11	III	1.390	0.41	0.27	0.23	0.18	362	485	503	523	**1.30**	**4.85**	**7.51**	**12.26**
S12	III	1.390	0.41	0.27	0.23	0.18	345	461	479	498	**1.23**	**4.56**	**7.08**	**11.58**
S13	III	1.390	0.41	0.27	0.23	0.18	316	420	438	456	**2.16**	**8.00**	**12.44**	**20.39**
S14	III	1.448	0.42	0.29	0.24	0.19	429	575	592	610	**0.20**	**0.77**	**1.20**	**1.96**
S15	III	1.448	0.42	0.29	0.24	0.19	425	569	587	605	**0.20**	**0.78**	**1.21**	**1.97**
S16	III	1.448	0.42	0.29	0.24	0.19	376	503	522	541	**1.12**	**4.32**	**6.74**	**11.09**

TR-55 Compare Peak Discharge

Project: Pawcatuck

Engineer: Lukas Klavins

Watershed ID	Peak Discharge Pre-Construction				Peak Discharge Post-Construction Prior to Addition of Stormwater Management Facilities			
	2yr	10yr	25yr	100yr	2yr	10yr	25yr	100yr
North East Area								
NE1	1	6	9	15	2	8	13	21
NE2	3	14	23	39	6	21	33	54
NE3	1	7	11	18	3	10	15	25
NE4	0	2	3	5	1	3	5	7
NE5	1	4	7	12	2	6	10	16
North West Area								
NW1	2	3	4	5	1	2	2	3
NW2	2	3	4	5	1	2	2	3
NW3	2	3	4	5	1	2	2	3
NW4	2	3	4	5	1	2	2	3
NW5	2	3	4	5	1	2	2	4
NW6	2	3	4	5	1	2	2	4
NW7	7	13	16	22	3	7	10	14
NW8	7	13	17	23	3	7	10	15
NW9	7	13	17	23	3	7	10	15
NW10	0	1	1	1	0	0	1	1
NW11	1	2	3	4	1	1	2	2
NW12	1	2	3	4	1	1	2	2
NW13	5	9	12	16	2	5	7	10
NW14	7	12	16	21	3	7	9	14
NW15	2	3	4	5	1	2	2	3
South Area								
S1	1	2	3	4	0	1	1	2
S2	1	2	2	4	0	1	1	2
S3	1	2	2	4	0	1	1	2
S4	3	6	9	12	1	3	5	7
S5	0	1	2	3	0	1	1	2
S6	0	1	2	3	0	1	1	2
S7	5	10	13	19	1	4	6	10
S8	1	3	4	5	0	1	1	2
S9	1	2	3	4	0	1	1	2
S10	8	18	25	36	2	9	14	22
S11	6	13	17	24	1	5	8	12
S12	6	12	17	23	1	5	7	12
S13	9	19	26	38	2	8	12	20
S14	0	1	1	2	0	1	1	2
S15	0	1	1	2	0	1	1	2
S16	5	11	15	21	1	4	7	11

TR-55 Peak Flow Attenuation Sizing

Project: Pawcatuck

Engineer: Lukas Klavins

CORONAL ENERGY powered by Panasonic

Detention Size is to mitigate peak development flows as follows to conform to the 2004 Connecticut Stormwater Quality Manual

Max Conveyance Protection (attenuate to the 10 year peak flow)

Max Peak Runoff (attenuate to the 25 year peak flow)

Reference: Chapter 7 of the 2004 Connecticut Stormwater Quality Manual

TR-55 Detention Sizing																				
Watershed ID	Peak Inflow (Post Construction) (cfs)				Peak Outflow (Pre Construction, CT Req) (cfs)				q_{out}/q_{in}				V_s/V_r				V_s (cy)			
	2yr	10yr	25yr	100yr	2yr	10yr	25yr	100yr	2yr	10yr	25yr	100yr	2yr	10yr	25yr	100yr	2yr	10yr	25yr	100yr
NE1	2.25	8.39	13.01	21.25	1.14	5.61	9.07	15.42	0.50	0.67	0.70	0.73	0.27	0.22	0.21	0.20	149	331	474	713
NE2	5.71	21.25	32.99	54.03	2.91	14.10	22.82	38.86	0.51	0.66	0.69	0.72	0.27	0.22	0.21	0.20	406	913	1308	1972
NE3	2.62	9.77	15.15	24.79	1.33	6.51	10.53	17.92	0.51	0.67	0.69	0.72	0.27	0.22	0.21	0.20	179	400	573	863
NE4	0.80	2.97	4.59	7.48	0.40	2.00	3.23	5.48	0.50	0.67	0.70	0.73	0.28	0.22	0.21	0.20	49	108	155	233
NE5	1.74	6.50	10.06	16.44	0.88	4.34	7.01	11.93	0.50	0.67	0.70	0.73	0.28	0.22	0.21	0.20	114	252	361	543
NW1	0.71	1.59	2.27	3.28	1.61	2.96	3.78	5.09	2.27	1.86	1.67	1.55	-3.53	-1.49	-0.88	-0.59	0	0	0	0
NW2	0.71	1.60	2.28	3.30	1.62	2.98	3.81	5.12	2.27	1.86	1.67	1.55	-3.51	-1.48	-0.87	-0.59	0	0	0	0
NW3	0.77	1.69	2.40	3.44	1.64	3.02	3.86	5.19	2.14	1.79	1.61	1.51	-2.77	-1.23	-0.73	-0.50	0	0	0	0
NW4	0.78	1.71	2.43	3.49	1.67	3.05	3.91	5.26	2.14	1.78	1.61	1.50	-2.74	-1.21	-0.72	-0.50	0	0	0	0
NW5	0.79	1.74	2.47	3.55	1.69	3.10	3.97	5.34	2.13	1.78	1.61	1.50	-2.71	-1.20	-0.71	-0.49	0	0	0	0
NW6	0.78	1.72	2.44	3.50	1.67	3.06	3.92	5.27	2.14	1.78	1.61	1.51	-2.74	-1.21	-0.72	-0.50	0	0	0	0
NW7	3.12	6.88	9.79	14.07	6.79	12.50	16.01	21.52	2.18	1.82	1.64	1.53	-2.96	-1.33	-0.79	-0.55	0	0	0	0
NW8	3.26	7.20	10.26	14.75	7.14	13.15	16.84	22.64	2.19	1.83	1.64	1.53	-3.01	-1.36	-0.80	-0.56	0	0	0	0
NW9	3.26	7.20	10.26	14.75	7.14	13.15	16.84	22.64	2.19	1.83	1.64	1.53	-3.01	-1.36	-0.80	-0.56	0	0	0	0
NW10	0.18	0.41	0.58	0.84	0.41	0.75	0.96	1.29	2.24	1.84	1.65	1.53	-3.32	-1.39	-0.82	-0.55	0	0	0	0
NW11	0.54	1.20	1.71	2.47	1.21	2.21	2.83	3.80	2.25	1.84	1.65	1.54	-3.37	-1.42	-0.84	-0.56	0	0	0	0
NW12	0.53	1.18	1.69	2.44	1.19	2.19	2.80	3.77	2.26	1.85	1.66	1.54	-3.43	-1.45	-0.85	-0.58	0	0	0	0
NW13	2.31	5.09	7.25	10.42	5.05	9.31	11.92	16.03	2.19	1.83	1.64	1.54	-3.04	-1.37	-0.81	-0.56	0	0	0	0
NW14	3.02	6.66	9.50	13.65	6.65	12.26	15.70	21.11	2.20	1.84	1.65	1.55	-3.11	-1.41	-0.83	-0.58	0	0	0	0
NW15	0.69	1.54	2.20	3.19	1.57	2.88	3.68	4.95	2.27	1.87	1.67	1.55	-3.54	-1.50	-0.88	-0.60	0	0	0	0
S1	0.21	0.82	1.28	2.11	1.13	2.25	3.08	4.28	5.28	2.75	2.41	2.03	-79.73	-7.54	-4.47	-2.21	0	0	0	0
S2	0.19	0.72	1.13	1.86	0.90	1.86	2.48	3.60	4.80	2.57	2.20	1.94	-57.34	-5.77	-3.06	-1.79	0	0	0	0
S3	0.21	0.77	1.20	1.95	0.91	1.87	2.49	3.61	4.38	2.41	2.08	1.86	-41.80	-4.49	-2.45	-1.46	0	0	0	0
S4	0.80	2.97	4.59	7.50	2.78	6.08	8.58	12.33	3.49	2.05	1.87	1.64	-18.61	-2.28	-1.51	-0.81	0	0	0	0
S5	0.22	0.86	1.34	2.20	0.33	1.03	1.57	2.51	1.49	1.19	1.17	1.14	-0.46	-0.05	-0.03	-0.01	0	0	0	0
S6	0.20	0.77	1.20	1.97	0.33	1.03	1.57	2.51	1.68	1.35	1.31	1.28	-0.90	-0.23	-0.19	-0.14	0	0	0	0
S7	1.01	3.75	5.82	9.53	4.81	9.91	13.24	19.27	4.78	2.64	2.28	2.02	-56.32	-6.50	-3.55	-2.16	0	0	0	0
S8	0.24	0.94	1.47	2.42	1.29	2.59	3.54	4.93	5.28	2.75	2.41	2.03	-79.73	-7.54	-4.47	-2.21	0	0	0	0
S9	0.25	0.96	1.49	2.45	0.99	2.21	2.99	4.42	4.00	2.31	2.01	1.80	-30.26	-3.78	-2.09	-1.28	0	0	0	0
S10	2.37	8.84	13.71	22.42	7.90	17.61	25.06	36.23	3.33	1.99	1.83	1.62	-15.57	-2.02	-1.36	-0.74	0	0	0	0
S11	1.30	4.85	7.51	12.26	6.33	12.67	17.35	24.14	4.87	2.61	2.31	1.97	-60.18	-6.21	-3.78	-1.91	0	0	0	0
S12	1.23	4.56	7.08	11.58	6.00	12.05	16.52	22.99	4.90	2.64	2.33	1.99	-61.58	-6.46	-3.95	-1.99	0	0	0	0
S13	2.16	8.00	12.44	20.39	9.23	19.37	26.01	38.24	4.28	2.42	2.09	1.88	-38.34	-4.58	-2.49	-1.53	0	0	0	0
S14	0.20	0.77	1.20	1.96	0.30	0.92	1.39	2.23	1.49	1.19	1.16	1.14	-0.46	-0.05	-0.03	-0.01	0	0	0	0
S15	0.20	0.78	1.21	1.97	0.30	0.92	1.40	2.25	1.49	1.19	1.16	1.14	-0.46	-0.05	-0.03	-0.01	0	0	0	0
S16	1.12	4.32	6.74	11.09	5.38	11.07	14.79	21.49	4.80	2.56	2.19	1.94	-57.23	-5.75	-3.05	-1.78	0	0	0	0

HEC-HMS Overview and Results

HEC-HMS is a computer program designed for modeling hydrologic systems developed by the United States Army Corps of Engineers (USACE). The program is designed to simulate the precipitation-runoff processes of various different types of watershed systems.

Input information about the watershed must be gathered prior to modeling the system. Information shown in the TR-55 analysis was utilized in the model. These inputs were geographical watershed area, curve numbers based on soil types, plant cover, impervious cover, and time of concentration. Additional information such as designed area-storage relationships for the proposed stormwater management basins as well as preliminarily sized outlet structures were incorporated to determine understand hydrologic impact of proposed facilities. Meteorological data from NOAA Atlas-14 for specific storm events were inputted to be analyzed. Per the 2004 Connecticut Stormwater Quality Manual design criteria the 2, 10, 24, 100 year storms were analyzed. Finally, simulation control specifications for a 24-hour storm were incorporated into the model.

Results from the modeled 2, 10, 25, 100-year simulation runs including peak discharge rates and total volume of runoff. Hydrographs which graph outflow of the watershed over time was included in the report and will be utilized for fine tuning the stormwater design in final engineering. Results were compared to TR-55 analysis attached and peak discharges for pre and post were similar to provide comfortability with the model of the stormwater routing with the basins. Figures of the HEC-HMS pre-development and post-development models are below:

1. HEC-HMS Inputs
2. Pre-Development Watershed Model
3. Pre-Development HEC-HMS Peak Discharge & Volumes
4. Post-Development Watershed Model
5. Post-Development HEC-HMS Peak Discharge and Volumes

HEC-HMS Inputs

Rainfall: (NOAA Atlas 14)

SCS Storm Type III

002YR-24HR Rainfall – 3.42 in

010YR-24HR Rainfall – 5.08 in

025YR-24HR Rainfall – 6.11 in

100YR-24HR Rainfall – 7.70 in

Subasin Parameters: (TR-55 Analysis)

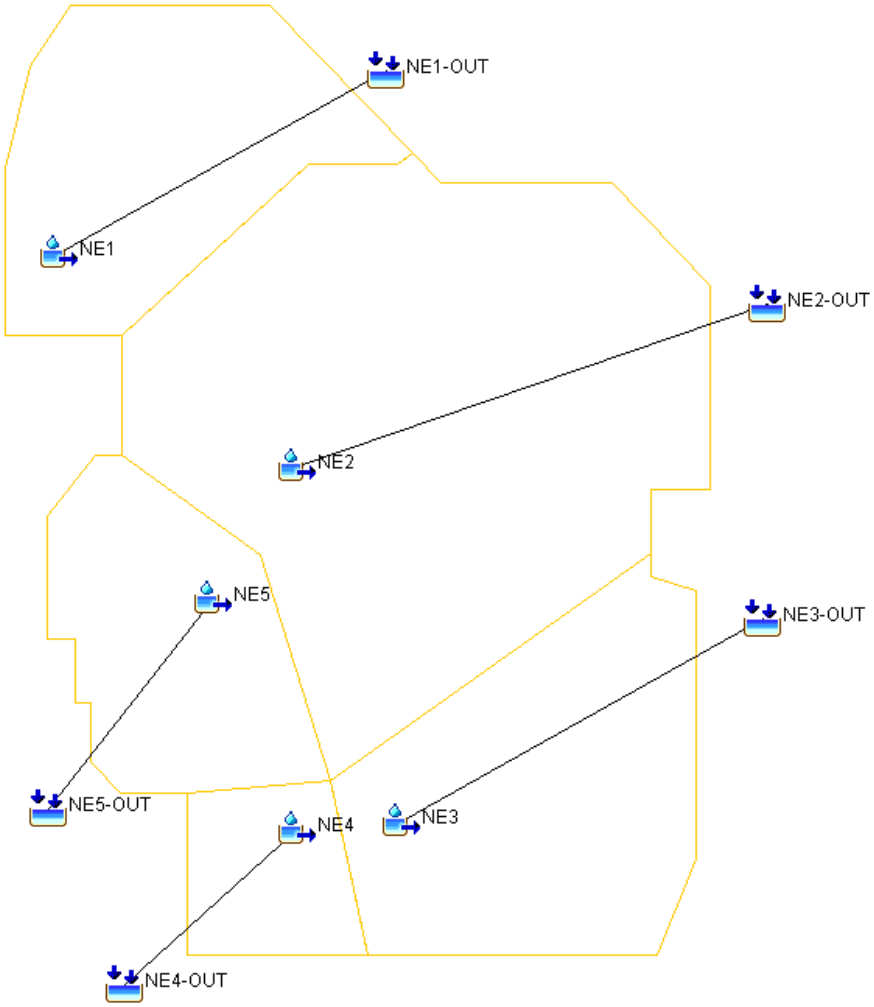
Watershed ID	Area (mi^2)	Loss Method	Transform Method	CN		Impervious (%)		Peaking Factor	Lag* (min)	
				Pre	Post	Pre	Post		Pre	Post
NE1	.01375	SCS Curve Number	SCS Unit Hydrograph	55	59	0	1	484	12.60	8.69
NE2	0.03766	SCS Curve Number	SCS Unit Hydrograph	55	59	0	1	484	15.48	10.87
NE3	0.01656	SCS Curve Number	SCS Unit Hydrograph	55	59	0	1	484	13.68	9.60
NE4	0.00453	SCS Curve Number	SCS Unit Hydrograph	55	59	0	1	484	10.08	6.98
NE5	0.01047	SCS Curve Number	SCS Unit Hydrograph	55	59	0	1	484	12.24	8.27

Lag = 0.6*Time of Concentration

Reservoir Parameters

Basin ID	Basin Storage			Primary Riser Outlet			Emergency Spillway Outlet			
	Elev (ft)	Area (ac)	Initial Elev (ft)	Elev (ft)	Proposed Structure	Coefficient	Elev (ft)	Proposed Structure	Length (ft)	Coefficient
SWM-NE1	90.0 92.0 94.0 95.0	0.1012 0.1537 0.2125 0.2429	90	93.0	18" DIA CMP RISER	0.6	94.0	Broad Crested Weir	20	2.8
SWM-NE2	54.5 56.0 58.0 59.5	0.2767 0.3267 0.4021 0.4657	54.5	56.0	18" DIA CMP RISER	0.6	58.5	Broad Crested Weir	20	2.8
SWM-NE3	85.5 86.0 88.0 90.0 90.5	0.1266 0.1406 0.2091 0.2820 0.3038	85.5	88.8	18" DIA CMP RISER	0.6	89.5	Broad Crested Weir	20	2.8
SWM-NE4	138.0 140.0 142.0 143.0	0.0235 0.0503 0.0834 0.1026	138	141.0	18" DIA CMP RISER	0.6	142.0	Broad Crested Weir	20	2.8
SWM-NE5	141.0 142.0 144.0 146.0	0.0726 0.0876 0.1284 0.1800	141	144.0	18" DIA CMP RISER	0.6	145.0	Broad Crested Weir	20	2.8

Pre-Development Watershed Model



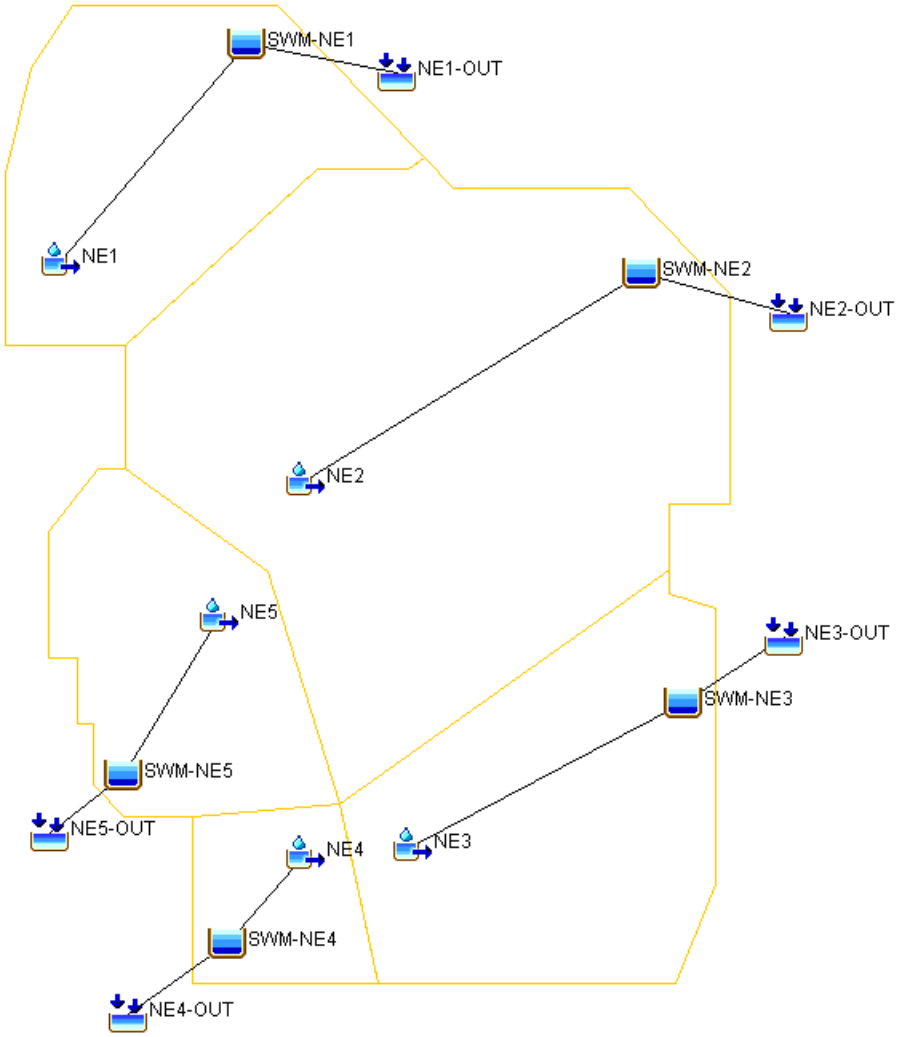
2YR-24HR Pre-Development				
Hydrologic Element	**Drainage Area**	**Peak Discharge (cfs)**	**Time of Peak**	**Volume (in)**
NE1	0.01375	1.1	01Jan2000, 12:30	0.32
NE1-OUT	0.01375	1.1	01Jan2000, 12:30	0.32
NE2	0.03766	2.8	01Jan2000, 12:30	0.32
NE2-OUT	0.03766	2.8	01Jan2000, 12:30	0.32
NE3	0.01656	1.3	01Jan2000, 12:30	0.32
NE3-OUT	0.01656	1.3	01Jan2000, 12:30	0.32
NE4	0.00453	0.4	01Jan2000, 12:25	0.32
NE4-OUT	0.00453	0.4	01Jan2000, 12:25	0.32
NE5	0.01047	0.8	01Jan2000, 12:30	0.32
NE5-OUT	0.01047	0.8	01Jan2000, 12:30	0.32

10YR-24HR Pre-Development				
Hydrologic Element	**Drainage Area**	**Peak Discharge (cfs)**	**Time of Peak**	**Volume (in)**
NE1	0.01375	5.4	01Jan2000, 12:20	1.02
NE1-OUT	0.01375	5.4	01Jan2000, 12:20	1.02
NE2	0.03766	13.9	01Jan2000, 12:25	1.01
NE2-OUT	0.03766	13.9	01Jan2000, 12:25	1.01
NE3	0.01656	6.4	01Jan2000, 12:20	1.02
NE3-OUT	0.01656	6.4	01Jan2000, 12:20	1.02
NE4	0.00453	1.9	01Jan2000, 12:15	1.02
NE4-OUT	0.00453	1.9	01Jan2000, 12:15	1.02
NE5	0.01047	4.2	01Jan2000, 12:20	1.02
NE5-OUT	0.01047	4.2	01Jan2000, 12:20	1.02

25YR-24HR Pre-Development				
Hydrologic Element	**Drainage Area**	**Peak Discharge (cfs)**	**Time of Peak**	**Volume (in)**
NE1	0.01375	9.1	01Jan2000, 12:20	1.58
NE1-OUT	0.01375	9.1	01Jan2000, 12:20	1.58
NE2	0.03766	23.6	01Jan2000, 12:20	1.57
NE2-OUT	0.03766	23.6	01Jan2000, 12:20	1.57
NE3	0.01656	10.8	01Jan2000, 12:20	1.57
NE3-OUT	0.01656	10.8	01Jan2000, 12:20	1.57
NE4	0.00453	3.3	01Jan2000, 12:15	1.58
NE4-OUT	0.00453	3.3	01Jan2000, 12:15	1.58
NE5	0.01047	7.1	01Jan2000, 12:15	1.58
NE5-OUT	0.01047	7.1	01Jan2000, 12:15	1.58

100YR-24HR Pre-Development				
Hydrologic Element	**Drainage Area**	**Peak Discharge (cfs)**	**Time of Peak**	**Volume (in)**
NE1	0.01375	16	01Jan2000, 12:15	2.57
NE1-OUT	0.01375	16	01Jan2000, 12:15	2.57
NE2	0.03766	41.2	01Jan2000, 12:20	2.57
NE2-OUT	0.03766	41.2	01Jan2000, 12:20	2.57
NE3	0.01656	18.6	01Jan2000, 12:20	2.57
NE3-OUT	0.01656	18.6	01Jan2000, 12:20	2.57
NE4	0.00453	5.7	01Jan2000, 12:15	2.57
NE4-OUT	0.00453	5.7	01Jan2000, 12:15	2.57
NE5	0.01047	12.4	01Jan2000, 12:15	2.57
NE5-OUT	0.01047	12.4	01Jan2000, 12:15	2.57

Post-Development Watershed Model



2YR-24HR Post-Development				
Hydrologic Element	**Drainage Area**	**Peak Discharge (cfs)**	**Time of Peak**	**Volume (in)**
NE1	0.01375	2.3	01Jan2000, 12:15	0.49
SWM-NE1	0.01375	0	01Jan2000, 00:00	0
NE1-OUT	0.01375	0	01Jan2000, 00:00	0
NE2	0.03766	6	01Jan2000, 12:20	0.49
SWM-NE2	0.03766	1.3	01Jan2000, 14:05	0.26
NE2-OUT	0.03766	1.3	01Jan2000, 14:05	0.26
NE3	0.01656	2.7	01Jan2000, 12:20	0.49
SWM-NE3	0.01656	0	01Jan2000, 00:00	0
NE3-OUT	0.01656	0	01Jan2000, 00:00	0
NE4	0.00453	0.8	01Jan2000, 12:15	0.49
SWM-NE4	0.00453	0	01Jan2000, 00:00	0
NE4-OUT	0.00453	0	01Jan2000, 00:00	0
NE5	0.01047	1.8	01Jan2000, 12:15	0.49
SWM-NE5	0.01047	0	01Jan2000, 00:00	0
NE5-OUT	0.01047	0	01Jan2000, 00:00	0

10YR-24HR Post-Development				
Hydrologic Element	**Drainage Area**	**Peak Discharge (cfs)**	**Time of Peak**	**Volume (in)**
NE1	0.01375	8.4	01Jan2000, 12:15	1.31
SWM-NE1	0.01375	1.7	01Jan2000, 13:05	0.72
NE1-OUT	0.01375	1.7	01Jan2000, 13:05	0.72
NE2	0.03766	22	01Jan2000, 12:15	1.31
SWM-NE2	0.03766	8.4	01Jan2000, 12:45	1.09
NE2-OUT	0.03766	8.4	01Jan2000, 12:45	1.09
NE3	0.01656	10	01Jan2000, 12:15	1.31
SWM-NE3	0.01656	1.6	01Jan2000, 13:35	0.64
NE3-OUT	0.01656	1.6	01Jan2000, 13:35	0.64
NE4	0.00453	3	01Jan2000, 12:10	1.32
SWM-NE4	0.00453	0.7	01Jan2000, 12:55	0.74
NE4-OUT	0.00453	0.7	01Jan2000, 12:55	0.74
NE5	0.01047	6.5	01Jan2000, 12:10	1.31
SWM-NE5	0.01047	1.8	01Jan2000, 12:45	0.79
NE5-OUT	0.01047	1.8	01Jan2000, 12:45	0.79

25YR-24HR Post-Development				
Hydrologic Element	**Drainage Area**	**Peak Discharge (cfs)**	**Time of Peak**	**Volume (in)**
NE1	0.01375	13.2	01Jan2000, 12:10	1.95
SWM-NE1	0.01375	5.5	01Jan2000, 12:35	1.35
NE1-OUT	0.01375	5.5	01Jan2000, 12:35	1.35
NE2	0.03766	34.4	01Jan2000, 12:15	1.95
SWM-NE2	0.03766	12.4	01Jan2000, 12:45	1.72
NE2-OUT	0.03766	12.4	01Jan2000, 12:45	1.72
NE3	0.01656	15.5	01Jan2000, 12:15	1.95
SWM-NE3	0.01656	5	01Jan2000, 12:45	1.27
NE3-OUT	0.01656	5	01Jan2000, 12:45	1.27
NE4	0.00453	4.7	01Jan2000, 12:10	1.95
SWM-NE4	0.00453	2.2	01Jan2000, 12:30	1.38
NE4-OUT	0.00453	2.2	01Jan2000, 12:30	1.38
NE5	0.01047	10.3	01Jan2000, 12:10	1.95
SWM-NE5	0.01047	5.2	01Jan2000, 12:30	1.43
NE5-OUT	0.01047	5.2	01Jan2000, 12:30	1.43

100YR-24HR Post-Development				
Hydrologic Element	**Drainage Area**	**Peak Discharge (cfs)**	**Time of Peak**	**Volume (in)**
NE1	0.01375	21.7	01Jan2000, 12:10	3.04
SWM-NE1	0.01375	14.3	01Jan2000, 12:25	2.45
NE1-OUT	0.01375	14.3	01Jan2000, 12:25	2.45
NE2	0.03766	55.8	01Jan2000, 12:15	3.04
SWM-NE2	0.03766	38.8	01Jan2000, 12:30	2.81
NE2-OUT	0.03766	38.8	01Jan2000, 12:30	2.81
NE3	0.01656	25	01Jan2000, 12:10	3.04
SWM-NE3	0.01656	16.5	01Jan2000, 12:25	2.37
NE3-OUT	0.01656	16.5	01Jan2000, 12:25	2.37
NE4	0.00453	7.6	01Jan2000, 12:10	3.05
SWM-NE4	0.00453	4.8	01Jan2000, 12:25	2.47
NE4-OUT	0.00453	4.8	01Jan2000, 12:25	2.47
NE5	0.01047	16.8	01Jan2000, 12:10	3.04
SWM-NE5	0.01047	11.4	01Jan2000, 12:25	2.52
NE5-OUT	0.01047	11.4	01Jan2000, 12:25	2.52

Weighted Curve Number

$$CN_{weighted} = \frac{\sum CN * A}{A_{total}}$$

$CN_{weighted}$	weighted Curve Number
CN	Curve Number of a individual area
A	area of individual area
A_{total}	sum of all the individual areas

Potential Maximum Retention After Runoff Begins

$$S = \frac{1000}{CN} - 10$$

S	potential maximum retention after runoff begins (in)
CN	Curve Number

Initial Abstraction

$$I_a = 0.2 * S$$

Ia	initial abstraction (in)
S	potential maximum retention after runoff begins (in)

SCS Runoff Equation

$$Q = \frac{(P - I_a)^2}{(P - I_a) + S}$$

Q	runoff (in)
P	rainfall (in)
S	potential maximum retention after runoff begins (in)
I_a	initial abstraction (in)

Sheet Flow Time of Concentration

$$T_{sf} = \frac{0.007 * (n * L)^{0.8}}{(P_2)^{0.5} * s^{0.4}}$$

T_{sf}	travel time (hr)
n	Manning 's roughness coefficient
L	flow length (ft)
P_2	2-year, 24-hour rainfall (in)
s	slope of hydraulic grade line (ft/ft)

Manning's Equation

$$V = \frac{1.49 * r^{2/3} * s^{1/2}}{n}$$

V	average velocity (ft/s)
r	hydraulic radius (ft), assumed 0.4 for unpaved areas per TR-55 direction
s	slope of the hydraulic grade line (ft/ft)
n	Manning's roughness coefficient for open channel flow

Shallow Concentrated Flow Time of Concentration

$$T_{sc} = \frac{L}{3600 * V}$$

T_{sc}	travel time (hr)
L	flow length (ft)
V	average velocity (ft/s)

Unit Peak Discharge Equation

$$\log(q_u) = C_0 + C_1 \log(T_c) + C_3(\log(T_c))^2$$

q_u	unit peak discharge (csm/in)
T_c	time of concentration (hr)
C_0, C_1, C_2	coefficients from table F-2 (reference TR-55)

Peak Discharge Equation

$$q_p = q_u * A_m * Q * F_p$$

q_p	peak discharge (cfs)
q_u	unit peak discharge (csm/in)
A_m	drainage area (mi^2)
Q	runoff (in)
F_p	pond and swamp adjustment factor

NOAA Atlas 14, Volume 10, Version 2
Location name: North Stonington, Town of, Connecticut, USA*
Latitude: 41.4197°, Longitude: -71.8323°
Elevation: 156.32 ft**
* source: ESRI Maps
** source: USGS

POINT PRECIPITATION FREQUENCY ESTIMATES

Sanja Perica, Sandra Pavlovic, Michael St. Laurent, Carl Trypaluk, Dale Unruh, Orlan Wilhite

NOAA, National Weather Service, Silver Spring, Maryland

PF_tabular | PF_graphical | Maps_&_aerials

PF tabular

PDS-based point precipitation frequency estimates with 90% confidence intervals (in inches)[1]

Duration	Average recurrence interval (years)									
	1	2	5	10	25	50	100	200	500	1000
5-min	0.332 (0.254-0.433)	0.400 (0.306-0.522)	0.511 (0.390-0.668)	0.604 (0.458-0.792)	0.731 (0.539-0.991)	0.829 (0.600-1.14)	0.927 (0.654-1.31)	1.05 (0.705-1.51)	1.22 (0.788-1.79)	1.35 (0.851-2.00)
10-min	0.471 (0.361-0.613)	0.567 (0.434-0.739)	0.725 (0.553-0.947)	0.855 (0.649-1.12)	1.03 (0.764-1.40)	1.17 (0.850-1.62)	1.31 (0.927-1.86)	1.49 (0.999-2.13)	1.73 (1.12-2.53)	1.91 (1.21-2.83)
15-min	0.554 (0.424-0.721)	0.667 (0.511-0.870)	0.852 (0.650-1.11)	1.01 (0.764-1.32)	1.22 (0.899-1.65)	1.38 (1.00-1.90)	1.55 (1.09-2.19)	1.75 (1.18-2.51)	2.03 (1.31-2.98)	2.24 (1.42-3.33)
30-min	0.767 (0.587-0.999)	0.926 (0.709-1.21)	1.19 (0.906-1.55)	1.40 (1.07-1.84)	1.70 (1.25-2.31)	1.93 (1.40-2.66)	2.16 (1.53-3.06)	2.45 (1.65-3.51)	2.84 (1.84-4.17)	3.14 (1.99-4.66)
60-min	0.980 (0.751-1.28)	1.19 (0.907-1.55)	1.52 (1.16-1.99)	1.80 (1.37-2.36)	2.19 (1.61-2.96)	2.48 (1.80-3.42)	2.78 (1.96-3.93)	3.15 (2.11-4.51)	3.65 (2.36-5.36)	4.03 (2.55-5.99)
2-hr	1.29 (0.993-1.67)	1.56 (1.20-2.02)	2.00 (1.53-2.60)	2.36 (1.80-3.08)	2.86 (2.12-3.86)	3.25 (2.36-4.44)	3.63 (2.58-5.11)	4.13 (2.78-5.87)	4.79 (3.11-6.97)	5.29 (3.36-7.80)
3-hr	1.51 (1.16-1.95)	1.81 (1.40-2.35)	2.32 (1.78-3.01)	2.74 (2.09-3.56)	3.31 (2.46-4.45)	3.76 (2.74-5.13)	4.20 (2.99-5.90)	4.78 (3.22-6.76)	5.54 (3.60-8.03)	6.12 (3.89-8.99)
6-hr	1.94 (1.50-2.49)	2.32 (1.80-2.99)	2.95 (2.28-3.80)	3.47 (2.66-4.49)	4.18 (3.12-5.59)	4.73 (3.47-6.42)	5.29 (3.78-7.37)	6.01 (4.07-8.45)	6.96 (4.55-10.0)	7.68 (4.91-11.2)
12-hr	2.43 (1.90-3.11)	2.90 (2.25-3.70)	3.65 (2.84-4.68)	4.28 (3.31-5.51)	5.15 (3.86-6.84)	5.82 (4.28-7.84)	6.48 (4.65-8.99)	7.36 (5.00-10.3)	8.52 (5.59-12.2)	9.40 (6.03-13.6)
24-hr	2.87 (2.25-3.65)	3.42 (2.68-4.36)	4.33 (3.38-5.52)	5.08 (3.94-6.50)	6.11 (4.60-8.07)	6.90 (5.11-9.26)	7.70 (5.55-10.6)	8.75 (5.97-12.1)	10.1 (6.67-14.4)	11.2 (7.20-16.1)
2-day	3.21 (2.53-4.06)	3.85 (3.03-4.88)	4.91 (3.85-6.23)	5.78 (4.51-7.36)	6.99 (5.29-9.18)	7.92 (5.88-10.6)	8.84 (6.41-12.1)	10.1 (6.90-13.9)	11.7 (7.72-16.5)	12.9 (8.34-18.4)
3-day	3.47 (2.74-4.37)	4.16 (3.28-5.25)	5.29 (4.16-6.69)	6.22 (4.87-7.90)	7.51 (5.70-9.83)	8.51 (6.34-11.3)	9.50 (6.89-13.0)	10.8 (7.42-14.8)	12.5 (8.29-17.6)	13.8 (8.94-19.6)
4-day	3.71 (2.94-4.67)	4.43 (3.50-5.58)	5.61 (4.42-7.08)	6.59 (5.16-8.34)	7.93 (6.03-10.3)	8.97 (6.69-11.9)	10.0 (7.27-13.6)	11.3 (7.81-15.5)	13.1 (8.70-18.4)	14.5 (9.38-20.5)
7-day	4.40 (3.49-5.51)	5.18 (4.11-6.49)	6.45 (5.10-8.10)	7.51 (5.90-9.46)	8.96 (6.84-11.6)	10.1 (7.54-13.3)	11.2 (8.15-15.1)	12.6 (8.71-17.2)	14.5 (9.64-20.1)	15.9 (10.3-22.4)
10-day	5.08 (4.05-6.35)	5.90 (4.69-7.37)	7.23 (5.73-9.06)	8.33 (6.57-10.5)	9.85 (7.53-12.7)	11.0 (8.26-14.4)	12.2 (8.88-16.3)	13.6 (9.43-18.5)	15.5 (10.3-21.5)	16.9 (11.0-23.7)
20-day	7.20 (5.76-8.95)	8.09 (6.46-10.1)	9.53 (7.60-11.9)	10.7 (8.50-13.4)	12.4 (9.49-15.8)	13.7 (10.2-17.6)	14.9 (10.8-19.7)	16.2 (11.3-21.8)	17.9 (12.0-24.6)	19.2 (12.5-26.7)
30-day	8.97 (7.20-11.1)	9.91 (7.94-12.3)	11.4 (9.14-14.2)	12.7 (10.1-15.8)	14.5 (11.1-18.4)	15.8 (11.9-20.3)	17.2 (12.4-22.4)	18.3 (12.8-24.5)	19.9 (13.4-27.2)	21.0 (13.8-29.2)
45-day	11.2 (8.98-13.8)	12.2 (9.78-15.0)	13.8 (11.1-17.1)	15.2 (12.1-18.9)	17.1 (13.1-21.6)	18.5 (13.9-23.6)	20.0 (14.5-25.8)	21.1 (14.8-28.1)	22.5 (15.2-30.6)	23.5 (15.5-32.5)
60-day	13.0 (10.5-16.0)	14.1 (11.3-17.3)	15.8 (12.7-19.5)	17.3 (13.8-21.4)	19.3 (14.9-24.3)	20.9 (15.7-26.5)	22.4 (16.2-28.8)	23.4 (16.5-31.1)	24.8 (16.8-33.7)	25.8 (17.0-35.6)

[1] Precipitation frequency (PF) estimates in this table are based on frequency analysis of partial duration series (PDS).

Numbers in parenthesis are PF estimates at lower and upper bounds of the 90% confidence interval. The probability that precipitation frequency estimates (for a given duration and average recurrence interval) will be greater than the upper bound (or less than the lower bound) is 5%. Estimates at upper bounds are not checked against probable maximum precipitation (PMP) estimates and may be higher than currently valid PMP values.

Please refer to NOAA Atlas 14 document for more information.

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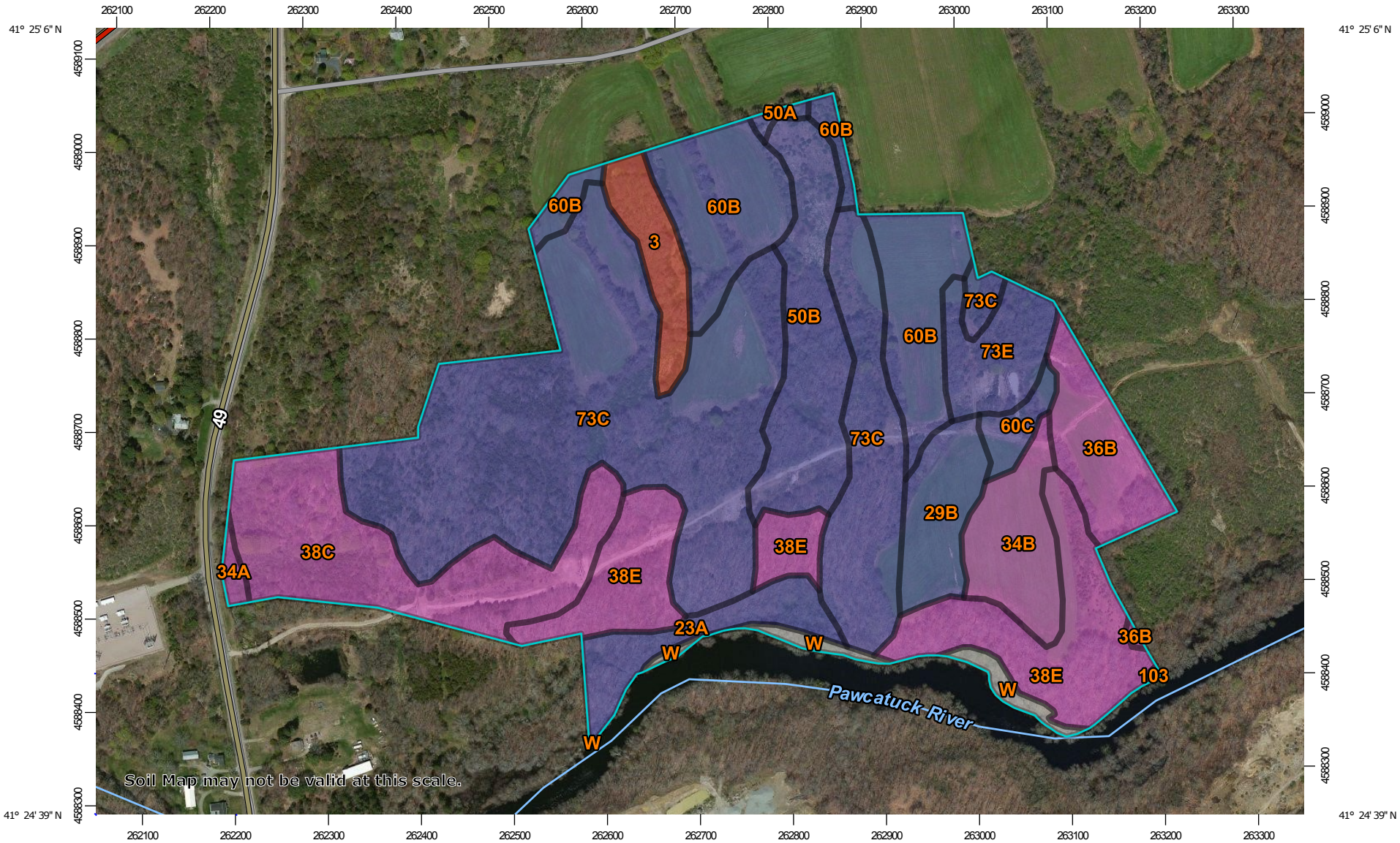
Map—Hydrologic Soil Group



Map Scale: 1:5,940 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 50 100 200 300

Feet: 0 250 500 1000 1500

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

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MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

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 1:12,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

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: State of Connecticut
Survey Area Data: Version 16, Sep 15, 2017

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

Date(s) aerial images were photographed: Mar 30, 2011—May 1, 2011

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.

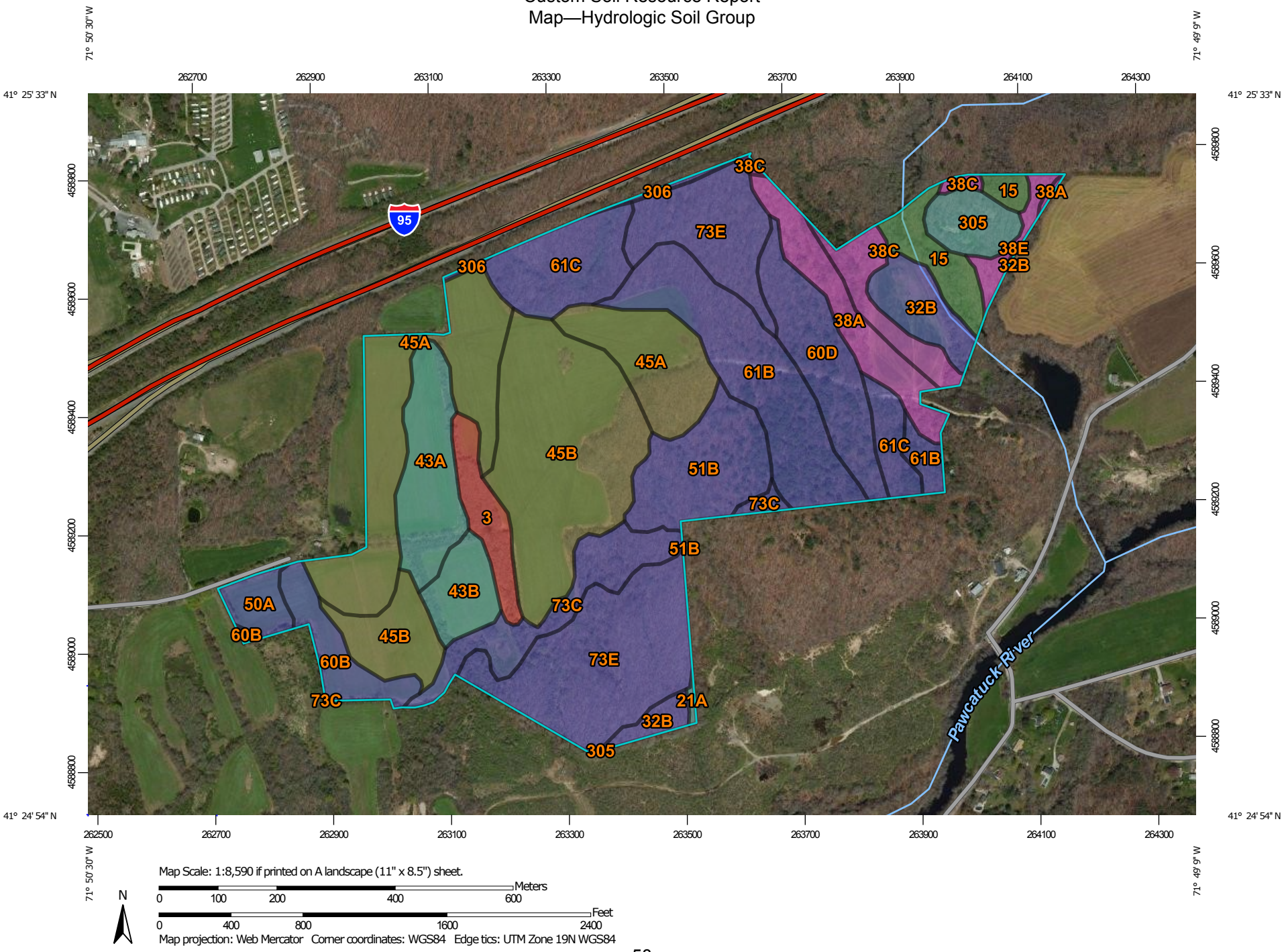
Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
3	Ridgebury, Leicester, and Whitman soils, 0 to 8 percent slopes, extremely stony	D	2.7	2.7%
23A	Sudbury sandy loam, 0 to 5 percent slopes	B	3.2	3.2%
29B	Agawam fine sandy loam, 3 to 8 percent slopes	B	3.4	3.5%
34A	Merrimac fine sandy loam, 0 to 3 percent slopes	A	0.4	0.4%
34B	Merrimac fine sandy loam, 3 to 8 percent slopes	A	3.9	4.0%
36B	Windsor loamy sand, 3 to 8 percent slopes	A	4.1	4.2%
38C	Hinckley loamy sand, 3 to 15 percent slopes	A	10.2	10.4%
38E	Hinckley loamy sand, 15 to 45 percent slopes	A	11.7	12.0%
50A	Sutton fine sandy loam, 0 to 3 percent slopes	B	0.3	0.3%
50B	Sutton fine sandy loam, 3 to 8 percent slopes	B	7.1	7.3%
60B	Canton and Charlton fine sandy loams, 3 to 8 percent slopes	B	10.8	11.1%
60C	Canton and Charlton fine sandy loams, 8 to 15 percent slopes	B	1.1	1.1%
73C	Charlton-Chatfield complex, 0 to 15 percent slopes, very rocky	B	34.0	34.9%
73E	Charlton-Chatfield complex, 15 to 45 percent slopes, very rocky	B	3.2	3.3%
103	Rippowam fine sandy loam	B/D	0.0	0.0%
W	Water		1.3	1.3%
Totals for Area of Interest			**97.2**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Map—Hydrologic Soil Group



Map Scale: 1:8,590 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 100 200 400 600

Feet: 0 400 800 1600 2400

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 19N WGS84

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Lines

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

Soil Rating Points

- A
- A/D
- B
- B/D
- C
- C/D
- D
- Not rated or not available

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 1:12,000.

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)

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Table—Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
3	Ridgebury, Leicester, and Whitman soils, 0 to 8 percent slopes, extremely stony	D	4.0	2.2%
15	Scarboro muck, 0 to 3 percent slopes	A/D	4.9	2.7%
21A	Ninigret and Tisbury soils, 0 to 5 percent slopes	C	0.2	0.1%
32B	Haven and Enfield soils, 3 to 8 percent slopes	B	5.8	3.2%
38A	Hinckley loamy sand, 0 to 3 percent slopes	A	6.8	3.8%
38C	Hinckley loamy sand, 3 to 15 percent slopes	A	4.6	2.5%
38E	Hinckley loamy sand, 15 to 45 percent slopes	A	1.7	1.0%
43A	Rainbow silt loam, 0 to 3 percent slopes	C	8.4	4.7%
43B	Rainbow silt loam, 3 to 8 percent slopes	C	4.0	2.2%
45A	Woodbridge fine sandy loam, 0 to 3 percent slopes	C/D	24.0	13.3%
45B	Woodbridge fine sandy loam, 3 to 8 percent slopes	C/D	27.6	15.3%
50A	Sutton fine sandy loam, 0 to 3 percent slopes	B	2.4	1.3%
51B	Sutton fine sandy loam, 2 to 8 percent slopes, very stony	B	9.4	5.2%
60B	Canton and Charlton fine sandy loams, 3 to 8 percent slopes	B	4.5	2.5%
60D	Canton and Charlton soils, 15 to 25 percent slopes	B	8.9	4.9%
61B	Canton and Charlton fine sandy loams, 0 to 8 percent slopes, very stony	B	16.0	8.9%
61C	Canton and Charlton fine sandy loams, 8 to 15 percent slopes, very stony	B	10.2	5.7%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
73C	Charlton-Chatfield complex, 0 to 15 percent slopes, very rocky	B	7.7	4.3%
73E	Charlton-Chatfield complex, 15 to 45 percent slopes, very rocky	B	25.4	14.1%
305	Udorthents-Pits complex, gravelly	C	3.6	2.0%
306	Udorthents-Urban land complex	B	0.5	0.3%
Totals for Area of Interest			**180.7**	**100.0%**

Rating Options—Hydrologic Soil Group

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Drainage Class

"Drainage class (natural)" refers to the frequency and duration of wet periods under conditions similar to those under which the soil formed. Alterations of the water regime by human activities, either through drainage or irrigation, are not a consideration unless they have significantly changed the morphology of the soil. Seven classes of natural soil drainage are recognized-excessively drained, somewhat excessively drained, well drained, moderately well drained, somewhat poorly drained, poorly drained, and very poorly drained. These classes are defined in the "Soil Survey Manual."