DiPrete Engineering

Stormwater Management Report

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No. 8557
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REGISTERED
PROFESSIONAL ENGINEER
CIVIL

Natick Avenue Solar

Located in Cranston, Rhode Island

Applicant: Ronald Rossi

4-30-2019

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Executive Summary

On behalf of the Client, we are submitting drainage calculations for the proposed development on Natick Avenue located in Cranston, RI. The site is located on Assessors' Plat 22 Lots 108 and 119. The site is currently covered in thinly spaced vegetation and has topography sloping from the northwest to the southeast. There are existing trails throughout the site and multiple existing structures. Wetlands exist at the western edge, and southeast corner of the property. The client proposes to clear a portion of land on the eastern half of the property and construct an 8.1-megawatt solar farm that will meet the Solar Power Performance Standards as set forth in the City of Cranston Zoning regulations Section 17.23.020. The solar farm will utilize approximately 28.26 acres of upland areas and clearing of natural vegetation will be limited to what is necessary for the construction and operation of the solar power facility.

The post development stormwater will be treated for water quality using Best Management Practices (BMPs). The Site has been designed to meet the Rhode Island Stormwater Design and Installation Standards Manual (RISDISM). Soil evaluations revealed water tables between 1' and 2' throughout the site. Ledge and rock outcrops were also found onsite.

To mitigate post development flows on site stone filled basins, stone trenches, and conveyance swales are utilized. These BMPs are designed to control runoff for the 2 through 100-year storm events and as water quality BMPs. These will remove 85% or more of TSS (total suspended solids) generated by the proposed access roads.

This report details how the site will show no net increase in stormwater runoff from pre-development to post development conditions, and how the proposed BMPs will provide water quality treatment for stormwater runoff.

Pre-development Conditions versus Post Development Conditions for each watershed are summarized below:

Subwatershed (design point)	1.2" Peak Flow		1-yr Peak Flow		10-yr Peak Flow		100-yr Peak Flow	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
DP-1: SE Perimeter Wetland (Includes DP-2)	0.18	0.02	2.61	0.89	28.22	15.52	100.80	99.04
DP-2: Northeast Abutters	0.15	0.02	0.73	0.56	7.41	3.46	25.91	19.70
DP-3: Southern Abutters	0.00	0.00	0.75	0.72	7.65	6.58	26.72	24.59
DP-4: Natick Ave	0.06	0.06	0.19	0.17	1.56	1.47	4.92	4.77
Totals:	0.39	0.10	4.28	2.34	44.85	27.03	158.35	148.10

All flows in cubic feet per second (cfs)

APPENDIX A: STORMWATER MANAGEMENT CHECKLIST AND LID PLANNING REPORT

PROJECT NAME: Natick Avenue Solar	(RIDEM USE ONLY)
CONTACT FOR STORMWATER DESIGN QUESTIONS: Kevin DeMers, P.E.	
PHONE NUMBER: (401) 943-1000	
EMAIL ADDRESS: kdemers@diprete-eng.com	
BRIEF PROJECT DESCRIPTION: Solar Array located in Cranston	DATE RECEIVED

STORMWATER MANAGEMENT PLAN ELEMENTS

APPENDIX A: STORMWATER MANAGEMENT CHECKLIST	**STORMWATER ANALYSIS AND DRAINAGE REPORT**	**SOIL EROSION AND SEDIMENT CONTROL PLAN**	**OPERATIONS AND MAINTENANCE PLAN**
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Note: **All** stormwater construction projects **must submit** a Stormwater Management Plan (SMP). However, not every element listed below (see the Stormwater Management Plan Table) is required per the RISDISM and the RIPDES Construction General Permit (CGP). This checklist will help you identify the elements of the stormwater plan you are required to submit with your permit application.

PART 1. PROJECT AND SITE INFORMATION

PROJECT TYPE (Check all that apply)

☐ RESIDENTIAL	☐ COMMERCIAL	☐ FEDERAL	☐ RETROFIT	☐ RESTORATION
☐ ROAD	X UTILITY	☐ FILL	☐ DREDGE	☐ MINE

☐ OTHER: (please explain)
SITE INFORMATION
X VICINITY MAP X EXISTING ZONING (Zoned as A-80)
DISCHARGE LOCATION: The WQv discharges to: (you may choose more than one answer if there are several discharge points on the project) (Guidance to identify receiving waters)

X GROUNDWATER	GROUNDWATER ☐ GAA X GA ☐ GB
X SURFACE WATER	☐ ISOLATED WETLAND ☐ NAMED WATERBODY X UNNAMED WATERBODY CONNECTED TO NAMED WATERBDY
☐ MS4	☐ RIDOT ☐ RIDOT ALTERATION PERMIT IS APPROVED ☐ TOWN ☐ OTHER:_____

RECEIVING WATER INFORMATION: (check all that apply and *repeat* this row for each waterbody)	
THE WATER QUALITY VOLUME DISCHARGES TO: ☐ N/A (discharges to: CSO, Disconnected wetland or Groundwater) WATERBODY NAME: No Name WATERBODY ID: RI0006017R-02 IMPAIRMENTS: Enterococcus X TMDL FOR: Enterococcus ☐ CONTRIBUTES TO A PRIORITY OUTFALL LISTED IN THE TMDL	☐ IMPAIRED (303(d) LIST) ☐ SRPW ☐ COLDWATER X WARMWATER ☐ UNASSESSED ☐ 4TH ORDER STREAM ☐ POND OF 50 ACRES OR MORE ☐ KNOWN HISTORY OF REPETITIVE FLOODING (i.e. Pocassett River) ☐ CONTRIBUTES STORMWATER TO A PUBLIC BEACH ☐ CONTRIBUTES TO SHELLFISHING GROUNDS

PROJECT HISTORY:	
☐ PRE-APPPLICATION MEETING DATE: _____	☐ MINUTES ARE ATTACHED
☐ RIDEM GRANT FUNDING INVOLVED	GRANT SOURCE:_____
☐ TOWN MASTER PLAN APPROVAL DATE: _____	☐ MINUTES ARE ATTACHED
☐ SUBDIVISION SUITABILITY REQUIRED	APPROVAL #: _____
☐ PREVIOUS ENFORCEMENT ACTION HAS BEEN TAKEN ON THIS PROPERTY	ENFORCEMENT # _____

FRESHWATER WETLANDS JURISDICTION: X **FEMA FLOODPLAIN FIRMETTE HAS BEEN REVIEWED** ☐ CALCULATIONS ARE PROVIDED FOR CUT/FILL PROPOSED ANYWHERE WITHIN THE 100-YR FLOODPLAIN ☐ RESTRICTIONS OR MODIFICATINS ARE PROPOSED TO THE FLOWPATH OR VELOCITIES IN A FLOODWAY. ☐ FLOODPLAIN STORAGE CAPACITY IS IMPACTED	AMOUNT OF FILL: _____(CY) AMOUNT OF CUT: _____(CY) (N/A)
CRMC JURISDICTION ☐ THIS PROJECT REQUIRES A CRMC PERMIT ☐ THE PROPERTY IS SUBJECT TO A SPECIAL AREA MANAGEMENT PLAN ☐ SEA LEVEL RISE MITIGATION WAS DESIGNED INTO THIS PROJECT	
MINUMUM STANDARD 8: LUHHPL IDENTIFICATION (N/A)	
OFFICE OF WASTE MANAGEMENT (OWM) ☐ THERE ARE KNOWN OR SUSPECTED RELEASES OF HAZARDOUS MATERIAL AT THE SITE ☐ THIS SITE IS ON THE LIST OF CERCLA and STATE SITES in RI	OWM CONTACT: _____ ☐ SITE ID#:_____
STORMWATER INDUSTRIAL PERMITTING ☐ THERE ARE EXISTING OR PROPOSED ACTIVITIES THAT ARE CONSIDERED LAND USES WITH HIGHER POTENTIAL POLLUTANT LOADS (LUHPPLS) (see Table 3-2) ☐ CONSTRUCTION IS PROPOSED ON A SITE THAT IS SUBJECT TO THE MULTI-SECTOR GENERAL PERMIT (MSGP) UNDER RULE 31(B)15 OF THE RIPDES REGULATIONS. ☐ ADDITIONAL STORMWATER TREATMENT IS REQUIRED BY THE MSGP	ACTIVITIES: _____ SECTOR: _____ MSGP PERMIT #: _____ EXPLAIN ADDITIONAL TREATMENT: ____ _____

MINIMUM STANDARD 6. REDEVELOPMENT (*Required calculation for all construction projects)		
☐ PRE-CONSTRUCTION IMPERVIOUS AREA		TOTAL IMPERVIOUS AREA **(TIA)** = 0 ac
☐ CALCULATE THE SITE SIZE SITE SIZE **(SS)** = **(TSA)** – **(JW)** – **(CL)** = 58.8 ac		TOTAL SITE AREA **(TSA)** = 64.03 ac JURISDICTIONAL WETLANDS **(JW)**: 5.2 ac CONSERVATION LAND **(CL)** = 0 ac
(TIA)/(SS) = 0/58.8 = 0 ac	**(TIA)/(SS)** IS **>** 0.4) ☐ YES (REDEVELOPMENT) (address minimum standards 3 and 7-11)	**(TIA)/(SS)** IS **<** 0.4) X NO (NEW DEVELOPMENT) (all standards must be addressed)

PART 2: MINIMUM STANDARD 1

LOW IMPACT DEVELOPMENT ASSESSMENT

(**NOT REQUIRED FOR REDEVELOPMENT OR RETROFITS**) – You may delete this section if it is not required

State Law requires the use of low impact-design techniques as the primary method of stormwater control to the maximum extent practicable. LID is intended to maintain or replicate predevelopment hydrology through the use of site planning, source control, and small-scale practices integrated throughout the site to prevent, infiltrate, and manage runoff as close to its source as possible. Non-structural LID techniques to Avoid and Reduce the stormwater impacts of development shall be explored as a first priority before LID structural practices are planned to Manage stormwater as part of a comprehensive LID approach.

The applicant must document specific LID Site Planning and Design Strategies applied for the project (see Manual Chapter Four and the *RI Low Impact Development (LID) Site Planning and Design Guidance Manual* for more details regarding each strategy). This checklist is designed to guide the required documentation of the site planning process, and to ensure that the proposed project is consistent with and taking advantage of LID strategies required or allowed in the municipality where the project is proposed. Included within this checklist are specific LID techniques (and practices) taken from the *RI Low Impact Development (LID) Site Planning and Design Guidance Manual* that a municipality may require or allow.

If a particular strategy is not used or not applicable, a written description of why a certain method is not used or applicable at the site must be provided. Appropriate answers may include such statements as:

- Town requires XXX (state the specific local requirement)
- Meets Town's dimensional requirement of XXXXX.
- Not practical for site because XXXXXX.
- Applying for waiver/variance to achieve this (pending; was approved; was denied)
- Applying for wavier/variance to seek relief from this (pending; approved; denied)

A) PRESERVATION OF UNDISTURBED AREAS, BUFFERS AND FLOODPLAINS X Sensitive resource areas and site constraints are identified (required) X Local development regulations have been reviewed (required) X All vegetated buffers and coastal and freshwater wetlands have been designed to be protected during and after construction ☐ Conservation Development or other site design technique to protect open space and pre-development hydrology; [NOTE: If this technique has been used, check box and skip to **c**.] X Maintain as much natural vegetation and pre-development hydrology as possible	***IF NOT IMPLEMENTED - EXPLAIN HERE***
B) LOCATE DEVELOPMENT IN LESS SENSITIVE AREAS AND WORK WITH THE NATURAL LANDSCAPE CONDITIONS, HYDROLOGY, AND SOILS X Building envelopes/ development sites directed away from wetlands/waterbodies X Development and stormwater systems are located in areas with greatest infiltration capacity (e.g., soil groups A and B. ☐ Plans show measures to prevent soil compaction in areas designated as Qualified Pervious Areas (QPA's) X Building envelopes/ development sites are directed away from floodplains X Site designed to locate buildings, roadways and parking to avoid impacts to surface water features. ☐ Building envelopes/ development sites directed away from steep slopes (≥15%) ☐ Other:	***IF NOT IMPLEMENTED - EXPLAIN HERE***
C) MINIMIZE CLEARING AND GRADING X Site clearing restricted to <u>minimum area needed</u> for building footprints, development activities, construction access and safety. X Site designed to locate buildings, roadways and parking to minimize grading (cut and fill quantities) ☐ Protection for stands of trees and individual trees and their root zones to be preserved is specified and such protection extends at least to the drip line ☐ Notes on plan specify that public trees that are removed or damaged during construction shall be replaced with equivalent.	***IF NOT IMPLEMENTED - EXPLAIN HERE*** Clearing and grading have been minimized

D) REDUCE IMPERVIOUS COVER ☐ Reduce roadway widths (≤22 feet for ADT ≤ 400; ≤ 26 feet for ADT 400-2,000) X Reduce driveway areas (length minimized via reduced ROW width (≤ 45 ft.) and/or reduced (or absolute minimum) front yard setback; width minimized to ≤ 9 ft. wide one lane; ≤ 18 ft. wide two lanes; shared driveways; pervious surface) ☐ Reduced building footprint: Explain approach ☐ Reduce sidewalk area (≤ 4 ft. wide; one side of the street; unpaved path; pervious surface) ☐ Reduce cul-de-sacs (radius < 45 ft; vegetated island; alternative turn-around) ☐ Reduced parking lot area: Explain approach X Pervious surfaces (driveways, sidewalks, parking areas/overflow parking area) X Maximum Impervious Surface (project meets or is less than the maximum specified by the Zoning Ordinance X Other (describe): Site has <1% impervious area in post development conditions	***IF NOT IMPLEMENTED - EXPLAIN HERE*** No roadways are proposed as part of this development. A permeable access drive is proposed to accommodate maintenance and emergency vehicles.
E) DISCONNECT IMPERVIOUS AREA ☐ Impervious surfaces have been disconnected and runoff has been diverted to QPAs to the maximum extent possible ☐ Residential street edges allow side-of-the-road drainage into vegetated open swales ☐ Parking lot landscaping breaks up impervious expanse AND accepts runoff X Other: Site has <1% impervious area in post development conditions	***IF NOT IMPLEMENTED - EXPLAIN HERE*** A negligible amount of impervious area is proposed
F) MITIGATE RUNOFF AT THE POINT OF GENERATION X Small-scale BMPs have been designated to treat runoff as close as possible to the source	***IF NOT IMPLEMENTED - EXPLAIN HERE***
G) PROVIDE LOW-MAINTENANCE NATIVE VEGETATION X Low-maintenance landscaping is proposed using native species and cultivars X Plantings of native trees and shrubs in areas previously cleared of native vegetation are shown on the site plan ☐ Lawn areas have been limited and/or minimized and yards have been kept undisturbed to the maximum extent on residential lots	***IF NOT IMPLEMENTED - EXPLAIN HERE*** No lawn areas proposed. Maintenance is to be performed onsite multiple times annually. This will include mowing areas between solar arrays.
H) RESTORE STREAMS/WETLANDS ☐ Historic drainage patterns have been restored by removing closed drainage systems, daylighting buried streams, and/or restoring degraded stream channels and/or wetlands. ☐ Removal of invasive species X Other	***IF NOT IMPLEMENTED - EXPLAIN HERE*** The stormwater system has been designed to replenish wetland areas with stormwater which has passed through BMPs

PART 3: SUMMARY OF REMAINING STANDARDS

Minimum Standard 2: Groundwater Recharge

X YES ☐ NO The project has been designed to meet the groundwater recharge standard.

If No, please explain the justification for groundwater recharge criterion waiver (i.e. threat of groundwater contamination, or physical limitation), if applicable (see Section 3.3.2);

With such a shallow water table onsite recharge volume was not considered a very important factor. The stone trenches retain the 1-year storm. Even though infiltration was not accounted for in the modeling, a minor amount of infiltration will occur sitewide more than recharging the groundwater onsite.

☐ YES X NO Is this site listed as a CERCLA or contaminated site?, if yes?

☐ YES ☐ NO Has any part of the site been approved for infiltration by the Office of Waste Management? (see Subsurface Contamination Guidance)

☐ YES X NO Is there an ELUR on the property?

TABLE 2-1: Summary of Recharge (see Manual section 3.3.2)

Subwatershed	Total Re_v Required (Acre-ft)	LID Stormwater Credits (Manual see Section 4.6.1)		Recharge Required by Remaining BMPs (acre-ft)	Recharge Provided by BMPs (acre-ft)
		Impervious volume directed to a QPA (acre-ft)	Recharge Credit Applied (acre-ft)		
DP-1: SE Perimeter Wetland	0.0	n/a	n/a	0.0	0.0
DP-2: NE Abutters	0.0	n/a	n/a	0.0	0.0
DP-3: S Abutters	0.0	n/a	n/a	0.0	0.0
DP-4: Natick Ave	0.0	n/a	n/a	0.0	0.0
Totals:	0.0	n/a	n/a	0.0	0.0

**Note: Only BMPs listed in Manual Table 3-5, List of BMPs Acceptable for Recharge may be used to meet the recharge requirement.*

X Indicate below where the pertinent calculations and/or information for the above items are provided (i.e. name of report/document, page numbers);

Stormwater Management Report – Section 3.2 and Re_v=1"*F*I/12
There is a negligible amount of impervious areas onsite.

Minimum Standard 3: Water Quality

X YES ☐ NO Does this project meet or exceed the required water quality volume WQv (see section 3.3.3)?

☐ YES X NO Is the proposed final impervious cover is greater than 20% of the disturbed area (see section 3.3.3)?

☐ If yes, the Spit Pervious/Impervious method in Hydro-Cad was used to calculate WQv, or

☐ If yes, TR-55 or TR-20 was used to calculate WQv, and

X If no, the project meets the minimum WQv of 0.2 watershed inches over the entire disturbed area.

X YES ☐ NO Does this project meet or exceed the ability to treat required water quality flow WQf(see section 3.3.3.2)?

X YES ☐ NO Is there an increase of impervious cover to a receiving water body with impairments?

If yes, please indicate below the method that was used to address the water quality requirements of no further degradation to a low quality water.

☐ RISDISM section H.3 Pollutant Loading Analysis

X The Water Quality Guidance Document (Water Quality Goals and Pollutant Loading Analysis Guidance for Discharges to Impaired Waters)

☐ YES X NO BMPs are proposed that are on the approved technology list if yes, please provide all of the required worksheets from the manufacturer.

☐ YES X NO Additional pollutant-specific requirements and/or pollutant removal efficiencies are applicable to the site as the result of a TMDL, SAMP or other watershed-specific requirements; If yes, please describe:

Impairment: Enteroccus (TMDL 9/22/2011). No sewer, septic, or pet wastes proposed/will occur

TABLE 3-1: Summary of Water Quality (see Manual section 3.3.3)

Subwatershed	Total WQ_v Required (Acre-ft)	LID Stormwater Credits (Manual see Section 4.6.1)		Water Quality Treatment Remaining (acre-ft)	Water Quality Provided by BMPs (acre-ft)
		Impervious volume directed to a QPA (acre-ft)	Water Quality Credit Applied (acre-ft)		
DP-1: SE Perimeter Wetland	0.79	n/a	n/a	0.79	0.077
DP-2: NE Abutters	0.14	n/a	n/a	0.14	0.00
DP-3: S Abutters	0.13	n/a	n/a	0.13	0.00
DP-4: Natick Ave	0.02	n/a	n/a	0.02	0.00
Totals:	1.08	n/a	n/a	1.08	0.077**

**Note: Only BMPs listed in Chapter 5 of the Manual or the Approved Technologies List of BMPs is Acceptable for Water Quality treatment.*

***There is minimal water quality concern on this site because the cover type is changing from a thinly covered forest to grass and there is a negligible amount of impervious is proposed. However, during the WQ storm 0.077-acre feet is infiltrated. It is important to note that all areas are routed to a BMP before discharging to the maximum extent practicable. Finally, 0.077 acre-feet only represents the infiltration volume modeled. For several unlined BMPs infiltration will occur, but to be conservative was not modeled. All runoff is onto a pervious surface. The panels flow onto grass which subsequently infiltrates the stormwater BMPs.*

X YES ☐ NO This project has met the setback requirements for each BMP. If no, please explain

X Indicate below where the pertinent calculations and/or information for the above items are provided (i.e. name of report/document, page numbers);

Stormwater management Report Appendix A

Minimum Standard 4: Conveyance and Natural Channel Protection (3.3.4)

✓ YES ☐ NO Is this standard waived? If yes, please check indicate one or more of the reasons below:

☐ The project directs discharge to a large river (i.e., 4th-order stream or larger. See Appendix I for State-wide list and map of stream order), bodies of water >50.0 acres in surface area (i.e., lakes, ponds, reservoirs), or tidal waters.

☒ The project directs is a small facility with impervious cover of less than or equal to 1 acre.

☐ The project has a post-development peak discharge rate from the facility that is less than 2 cfs for the 1-year, 24-hour Type III design storm event (prior to any attenuation). (**NOTE:** *LID design strategies can greatly reduce the peak discharge rate)*

X YES ☐ NO Conveyance and natural channel protection for the site have been met.

TABLE 4-1: Summary of Channel Protection Volumes (see Manual section 3.3.4)

Drainage Point	Receiving Water Body Name	Coldwater Fishery? Y/N	Total CPv Required (acre-ft)	Total CPv Provided (acre-ft)	Release Rate Modeled in the 1-yr storm (cfs)
DP-1: SE Perimeter Wetland	No Name: RI0006017R-02	N	0	0	0
DP-2: NE Abutters	No Name: RI0006017R-02	N	0	0	0
DP-3: S Abutters	No Name: RI0006017R-02	N	0	0	0
DP-4: Natick Ave	No Name: RI0006017R-02	N	0	0	0

X YES ☐ NO The CPv is released at roughly a uniform rate over a 24-hour duration (see example sizing calculations in Appendix D of the RISDISM).

☐ YES X NO Do additional design restrictions apply resulting from any discharge to cold water fisheries;

If yes, please indicate restrictions and solutions

X Indicate below where the pertinent calculations and/or information for the above items are provided (i.e. name of report/document, page numbers);

See Stormwater Management Report A3.4.2 for swale calculations

Minimum Standard 5: Overbank Flood Protection (3.3.5) (and other potential high flows)

☐ YES X NO Is this standard waived? If yes, please check indicate one or more of the reasons below:

☐ The project directs discharge to a large river (i.e., 4th-order stream or larger. See Appendix I for State-wide list and map of stream order), bodies of water >50.0 acres in surface area (i.e., lakes, ponds, reservoirs), or tidal waters.

☐ A Downstream Analysis (see section 3.3.6), indicates that peak discharge control would not be beneficial or would exacerbate peak flows in a downstream tributary of a particular site (i.e. through coincident peaks)

☐ YES X NO Does the project flow to an MS4 system? If yes, indicate below:

☐ RIDOT ☐ Other _____

(**NOTE**: *your project could be approved by RIDEM but not meet RIDOT or Town standards. RIDOT's regulations indicate that post-volumes must be **less** than pre-volumes for the 10-yr storm at the design point entering the RIDOT system)*. If you have not already received approval for the discharge to an MS4, please explain your strategy to comply with RIDEM and the MS4.

_____
_____
_____

X YES ☐ NO Did you use a model for your analysis, if yes, indicate below

☐ TR-55 ☐ TR-20 X Hydrocad ☐ Other _____

X YES ☐ NO Does the hydrologic model demonstrate that flows from the 100-year event will be safely conveyed to a control practice designed to manage the 100-year event? If no, please explain

_____
_____

X YES ☐ NO Do off-site areas contribute to the subwatersheds and design points? If yes,

X YES ☐ NO Are the areas modeled as "present condition" for both pre- and post-development analysis

X YES ☐ NO Are the off-site areas are shown on the subwatershed maps

X YES ☐ NO Does the hydrologic model confirm safe passage of the 100-year flow through the site for off-site runoff;

☐ YES X NO Is a Downstream Analysis required? (see Manual Section 3.3.6):

Please calculate the following:

Area of disturbance within the sub-watershed (areas) 28.26 acres

Impervious cover (%) <1%

☐ YES X NO Is a dam breach analysis required (earthen embankments over six (6) feet in height, or a capacity of 15 acre-feet or more, and contributes to a significant or high hazard dam?

X YES ☐ NO Does this project meet the overbank flood protection standard?

Subwatershed (design point)	1.2" Peak Flow		1-yr Peak Flow		10-yr Peak Flow		100-yr Peak Flow	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
DP-1: SE Perimeter Wetland (Includes DP2)	0.18	0.02	2.61	0.89	28.22	15.52	100.80	99.04
DP-2: Northeast Abutters	0.15	0.02	0.73	0.56	7.41	3.46	25.91	19.70
DP-3: Southern Abutters	0.00	0.00	0.75	0.72	7.65	6.58	26.72	24.45
DP-4: Natick Ave	0.06	0.06	0.19	0.17	1.56	1.47	4.92	4.77
Totals:	0.39	0.10	4.28	2.34	44.85	27.03	158.35	148.10

X Indicate below where the pertinent calculations and/or information for the above items are provided (i.e. name of report/document, page numbers);

- ☐ Existing condition analysis for each subwatershed, including (curve numbers, times of concentration, runoff rates, volumes, and water surface elevations showing methodologies used and supporting calculations);

  Appendix A Stormwater Management Report

- ☐ Proposed condition analysis for each subwatershed, including (curve numbers, times of concentration, runoff rates, volumes, water surface elevations, and routing showing the methodologies used and supporting calculations);

  Appendix A Stormwater Management Report

- ☐ Final sizing calculations for structural stormwater BMPs including, contributing drainage area, storage, and outlet configuration;

  Appendix A Stormwater Management Report

- ☐ Stage-storage, inflow and outflow hydrographs for storage facilities (e.g., detention, retention, or infiltration facilities);

  Appendix A Stormwater Management Report

Table 5-2 Summary of Best Management Practices

DP No.	BMP ID.	BMP Type (i.e. bioretention or tree filter)	BMP Functions (acre-ft)				Overbank Flood Reduction	Internal Bypass	Horizontal Setback Criteria Met	
			Pre-treatment (volume)	Re_v	WQ_v	CP_v *1-yr storm retained	Y/N	Y/N	Distance (ft)	From constraint (i.e. private well or foundation)
107	Stone Trench A	Stone Trench	N/A	Yes*	Yes*	Yes*	Y	N		
108	Stone Filled Basin B	Stone Filled Basin	N/A	Yes*	Yes*	Yes*	Y	N	>50	>50
110	Stone Trench E	Stone Trench	N/A	Yes*	Yes*	Yes*	Y	N		
112	Stone Filled Basin G	Stone Filled Basin	N/A	n/a	n/a	n/a	Y	N		
111	Stone Filled Basin H	Stone Filled Basin	N/A	Yes*	Yes*	Yes*	Y	N	>50	>50
206	Stone Filled Basin C	Stone Filled Basin	N/A	n/a	n/a	n/a	Y	N		
205	Stone Trench F	Stone Trench	N/A	n/a	n/a	n/a	Y	N		
304	Stone Filled Basin D	Stone Filled Basin	N/A	n/a	n/a	n/a	Y	N		
		TOTAL:								

***A, B, E, &H all provide Recharge, WQv, and CPv through infiltration. G, C, F, &D will infiltrate over time but has not been modeled as part of this analysis.**

Table 5-3 Summary of Soils to evaluate each BMP

DP No.	BMP ID.	BMP Type (i.e. bioretention or tree filter)	Soils Analysis for Each BMP						
			Primary Test Pit ID #	Secondary	Top of Filter Elevation (ft)	SHWT Elevation (ft)	Separation Distance (ft)	Hydrologic Soil Group A,B,C or D	Exfiltration Rate Applied (in/hr)
107	A	Stone Trench	TH-4		168.0	160.2	17.8	B	1.02
108	B	Stone Filled Basin	TH-7		140.0	136.5	3.5	B	1.02
110	E	Stone Trench	TH-5		181.5	178.0	3.5	B	1.02
112	G	Stone Filled Basin	TH-5		148.0	138.0	10	B	n/a
111	H	Stone Filled Basin	TH-7		124.0	118.4	6.6	B	1.02
206	C	Stone Filled Basin	TH-5		142.0	143.0	-1 (LINED)	B	n/a
205	F	Stone Trench	TH-5		VARIES	VARIES	>1	B	n/a
304	D	Stone Filled Basin	TH-1		188.0	187	1.0	B	n/a

Minimum Standard 7: (questions are now asked in Minimum Standard 10 and 11)

Minimum Standard 8: Land Uses with Higher Potential Pollutant Loads (LUHPPLs)

☐ YES X NO Are there any existing activities or land uses proposed that would be considered LUHPPLs (see Manual Table 3-2)? If yes, please describe. If no, you may continue on to Minimum Standard 9:

_____

_____

☐ YES X NO Are these activities already covered under an MSGP? If, no please explain if you have applied for an MSGP, or intend to do so?

_____

_____

☐ YES X NO ☐ List the specific BMPs that are proposed for this project that receive stormwater from LUHPPL drainage areas. These BMP types must be listed in Manual Table 3-3, "Acceptable BMPs for Use at LUHPPLs";

Please list BMPs _____

☐ Additional BMPs, or additional pretreatment BMP's if any, that meet RIPDES MSGP requirements;

Please list BMPs _____

☐ Indicate below where the pertinent calculations and/or information for the above items are provided (i.e. name of report/document, page numbers);_____

_____

Minimum Standard 9: Illicit Discharges

☐ YES X NO Have you checked for illicit discharges?

☐ YES X NO Have any been found and/or corrected? If yes, please identify

_____

☐ YES X NO Does your report explain preventative measures that keep non-stormwater discharges out of the Waters of the State (during and after construction)?

Minimum Standard 10 Soil Erosion and Sediment Control

X YES ☐ NO Have you included a Soil Erosion and Sediment Control Plan Set and/or Complete Construction Plan Set?

X YES ☐ NO Did you provide a separately bound document based upon the SESC Template? If yes, proceed to Minimum Standard 11 (the following items can be assumed to be addressed). If no, include a document with your submittal that addresses the following:

Elements of a SESC Plan:

X Soil Erosion and Sediment Control Plan project narrative including a description of how the fifteen (15) Performance Criteria have been met:

X Provide Natural Buffers and Maintain Existing Vegetation;

X Minimize Area of Disturbance;

X Minimize the Disturbance of Steep Slopes;
X Preserve Topsoil;
X Stabilize Soils;
X Protect Storm Drain Inlets;
X Protect Storm Drain Outlets;
X Establish Temporary Controls for the Protection of Post-Construction Stormwater Control Measures;
X Establish Perimeter Controls and Sediment Barriers;
X Divert or Manage Run-On from Up-Gradient Areas;
X Properly Design Constructed Stormwater Conveyance Channels;
X Retain Sediment On-Site;
X Control Temporary Increases in Stormwater Velocity, Volume, and Peak Flows;
X Apply construction Activity Pollution Prevention Control Measures;
X Install, Inspect, and Maintain Control Measures and Take Corrective Actions.

X Qualified SESC plan preparer's information and certification;

☐ Operator's information and certification; if not known at the time of application the operator must certify the SESC Plan upon selection and prior to initiating site activities;

X Description of control measures such as temporary sediment trapping and conveyance practices, including design calculations and supporting documentation, as required.

Minimum Standard 7&11: Stormwater Management System Operation, Maintenance and Pollution Prevention Plan (See section 3.2.11 and Appendices G and E for guidance)

X YES ☐ NO Have you minimized all sources of pollutant contact with stormwater runoff, to the maximum extent practicable?

X YES ☐ NO Have you provided a separately bound **Operations, Maintenance and Pollution Prevention Manual** for the site and for all of the BMPs?

The (O&M and PP Plan Contains):

X YES ☐ NO Contact name, address, and phone number of the responsible party for maintenance;

X YES ☐ NO 8.5" x 11" map indicating the location of all of the proposed stormwater BMPs that will require maintenance;

X YES ☐ NO Description of routine and non-routine maintenance tasks and their frequency for required elements for each BMP;

X YES ☐ NO A description and delineation of public safety features;

X YES ☐ NO An estimated operations and maintenance budget;

X YES ☐ NO Minimum vegetative cover requirements;

X YES ☐ NO Access and safety for maintenance?

X YES ☐ NO Lawn, Garden and Landscape Management meet the requirements of section G.7? If not, why not?

_____

_____

X YES ☐ NO Is the property owner or homeowners association is responsible for the stormwater maintenance of all BMP's?

If no, you must provide a legally binding and enforceable maintenance agreement (see Appendix E-page

26) that identifies the entity that will be responsible for maintenance of the stormwater. Please indicate where this agreement can be found in your report:_____

☐ YES X NO Do you anticipate that you will need legal agreements related to the stormwater structures? (e.g. off-site easements, deed restrictions, and covenants).
If yes, have you obtained them? Or please explain your plan to obtain them:
_____
_____

☐ YES X NO Is stormwater being directed from public areas to private property? If yes, *(***NOTE***: this is not allowed unless there is a funding mechanism in place to provide the finances for the long-term maintenance of the BMP and drainage unless there is a funding mechanism is demonstrated that can guarantee the long-term maintenance of a stormwater BMP by an individual homeowner*)
_____
_____

Pollution Prevention Section Contains:

☐ YES X NO Designated snow stockpile locations?

☐ YES ☐ NO Trash racks to prevent floatables, trash and debris from discharging to waters of the state? N/A

☐ YES X NO Asphalt only based sealants?

☐ YES X NO Pet waste stations? (**NOTE:** *if a receiving water has a bacterial impairment and the project involves housing units, this could be an important part your pollution prevention plan*)

☐ YES X NO Regular sweeping? Please describe No impervious roads proposed.

☐ YES X NO Deicing specifications in accordance with Appendix G of the Manual. (**NOTE***: if the groundwater is GAA or this area contributes to a drinking water supply, this could be an important part of your pollution prevention plan (see Appendix G):* No deicing will be permitted onsite.

X YES ☐ NO A prohibition of phosphate based fertilizers? (**NOTE**: *if the site discharges to a phosphorus impaired waterbody, this could be an important part of your pollution prevention plan*)?

PART 3: SUBWATERSHED MAPPING AND SITE PLAN DETAILS

Existing and Proposed Subwatershed Mapping (REQUIRED)

X Existing and proposed drainage area delineations

X Locations, cross sections, and profiles of all streams and drainage swales and their method of stabilization;

X Drainage flow paths, mapped according to the DEM Guidance for Preparation of Drainage Area Maps (included in Appendix K).

X Complete drainage area boundaries; include off-site areas in both mapping and analyses, as applicable;

X Logs of borings and/or test pit investigations along with supporting soils/geotechnical report.

X Mapped seasonal high water table,

X Mapped locations of the site-specific borings and/or test pits and soils information from the test pits at the locations of the BMPs

X Mapped locations of the BMPs with the BMPs consistently identified on the Site Construction Plans

☐ Mapping bedrock within 3' of any BMP N/A

X YES ☐ NO Soils were logged by a:

X DEM-licensed Class IV soil evaluator Name: Marianne Diffin

☐ RI-registered PE. Name; _____

Subwatershed Summary *(add or subtract rows as necessary)*				
Subwatershed (acres to each design point)	**First Receiving Water ID or MS4**	**Area Disturbed (acres)**	**Existing Impervious (acres)**	**Proposed Impervious (acres)**
DP-1: SE Perimeter Wetland	No Name RI0006017R-02	21.08	0	0
DP-2: NE Abutters	No Name RI0006017R-02	2.39	0	0
DP-3: S Abutters	No Name RI0006017R-02	4.79	0	0
DP-4: Natick Ave	No Name RI0006017R-02	0	0	0
Totals:		28.26	0	0*

*Negligible Impervious area onsite.

Site Construction Plans (the following applicable specifications are provided)

X Existing and proposed plans (scale not greater than 1" = 40') with North arrow

X Existing and proposed site topography (with 1 or 2-foot contours). 10-foot contours accepted for off-site areas

X Boundaries of existing predominant vegetation and proposed limits of clearing;

X Site Location clarification

X Location and field-verified boundaries of resource protection areas such as:

- freshwater and coastal wetlands, lakes, ponds,
- coastal shoreline features
- Perennial and intermittent streams, in addition to areas subject to storm flowage (ASSFs);

X All required setbacks (e.g., buffers, water supply wells, septic systems);

X Representative cross-section and profile drawings, notes and details of structural stormwater management practices and conveyances (i.e., storm drains, open channels, swales, etc.), which include:

- Location and size of the stormwater treatment practices (type of practice, depth, area). Stormwater treatment practices (BMPs) must have labels that correspond to table 5-2;
- Design water surface elevations (applicable storms);

- Structural details of outlet structures, embankments, spillways, stilling basins, grade control structures, conveyance channels, etc.;
- Existing and proposed structural elevations (e.g., invert of pipes, manholes, etc.);
- Location of floodplain and, if applicable, floodway limits and relationship of site to upstream and downstream properties or drainage that could be affected by work in the floodplain;
- Planting plans for structural stormwater BMPs, including species, size, planting methods, and maintenance requirements of proposed planting;
- Logs of borings and/or test pit investigations along with supporting soils/geotechnical report and corresponding water tables.

☐ Mapping of any OWM approved activities related to current/former site use areas for any known contamination and/or remedial clean-up efforts.

X Location of existing and proposed roads, buildings, and other structures including limits of disturbance;

- Existing and proposed utilities (e.g., water, sewer, gas, electric) and easements;
- Location of existing and proposed conveyance systems such as grass channels, swales, and storm drains, as well as location(s) of final discharge point (wetland, waterbody);
- Cross sections of roadways, with edge details such as curbs and sidewalks;
- Location and dimensions of channel modifications, such as bridge or culvert crossings;
- Locations, cross sections, and profiles of all stream or wetland crossings and their method of stabilization

1.0 Project Description

The purpose of this report is to specify a Storm Water Management System to be implemented in the new Project on Natick Avenue in Cranston, RI.

The site has a total area of 64.03 acres and are located on Assessor's Plat 22 Lots 118 and 109 and are zoned A-80. The proposed development is for an 8.1-megawatt solar farm that will meet the Solar Power Performance Standards as set forth in the City of Cranston Zoning regulations Section 17.23.020. The solar farm will utilize approximately 28.26 acres of upland areas and clearing of natural vegetation will be limited to what is necessary for the construction and operation of the solar power facility. Topsoil will only be disturbed as necessary to provide proper grading for installation of the solar power facility, but topsoil will not be removed from the site. The areas of development will be located outside all the jurisdictional wetland areas, including the buffer areas. The majority of the area between the panels and underneath the panels will remain as grass, which will provide absorption and infiltration for storm water.

Access to the to the site will be from the existing driveway located off Natick Avenue. The applicant is proposing only minimal improvements to this existing roadway, as necessary, to provide safe access for construction, maintenance, and fire/emergency safety vehicles. The development area will be enclosed by a security fence and signage will only be located on this fence.

The stormwater quality will be improved by utilizing Best Management Practices (BMPs) as established by the RISDISM for the treatment of storm water runoff from the proposed development. BMPs will consist of stone trenches and swales. The system has been designed to meet the RIDEM Stormwater Design and Installations Standards Manual.

2.0 Site Conditions

2.1 SOILS

There are the following soil types within the analyzed area of the Site as mapped by the NRCS USDA Soil Conservation service:

Soil Symbol	Description	Hydrologic Group
CaD	Canton-Charlton-Rock outcrop complex, 15 to 35 percent slopes	B
CeC	Canton and Charlton fine sandy loams, very rocky, 3 to 15 percent slopes	B
ChB	Canton and Charlton very stony fine sandy loams, 3 to 8 percent slopes	B
Rf	Ridgebury, Whitman, and Leicester extremely stony fine sandy loams	D
WcB	Wapping very stony silt loam, 0 to 8 percent slopes	B

The onsite soils are predominantly in Hydrologic Group B. Soils within the limit of disturbance include CeC – Canton and Charlton fine sandy loams, and WcB – Wapping very stony silt loam. Wetland soils are Rf – Ridgebury, Whitman and Leicester extremely stony fine sandy loams, which is Hydrologic Group D. Soil evaluations show that the water table on the site ranged from 0" to 78" and depth to ledge ranged from 36" to not present at all, with some ledge visible at the surface.

Site specific soil evaluations can be found in Appendix A2.1.

2.2 EXISTING SITE CONDITIONS

The site is currently covered in existing vegetation identified as mixed forest and grass and has varying degrees of topography throughout the site. The south portion of the site has moderate to severe slopes and has thinly spaced vegetation throughout. There are existing trails throughout the site and multiple existing structures. The site has wetland areas on its western side and eastern side. All stormwater from the site eventually discharge to an existing wetland system which finally discharges to Meshanticut Brook. Four design points have been identified within the proposed development area. Design Point 1 is the southeastern wetland area and receives water from the majority of the proposed development. Design Point 2 is northeastern abutters that receives water from the properties of northern abutters and the northeast corner of the development. Design Point 3 has been identified as southern abutting properties and receives runoff from the southwestern side of the proposed development. Design Point 4 has been identified as Natick Ave that receives water from a portion of the northeast area of the site.

2.3 POST SITE CONDITIONS

The proposed drainage analysis uses stormwater management systems to control and treat runoff from the proposed development. The following BMP's are used on site and have been designed to include the following elements:

- Open Channels (Swales)
    - Provide conveyance of stormwater
    - Pretreatment
- Stone Filled Basins –these basins serve varying purposes depending on the groundwater separation they exhibit. Please refer to the RIDEM Appendix A checklist at the beginning of this report. It is also important to review the site plans because many of these BMPs function in series to meet peak, WQ, and CPv requirements.
    - 1' or less of groundwater table separation function as a detention pond for peak control.
    - 1-2' of groundwater table separation no infiltration accounted for and 1-year storm retained.
    - 2' of groundwater table separation infiltration.
- Stone Trenches

The above elements will used to meet the design standards of the Rhode Island Stormwater Design and Installation Standard.

The primary goal of increasing water quality treatment is accomplished by providing water quality BMPs. Stormwater runoff mitigation is provided through the use of stone trenches. By reducing post development stormwater flow rate to a level no greater than the pre-development rate, the second goal of the proposed drainage system is achieved. Any potential impacts from the proposed development on the abutting properties the southeastern wetland, and Natick Avenue have been mitigated.

3.0 Minimum Standards

The site has been designed to meet the minimum standards as outlined in the Rhode Island Stormwater Design and Installation Standards Manual (RISDISM). The following sections outline how the site meets and exceeds the minimum required standards.

3.1 Minimum Standard 1: LID Site Planning and Design Strategies

See "Appendix A: Stormwater Management Checklist" from the RISDISM provided at the beginning of this report.

3.2 Minimum Standard 2: Groundwater Recharge

Groundwater is to be recharged per watershed based on impervious area coverage in accordance with section 3.2.2 of the RISDISM.

Groundwater recharge is determined from the following equation:
Re_v=1"*F*I/12

Where:

Re_v=Groundwater Recharge Volume (ac-ft)

F=Recharge Factor based on Hydrologic Soil Groups (HSG) (see table below)

I=Impervious Area (acres)

HSG	Recharge Factor (F)
A	0.60
B	0.35
C	0.25
D	0.10

There is a negligible amount of impervious area being proposed onsite.

The required recharge volume is based on all impervious area, not just areas which are captured in the proposed BMPs.

HydroCAD printouts are available in Appendix A3.2 for the water quality storm. The water quality storm is calculated in HydroCAD using the 'calculate separate Pervious/Impervious runoff' option.

3.3 Minimum Standard 3: Water Quality

All stormwater is treated through an approved BMP before being discharged to the extent practicable. This site has been designed to use stone filled basins and stone trenches to allow for infiltration (infiltration not accounted for on every pond, please refer to HCAD and Appendix A). BMPs serve varying purposes depending on the groundwater separation they exhibit. This site was designed to prevent the need for trucking in tens of thousands of yards of fill to raise the elevation of BMPs and naturally route

water to BMP areas where separation minimums can be met. It is also important to review the site plans because many of these BMPs function in series to meet peak, WQ, and CPv requirements.

There is a pollutant specific requirement for Enterococcus onsite, however, because there are no septic, sewer, or pet wastes onsite the runoff will not contribute to this impairment. Additionally, the entire site will be vegetated and function similar to a grass filter strip once complete. Finally, because infiltration is utilized onsite bacterial impairments will be treated before discharge.

3.4 Minimum Standard 4: Conveyance and Natural Channel Protection

3.4.1 Drainage Network Design Parameters:

A. PIPES

- All drainage pipes are HDPE or equivalent unless otherwise noted.
- Manning's coefficient = 0.012 for HDPE Pipe
- Diameters & lengths as specified
- The 100-year design storm is utilized for the drainage pipe design to ensure that the drainage system contains and channels water to the BMP areas as shown on the plans.

B. STRUCTURES

- No structures are utilized in this design.

C. OPEN CHANNELS SYSTEMS (SWALES)

- All open channels systems shall be grass channels unless otherwise noted
- Manning's coefficient =0.030
- Width, depth, slope and side slopes as noted on plans.
- The 100-year design storm is utilized for the open channel design to ensure that the drainage system contains and channels water to the BMP areas as shown on the plans.
- Hydraflow Express Extension for Autodesk Civil 3D has been used to model a typical swale. See Appendix A3.5.4.4.

3.4.2 Channel Protection Volume:

The detention basins have been designed to release the 1-year storm volume over a 24 hour time span in accordance with Section 3.2.4 of the RISDISM.

The site has been designed to fully infiltrate the channel protection volume with the exception of Stone Filled Basin H. Stone Filled basin H has been fit with a culvert system which along with infiltration will help slowly release the 1-year storm volume over a 24 hour time span in accordance with Section 3.2.4 of the RISDISM.

The channel protection required has been met.

See table 4-1 of the Appendix A Checklist for a Summary of Channel Protection Volumes. HydroCAD printouts are available in Appendix A3.5.4.2 for the 1-year storm event.

3.5 Minimum Standard 5: Overbank Flood Protection & Downstream Analysis

3.5.1 Method of Analysis

USDA Soil Conservation Service Method as defined by Technical Release No. 20 (TR-20) determines Stormwater runoff rate and volume. Type III rainfall distribution is utilized. Time of concentration is determined using Technical Release No 55 (TR-55) methodology, through the computer program *HydroCAD ver. 10.0* by Applied Microcomputer Systems.

Soil has been modeled in HydroCAD with a 1.02 inches/hr infiltration rate per Section 5.5.4 of the Stormwater Regulations where applicable. Soil evaluations have been performed by DiPrete Engineering. The existing soil has a texture of Loamy Sand. Based on table 5.5.4 the underlying soils have the same/less/greater infiltration rate.

The drainage system has been designed to mitigate all stormwater flows for the 10- and 100-year storm events. The emergency outlets have been sized to handle the 100-year storm event.

3.5.2 Design Storm

Analysis of 1-year, 10-year, and 100-year frequency storms are included. The following 24-hour rainfall intensities are obtained from the Rhode Island Stormwater Design and Installation Standards Manual,

Table 3-1 for Providence County.

1 year =	2.7 inches
10 year =	4.9 inches
100 year=	8.7 inches

3.5.3 Design Point Breakdown

The site is analyzed as 4 Design points. In the pre-development stage there are 4 subcatchments. In the post development stage, there are 13 subcatchments. Each watershed will demonstrate zero increase of runoff due to the proposed development. A description of each watershed and associated subcatchments are summarized as follows:

Design Point #1: SE Perimeter Wetland

In pre-development conditions, there is one watershed to the Design Point. Pre-1 (11) contains most of the project site and is predominately thinly wooded. In post development conditions there are seven sub watersheds. Once this water reached the SE Perimeter Wetland in both pre and post conditions it is conveyed to a 24'' metal culvert and under Natick Ave.

Below is a summary of the hydrologic parameters for the pre and post development sub-areas in Design Point-1.

	Area (acres)	CN	Tc (min)
Pre-11	30.168	59	26.0
Post-101	10.849	61	15.7
Post-102	2.204	59	10.6
Post-103	1.217	64	6.0
Post-104	5.197	61	13.9
Post-105	2.946	61	9.2
Post-105A	3.794	61	11.1
Post-106	2.929	61	11.6

Design Point #2: NE Abutters

In pre-development conditions, there is one watershed to the Design Point. Pre-2 (21) a large amount offsite area. The cover type is predominately thinly wooded. In post development conditions there are three sub watersheds. This design point was created to be certain that flow in post conditions does not exceed pre-conditions to protect the abutting properties and homes. This design point eventually runs back across the property and to DP-1

Below is a summary of the hydrologic parameters for the pre and post development sub-areas in Design Point-2.

	Area (acres)	CN	Tc (min)
Pre-21	8.072	60	17.2
Post-201	5.289	60	14.9
Post-203	2.693	65	16.2
Post-204	0.539	61	6.0

Design Point #3: S Abutters

In pre-development conditions, there is one watershed to the Design Point 3, Pre-3 (31). The cover type is predominately thinly wooded. In post development conditions there are two sub watersheds. This design point was created to ensure homes and properties to the south of this development are protected from any hydrologic change associated with the modification in cover type associated with this development. As shown in this report BMPs are able to offset this change.

Below is a summary of the hydrologic parameters for the pre and post development sub-areas in Design Point-2.

	Area (acres)	CN	Tc (min)
Pre-31	8.129	60	16.2
Post-301	6.495	61	16.0
Post-302	1.486	61	8.8

Design Point #4: Natick Ave Undetained

In pre-development conditions, there is one watershed discharging to Design Point 4, Pre-4 (41). The cover type is predominately thinly wooded and contained a few abutters homes. In post development conditions there is one sub watershed as well. This watershed represents almost entirely offsite area with the only change being the enhanced permeable access drive on the proposed site. This was modeled to be sure all water flowing to the culvert beneath Natick Ave was properly modeled.

Below is a summary of the hydrologic parameters for the pre and post development sub-areas in Design Point-4.

	Area (acres)	CN	Tc (min)
Pre-41	1.201	63	11.6
Post-401	1.201	62	11.6

3.5.4 Q_p BMP Calculations

The outlets have been sized to safely pass the 100-year storm and beyond without erosion or overtopping the embankment. Under normal conditions, minimal stormwater will flow over the emergency spillway and the pond will have freeboard to extent practicable. Please see plans for all inverts.

The velocity over all spillways is less than 3 ft/s, thus no erosion will take place on the embankment or downstream. All of the weirs and pipes are fit with riprap in order to be conservative and prevent erosive flows. See attached HydroCAD reports.

Outlet Protection

Riprap aprons are designed at the drainage pipe discharges and outlets. The aprons are designed to prevent scour at the storm water outlet and to minimize the potential for downstream erosion by reducing the velocity of concentrated storm water flows. See riprap and level spreader details in the plan set.

3.5.5 Downstream Analysis

The Site has limit of disturbed area of 28.26 acres and contains a negligible amount of impervious area (concrete equipment pads). There will be no net increase in stormwater runoff from pre-development to post-development conditions from the 1 year through 100-year storm event. Due to the reduction in stormwater flow from pre to post development, insignificant amount of proposed impervious area, location of the site and stable surrounding drainage conditions a downstream analysis was not performed per the ultimate design point. A downstream analysis is not required per the rules of section 3.3.6 in the RIDEM checklist.

3.5.6 Overbank Flood Protection Conclusion

The table below presents a summary of the pre-development flows vs. the mitigated post development flows. The table shows a decrease in the rate of runoff for all storms included in the analysis.

Pre-Development Flows vs. Post-Development Flows Mitigated

Subwatershed (design point)	1.2" Peak Flow		1-yr Peak Flow		10-yr Peak Flow		100-yr Peak Flow	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post
DP-1: SE Perimeter Wetland (Includes DP2)	0.18	0.02	2.61	0.89	28.22	15.52	100.80	99.04
DP-2: Northeast Abutters	0.15	0.02	0.73	0.56	7.41	3.46	25.91	19.70
DP-3: Southern Abutters	0.00	0.00	0.75	0.72	7.65	6.58	26.72	24.59
DP-4: Natick Ave	0.06	0.06	0.19	0.17	1.56	1.47	4.92	4.77
Totals:	0.39	0.10	4.28	2.34	44.85	27.03	158.35	148.10

All flows in cubic feet per second (cfs)

As shown in the table above, no increase in stormwater runoff flow will occur following the proposed construction during the 1 through 100-year storm events.

3.6 Minimum Standard 6: Redevelopment and Infill Projects.

The site is not classified as a redevelopment or infill project.

3.7 Minimum Standard 7: Pollution Prevention

A Soil Erosion and Sediment Control Plan (SESC) for this development can be found under a separate document. See the Soil Erosion and Sediment Control Plan for the development prepared by DiPrete Engineering. The SESC contains information for construction pollution prevention. For post construction pollution prevention see the Operations and Maintenance (O&M) document prepared for this development by DiPrete Engineering.

3.8 Minimum Standard 8: Land Uses with High Potential Pollutant Loads (LUHPPls)

The site is not considered LUHHPL.

3.9 Minimum Standard 9: Illicit Discharges

There are no proposed Illicit Discharges on site. The site will be serviced by public water and sewer.

3.10 Minimum Standard 10: Construction Activity Soil Erosion, Runoff and Sedimentation and Pollution Prevention Control Measure Requirements

See the SESC for this development prepared by DiPrete Engineering.

3.11 Minimum Standard 11: Stormwater Management System Operation and Maintenance

See the O&M for this development prepared by DiPrete Engineering.

Appendix A

A2.1 Soil Evaluations

DiPrete Engineering

Project Number: 2437-015 Natick Ave Solar
Property Location: 1936 Phenix Avenue, Cranston, RI
Date of Test Hole: February 21, 2019
Soil Evaluator: Marianne Diffin License #: D-4093
Weather: Fair, 40's Shaded (Y/N): Y Time: 10:00 am

TH 1 **Parent Material**: Eolian over Ablation Till

Horizon	Depth	Matrix	Redox (Y/N)	Texture	Consistence	Soil Category
Oe	0-4"					
Ap	4-13"	10YR 3/1	N	sil	1 - sbk - fr	5
Bw1	13-24"	10YR 5/2	Y	vfsl	1 - sbk - fr	5
Bw1	24-78"	10YR 5/3	Y	sil	1 - sbk - fr	5
2C	78-84"	10YR 6/2	Y	fs	0 - l - vfr	1

TH 2 **Parent Material**: Eolian over Ablation Till

Horizon	Depth	Matrix	Redox (Y/N)	Texture	Consistence	Soil Category
A	0-4"	10YR 3/3	N	sil	1 - sbk - fr	5
Bw	4-29"	10YR 5/6	Y	sil	1 - sbk - fr	5
2C1	29-60"	10YR 5/2	Y	vfs	1 - sbk - vfr	7
2C2	60-90"	10YR 5/3	Y	s	0 - l - sg	1

TH 1 Total Depth 84" Impervious/Limiting Layer Depth n/a (og) GW Seepage Depth 29" SHWT 12" (og)

TH 2 Total Depth 90" Impervious/Limiting Layer Depth n/a (og) GW Seepage Depth 24" SHWT 12" (og)

Comments: Lenses of siltier materials within C horizons of both testholes

DiPrete Engineering

Project Number: 2437-015 Natick Ave Solar
Property Location: 1936 Phenix Avenue, Cranston, RI
Date of Test Hole: February 21, 2019
Soil Evaluator: Marianne Diffin License #: D-4093
Weather: Fair, 40's Shaded (Y/N): Y Time: 11:00 am

TH 3 **Parent Material**: Ablation Till

Horizon	Depth	Matrix	Redox (Y/N)	Texture	Consistence	Soil Category
Ap	0-11"	10YR 2/2	N	sl	1 - sbk - fr	3
Bw1	11-18"	10YR 5/3	Y	sl	1 - sbk - fr	3
Bw2	18-32"	10YR 5/2	Y	fsl	1 - sbk - fr	7
C	32-84"	10YR 6/3	Y	fsl	0 - m - vfr	7

TH 4 **Parent Material**: Eolian over Ablation Till

Horizon	Depth	Matrix	Redox (Y/N)	Texture	Consistence	Soil Category
HTM	0-10"					
Ap	10-18"	10YR 2/2	N	sil	1 - sbk - fr	5
Bw	18-30"	10YR 5/4	Y	sil	1 - sbk - fr	5
2C	30-54"	10YR 5/2	Y	fs	1 - sbk - vfr	1

TH 3 Total Depth 84" Impervious/Limiting Layer Depth n/a (og) GW Seepage Depth n/a SHWT 24" (og)

TH 4 Total Depth 54" Impervious/Limiting Layer Depth 54" (og) GW Seepage Depth 54" SHWT 24" (og)

Comments: Pockets of siltier material in C horizon of testhole 3

DiPrete Engineering

Project Number: 2437-015 Natick Ave Solar
Property Location: 1936 Phenix Avenue, Cranston, RI
Date of Test Hole: February 21, 2019
Soil Evaluator: Marianne Diffin License #: D-4093
Weather: Fair, 40's Shaded (Y/N): Y Time: 1:00 pm

TH 5 **Parent Material**: Eolian over Ablation Till

Horizon	Depth	Matrix	Redox (Y/N)	Texture	Consistence	Soil Category
A	0-10"	10YR 3/4	N	sil	1 - sbk - fr	5
Bw	10-24"	10YR 5/4	N	sil	1 - sbk - fr	5
2C	24-54"	10YR 5/4	N	gls	0 - m - vfr	6

TH 6 **Parent Material**: Eolian over Ablation Till

Horizon	Depth	Matrix	Redox (Y/N)	Texture	Consistence	Soil Category
Ap	0-10"	10YR 3/2	N	sil	1 - sbk - fr	5
Bw	10-24"	10YR 5/3	Y	sil	1 - sbk - fr	5
2C	24-54"	10YR 5/2	Y	fsl	0 - m - vfr	7

TH 5 Total Depth 54" Impervious/Limiting Layer Depth 54" (og) GW Seepage Depth n/a SHWT 54" (og)

TH 6 Total Depth 54" Impervious/Limiting Layer Depth 54" (og) GW Seepage Depth 50" SHWT 24" (og)

Comments:

DiPrete Engineering

Project Number: 2437-015 Natick Ave Solar
Property Location: 1936 Phenix Avenue, Cranston, RI
Date of Test Hole: February 21, 2019
Soil Evaluator: Marianne Diffin License #: D-4093
Weather: Fair, 40's Shaded (Y/N): Y Time: 2:00pm

TH 7 **Parent Material**: Eolian over Ablation Till

Horizon	Depth	Matrix	Redox (Y/N)	Texture	Consistence	Soil Category
A	0-5"	10YR 3/4	N	sil	1 - sbk - fr	5
Bw	5-36"	10YR 5/3	N	sil	1 - sbk - fr	5
2C	36-42"	10YR 5/2	N	gsl	1 - sbk - fr	3

TH 8 **Parent Material**: Ablation Till

Horizon	Depth	Matrix	Redox (Y/N)	Texture	Consistence	Soil Category
A	0-5"	10YR 3/2	N	sl	1 - sbk - fr	3
Bw1	5-14"	10YR 4/6	N	sl	1 - sbk - fr	3
Bw2	14-24"	2.5Y 5/6	Y	fsl	1 - sbk - fr	4
C	24-84"	2.5Y 5/3	Y	fs	1 - sbk - fr	1

TH 7 Total Depth 42" Impervious/Limiting Layer Depth 42" (og) GW Seepage Depth n/a SHWT 42" (og)

TH 8 Total Depth 84" Impervious/Limiting Layer Depth n/a (og) GW Seepage Depth n/a SHWT 60" (og)

Comments: Testhole 8 had redox starting at 18" but was dry thoughout, despite all other testholes evaluated on-site with redox being quite wet throughout the profile.

DiPrete Engineering

Project Number: 2437-015 Natick Ave Solar
Property Location: 1936 Phenix Avenue, Cranston, RI
Date of Test Hole: February 21, 2019
Soil Evaluator: Marianne Diffin License #: D-4093
Weather: Fair, 40's Shaded (Y/N): Y Time: 3:00pm

TH 9 **Parent Material**: Eoilian over Ablation Till

Horizon	Depth	Matrix	Redox (Y/N)	Texture	Consistence	Soil Category
A	0-3"	10YR 3/2	N	sil	1 - sbk - fr	5
Bw1	3-11"	7.5YR 4/4	N	sil	1 - sbk - fr	5
Bw2	11-22"	10YR 5/6	N	sil	1 - sbk - fr	5
2C	22-42"	10YR 5/2	N	ls	0 - m - vfr	6

TH 10 **Parent Material**: Eolioan over Ablation Till

Horizon	Depth	Matrix	Redox (Y/N)	Texture	Consistence	Soil Category
A	0-4"	10YR 3/2	N	sil	1 - sbk - fr	5
Bw1	4-36"	10YR 5/4	N	sil	1 - sbk - fr	5
2C	36-72"	2.5YR 5/3	N	bdls	0 - m - vfr	6

TH 9 Total Depth 42" Impervious/Limiting Layer Depth 42" (og) GW Seepage Depth n/a SHWT 42" (og)

TH 10 Total Depth 72" Impervious/Limiting Layer Depth 72" (og) GW Seepage Depth n/a SHWT 60" (og)

Comments:

A3.2 Water Quality HydroCAD Storm Analysis

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Split Pervious/Imperv.
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment101: Post-101 Runoff Area=10.849 ac 0.20% Impervious Runoff Depth=0.00"
Flow Length=831' Tc=15.7 min CN=60/98 Runoff=0.02 cfs 0.002 af

Subcatchment102: Post-102 Runoff Area=2.204 ac 1.36% Impervious Runoff Depth=0.01"
Flow Length=345' Tc=10.6 min CN=58/98 Runoff=0.03 cfs 0.002 af

Subcatchment103: Post-103 Runoff Area=1.217 ac 7.40% Impervious Runoff Depth=0.07"
Tc=6.0 min CN=61/98 Runoff=0.10 cfs 0.007 af

Subcatchment104: WPost-104 Runoff Area=5.197 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=975' Tc=13.9 min CN=61/0 Runoff=0.00 cfs 0.000 af

Subcatchment105: WPost-105 Runoff Area=2.946 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=714' Tc=9.2 min CN=61/0 Runoff=0.00 cfs 0.000 af

Subcatchment105A: WPost-105A Runoff Area=3.794 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=696' Tc=11.1 min CN=61/0 Runoff=0.00 cfs 0.000 af

Subcatchment106: Post 106 - UNDETAINED Runoff Area=2.929 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=570' Tc=11.6 min CN=61/0 Runoff=0.00 cfs 0.000 af

Subcatchment107B: Stone Trench A Runoff Area=0.612 ac 100.00% Impervious Runoff Depth=0.99"
Tc=0.0 min CN=0/98 Runoff=0.82 cfs 0.050 af

Subcatchment108B: Stone Trench B Runoff Area=0.018 ac 100.00% Impervious Runoff Depth=0.99"
Tc=0.0 min CN=0/98 Runoff=0.02 cfs 0.001 af

Subcatchment110B: Stone Trench E Runoff Area=0.074 ac 100.00% Impervious Runoff Depth=0.99"
Tc=0.0 min CN=0/98 Runoff=0.10 cfs 0.006 af

Subcatchment111B: Stone Trench H Runoff Area=0.027 ac 100.00% Impervious Runoff Depth=0.99"
Tc=0.0 min CN=0/98 Runoff=0.04 cfs 0.002 af

Subcatchment201: Post-201 Runoff Area=5.289 ac 3.12% Impervious Runoff Depth=0.03"
Flow Length=1,350' Tc=14.9 min CN=59/98 Runoff=0.14 cfs 0.014 af

Subcatchment203: WPost-203-Undetained Runoff Area=2.693 ac 0.74% Impervious Runoff Depth=0.01"
Flow Length=850' Tc=16.2 min CN=65/98 Runoff=0.02 cfs 0.002 af

Subcatchment204: WPost-204 Runoff Area=0.539 ac 0.00% Impervious Runoff Depth=0.00"
Tc=6.0 min CN=61/0 Runoff=0.00 cfs 0.000 af

Subcatchment301: Post 301 UNDETAINED Runoff Area=6.495 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=1,082' Tc=16.0 min CN=61/0 Runoff=0.00 cfs 0.000 af

Subcatchment302: Post 302 Runoff Area=1.486 ac 0.00% Impervious Runoff Depth=0.00"
Flow Length=208' Tc=8.8 min CN=61/0 Runoff=0.00 cfs 0.000 af

Subcatchment 401: Post-401 Runoff Area=1.201 ac 5.75% Impervious Runoff Depth=0.06"
Flow Length=658' Tc=11.6 min CN=59/98 Runoff=0.06 cfs 0.006 af

Pond 107: Stone Trench A Peak Elev=168.10' Storage=0.006 af Inflow=0.83 cfs 0.052 af
Discarded=0.60 cfs 0.052 af Primary=0.00 cfs 0.000 af Outflow=0.60 cfs 0.052 af

Pond 108: Stone Filled Basin B Peak Elev=140.01' Storage=0.000 af Inflow=0.02 cfs 0.001 af
Discarded=0.02 cfs 0.001 af Primary=0.00 cfs 0.000 af Outflow=0.02 cfs 0.001 af

Pond 110: Stone Trench E Peak Elev=181.59' Storage=0.002 af Inflow=0.18 cfs 0.016 af
Discarded=0.08 cfs 0.016 af Primary=0.00 cfs 0.000 af Outflow=0.08 cfs 0.016 af

Pond 111: Stone Filled Basin H Peak Elev=124.02' Storage=0.000 af Inflow=0.04 cfs 0.015 af
Discarded=0.03 cfs 0.015 af Primary=0.00 cfs 0.000 af Outflow=0.03 cfs 0.015 af

Pond 112: Stone Filled Basin G Peak Elev=138.00' Storage=0.000 af Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Pond 205: Stone Trench F (Impervious Peak Elev=115.00' Storage=0.000 af Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Pond 206: Stone Filled Basin C (Lined) Peak Elev=142.11' Storage=0.008 af Inflow=0.14 cfs 0.014 af
Primary=0.00 cfs 0.000 af Secondary=0.02 cfs 0.013 af Tertiary=0.00 cfs 0.000 af Outflow=0.02 cfs 0.013 af

Pond 304: Stone Filled Basin D Peak Elev=188.00' Storage=0.000 af Inflow=0.00 cfs 0.000 af
Outflow=0.00 cfs 0.000 af

Link 113: DP-1-SE Perimeter Wetland Inflow=0.02 cfs 0.002 af
Primary=0.02 cfs 0.002 af

Link 114: Culvert Under Natick Ave Inflow=0.02 cfs 0.002 af
Primary=0.02 cfs 0.002 af

Link 207: DP-2-NE Abutters Inflow=0.02 cfs 0.002 af
Primary=0.02 cfs 0.002 af

Link 305: DP-3-S Abutters Inflow=0.00 cfs 0.000 af
Primary=0.00 cfs 0.000 af

Link 402: DP-4-Natick Ave UNDETAINED Inflow=0.06 cfs 0.006 af
Primary=0.06 cfs 0.006 af

A3.4.2 Drainage Network Hydraulic Calculations

Channel Report

Hydraflow Express Extension for Autodesk® Civil 3D® by Autodesk, Inc. Wednesday, Nov 4 2020

2437-015 Natick Solar Typical Swale

Triangular

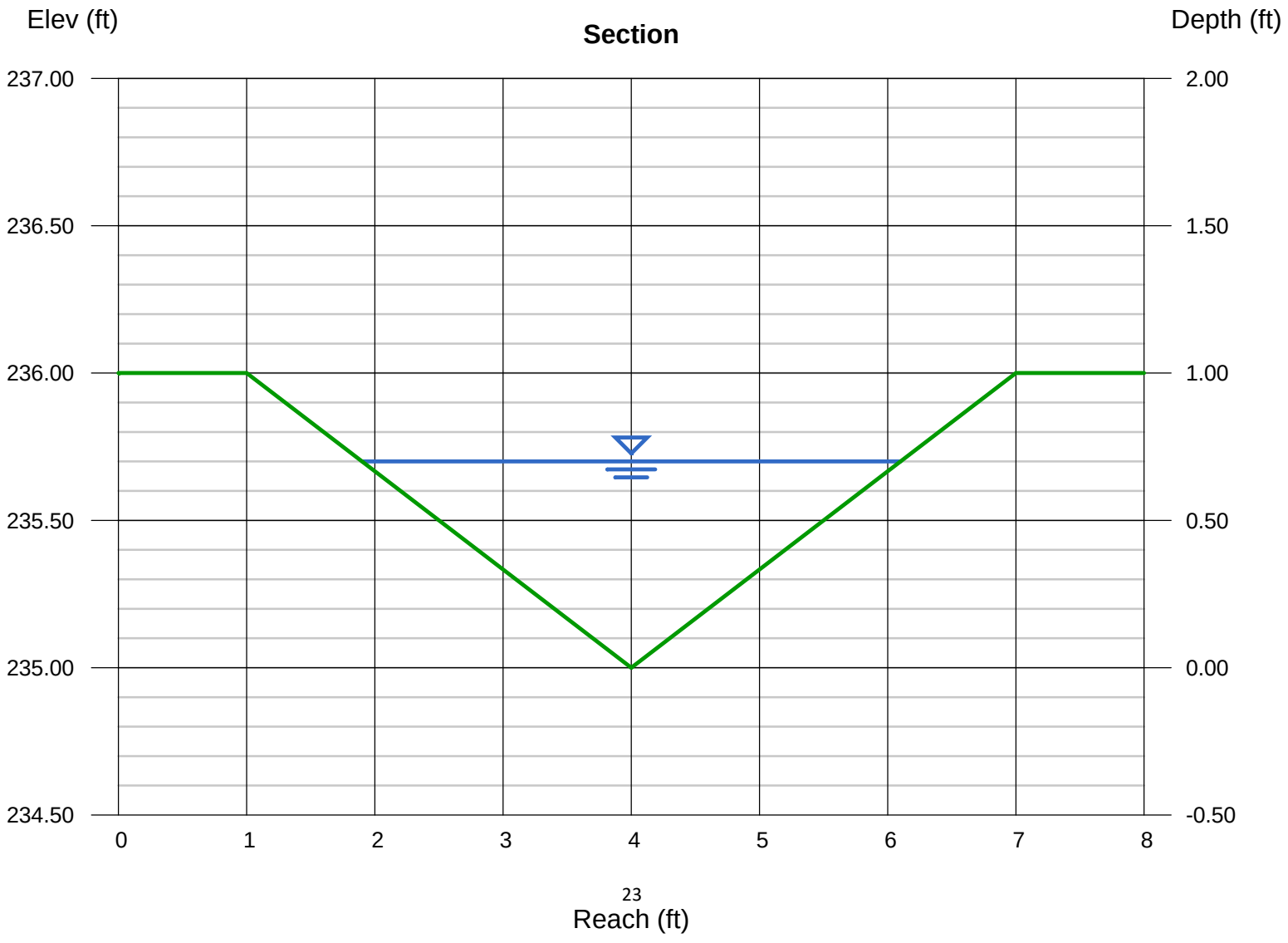
Side Slopes (z:1)	= 3.00, 3.00
Total Depth (ft)	= 1.00
Invert Elev (ft)	= 235.00
Slope (%)	= 8.60
N-Value	= 0.030

Calculations

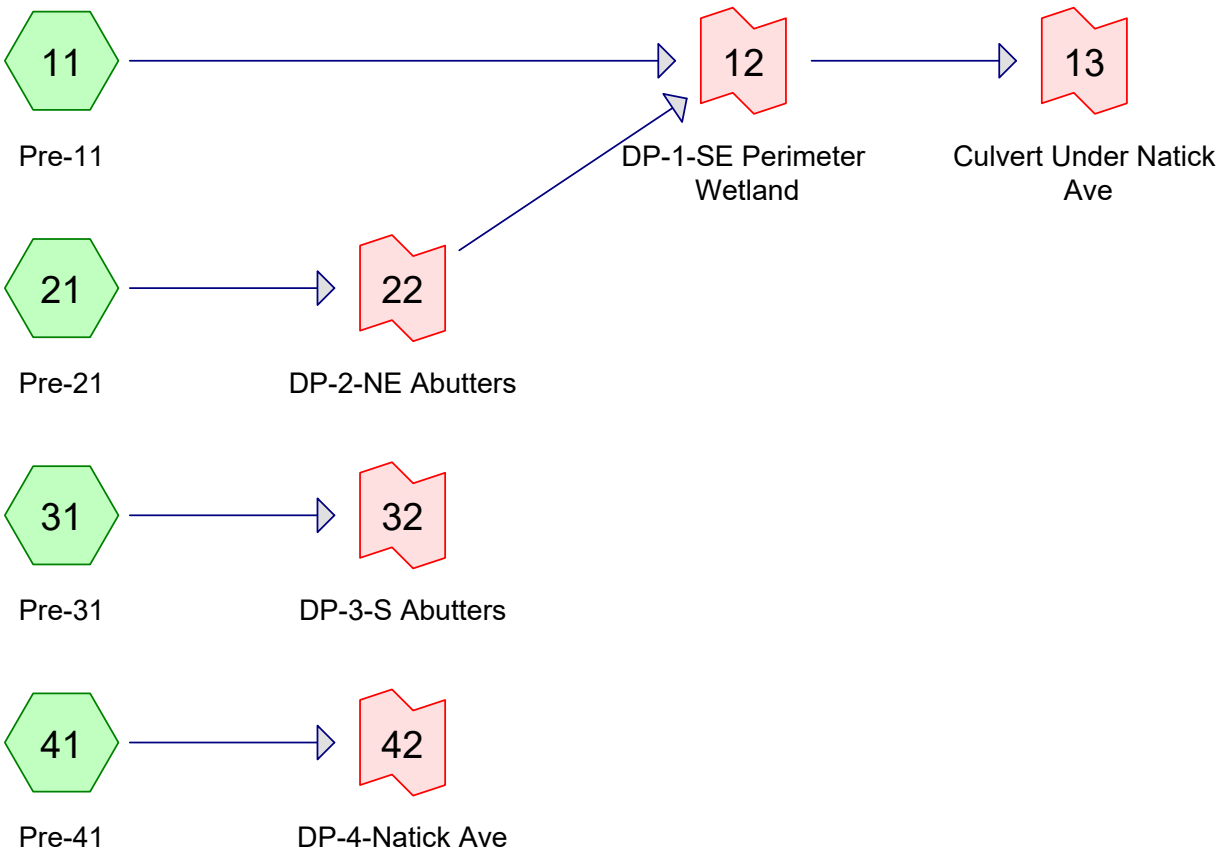
Compute by:	Q vs Depth
No. Increments	= 10

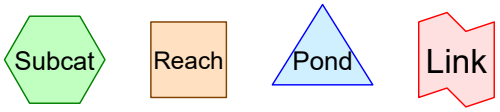
Highlighted

Depth (ft)	= 0.70
Q (cfs)	= 10.24
Area (sqft)	= 1.47
Velocity (ft/s)	= 6.96
Wetted Perim (ft)	= 4.43
Crit Depth, Yc (ft)	= 0.94
Top Width (ft)	= 4.20
EGL (ft)	= 1.45



A3.5.4.1 HydroCAD Node Diagram

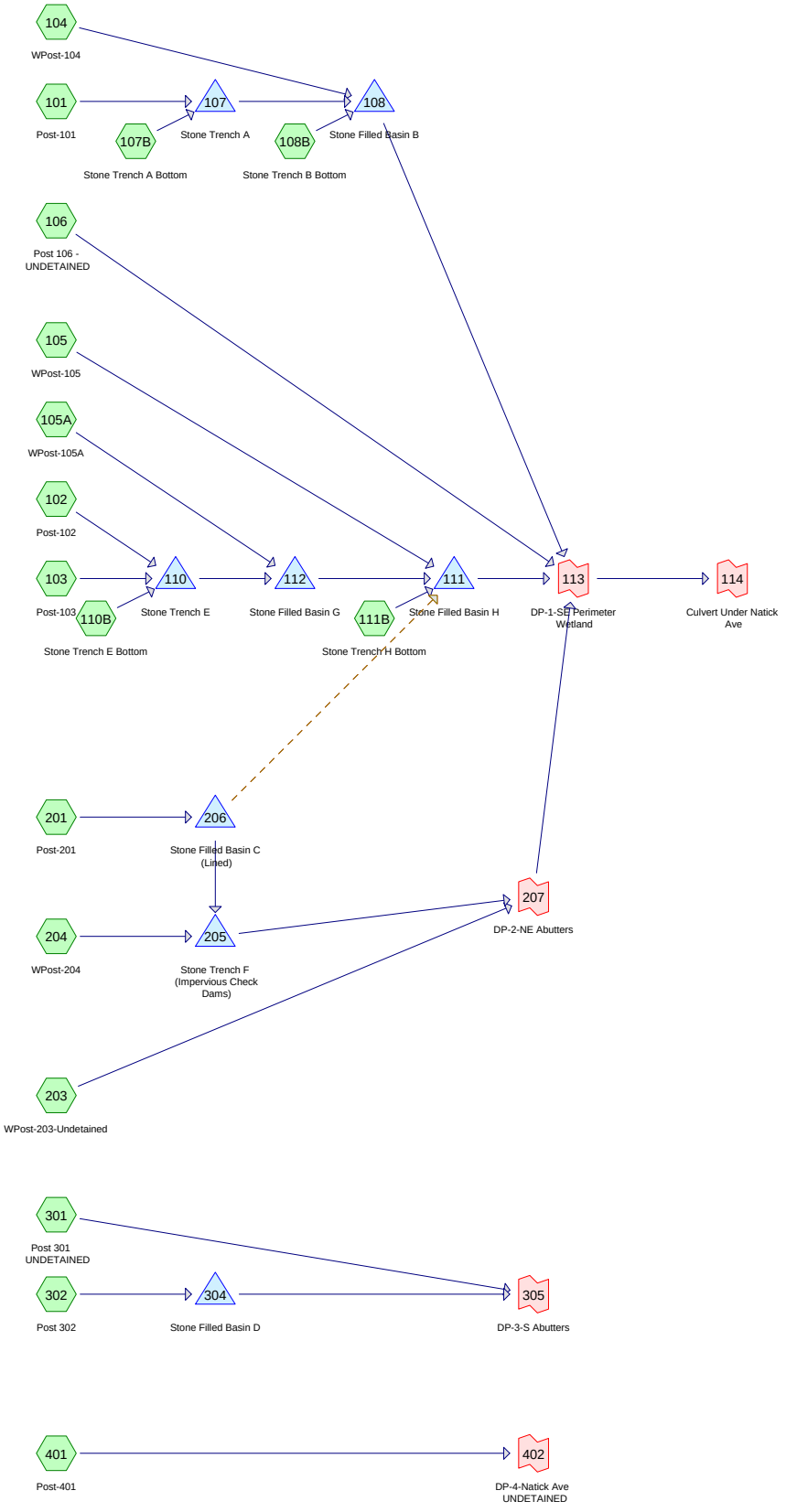




Routing Diagram for 2437-015-EHCD-DRFT
Prepared by DiPrete Engineering, Printed 4/25/2019
HydroCAD® 10.00-22 s/n 02288 © 2018 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
5.526	61	>75% Grass cover, Good, HSG B (11, 21, 31, 41)
2.204	82	Dirt roads, HSG B (11, 21, 31, 41)
0.306	98	Roofs, HSG B (11, 21, 41)
39.534	58	Woods/grass comb., Good, HSG B (11, 21, 31, 41)
47.570	**60**	**TOTAL AREA**



Routing Diagram for 2437-015-PHCD-DRFT
Prepared by DiPrete Engineering, Printed 11/4/2020
HydroCAD® 10.10-4b s/n 01125 © 2020 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
31.163	61	>75% Grass cover, Good, HSG B (101, 102, 103, 104, 105, 105A, 106, 201, 203, 204, 301, 302, 401)
0.635	61	Access Road, Good, HSG B (101, 103, 104, 203, 401)
0.370	61	Access Road, HSG B (105A, 106, 201)
0.612	98	BMP BOTTOM (107B)
0.209	98	BMP Bottom (103, 108B, 110B, 111B)
0.370	82	Dirt roads, HSG B (301)
0.306	98	Roofs, HSG B (101, 102, 201, 203, 401)
2.055	66	Woods, Poor, HSG B (203)
11.850	58	Woods/grass comb., Good, HSG B (101, 102, 106, 201, 301, 401)
47.570	**62**	**TOTAL AREA**

A3.5.4.2 HydroCAD 1-Year Storm Analysis

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 11: Pre-11 Runoff Area=30.168 ac 0.17% Impervious Runoff Depth=0.21"
Flow Length=1,783' Tc=26.0 min CN=59 Runoff=1.97 cfs 0.522 af

Subcatchment 21: Pre-21 Runoff Area=8.072 ac 2.29% Impervious Runoff Depth=0.23"
Flow Length=1,933' Tc=17.2 min CN=60 Runoff=0.73 cfs 0.156 af

Subcatchment 31: Pre-31 Runoff Area=8.129 ac 0.00% Impervious Runoff Depth=0.23"
Flow Length=1,082' Tc=16.2 min CN=60 Runoff=0.75 cfs 0.158 af

Subcatchment 41: Pre-41 Runoff Area=1.201 ac 5.75% Impervious Runoff Depth=0.31"
Flow Length=658' Tc=11.6 min CN=63 Runoff=0.19 cfs 0.031 af

Link 12: DP-1-SE Perimeter Wetland Inflow=2.61 cfs 0.679 af
Primary=2.61 cfs 0.679 af

Link 13: Culvert Under Natick Ave Inflow=2.61 cfs 0.679 af
Primary=2.61 cfs 0.679 af

Link 22: DP-2-NE Abutters Inflow=0.73 cfs 0.156 af
Primary=0.73 cfs 0.156 af

Link 32: DP-3-S Abutters Inflow=0.75 cfs 0.158 af
Primary=0.75 cfs 0.158 af

Link 42: DP-4-Natick Ave Inflow=0.19 cfs 0.031 af
Primary=0.19 cfs 0.031 af

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment101: Post-101 Runoff Area=10.849 ac 0.20% Impervious Runoff Depth=0.26"
Flow Length=831' Tc=15.7 min CN=61 Runoff=1.21 cfs 0.234 af

Subcatchment102: Post-102 Runoff Area=2.204 ac 1.36% Impervious Runoff Depth=0.21"
Flow Length=345' Tc=10.6 min CN=59 Runoff=0.18 cfs 0.038 af

Subcatchment103: Post-103 Runoff Area=1.217 ac 7.40% Impervious Runoff Depth=0.34"
Tc=6.0 min CN=64 Runoff=0.28 cfs 0.035 af

Subcatchment104: WPost-104 Runoff Area=5.197 ac 0.00% Impervious Runoff Depth=0.26"
Flow Length=975' Tc=13.9 min CN=61 Runoff=0.59 cfs 0.112 af

Subcatchment105: WPost-105 Runoff Area=2.946 ac 0.00% Impervious Runoff Depth=0.26"
Flow Length=714' Tc=9.2 min CN=61 Runoff=0.35 cfs 0.063 af

Subcatchment105A: WPost-105A Runoff Area=3.794 ac 0.00% Impervious Runoff Depth=0.26"
Flow Length=696' Tc=11.1 min CN=61 Runoff=0.44 cfs 0.082 af

Subcatchment106: Post 106 - UNDETAINED Runoff Area=2.929 ac 0.00% Impervious Runoff Depth=0.26"
Flow Length=570' Tc=11.6 min CN=61 Runoff=0.34 cfs 0.063 af

Subcatchment107B: Stone Trench A Runoff Area=0.612 ac 100.00% Impervious Runoff Depth=2.47"
Tc=0.0 min CN=98 Runoff=1.95 cfs 0.126 af

Subcatchment108B: Stone Trench B Runoff Area=0.018 ac 100.00% Impervious Runoff Depth=2.47"
Tc=0.0 min CN=98 Runoff=0.06 cfs 0.004 af

Subcatchment110B: Stone Trench E Runoff Area=0.074 ac 100.00% Impervious Runoff Depth=2.47"
Tc=0.0 min CN=98 Runoff=0.24 cfs 0.015 af

Subcatchment111B: Stone Trench H Runoff Area=0.027 ac 100.00% Impervious Runoff Depth=2.47"
Tc=0.0 min CN=98 Runoff=0.09 cfs 0.006 af

Subcatchment201: Post-201 Runoff Area=5.289 ac 3.12% Impervious Runoff Depth=0.23"
Flow Length=1,350' Tc=14.9 min CN=60 Runoff=0.49 cfs 0.102 af

Subcatchment203: WPost-203-Undetained Runoff Area=2.693 ac 0.74% Impervious Runoff Depth=0.38"
Flow Length=850' Tc=16.2 min CN=65 Runoff=0.56 cfs 0.084 af

Subcatchment204: WPost-204 Runoff Area=0.539 ac 0.00% Impervious Runoff Depth=0.26"
Tc=6.0 min CN=61 Runoff=0.07 cfs 0.012 af

Subcatchment301: Post 301 UNDETAINED Runoff Area=6.495 ac 0.00% Impervious Runoff Depth=0.26"
Flow Length=1,082' Tc=16.0 min CN=61 Runoff=0.72 cfs 0.140 af

Subcatchment302: Post 302 Runoff Area=1.486 ac 0.00% Impervious Runoff Depth=0.26"
Flow Length=208' Tc=8.8 min CN=61 Runoff=0.18 cfs 0.032 af

Subcatchment 401: Post-401 Runoff Area=1.201 ac 5.75% Impervious Runoff Depth=0.29"
Flow Length=658' Tc=11.6 min CN=62 Runoff=0.17 cfs 0.029 af

Pond 107: Stone Trench A Peak Elev=168.34' Storage=0.055 af Inflow=1.95 cfs 0.360 af
Discarded=0.63 cfs 0.360 af Primary=0.00 cfs 0.000 af Outflow=0.63 cfs 0.360 af

Pond 108: Stone Filled Basin B Peak Elev=143.00' Storage=0.046 af Inflow=0.60 cfs 0.116 af
Discarded=0.10 cfs 0.116 af Primary=0.00 cfs 0.000 af Outflow=0.10 cfs 0.116 af

Pond 110: Stone Trench E Peak Elev=182.65' Storage=0.028 af Inflow=0.44 cfs 0.088 af
Discarded=0.08 cfs 0.088 af Primary=0.00 cfs 0.000 af Outflow=0.08 cfs 0.088 af

Pond 111: Stone Filled Basin H Peak Elev=128.15' Storage=0.079 af Inflow=0.50 cfs 0.252 af
Discarded=0.09 cfs 0.178 af Primary=0.26 cfs 0.074 af Outflow=0.35 cfs 0.252 af

Pond 112: Stone Filled Basin G Peak Elev=138.32' Storage=0.013 af Inflow=0.44 cfs 0.082 af
Outflow=0.20 cfs 0.082 af

Pond 205: Stone Trench F (Impervious Peak Elev=115.31' Storage=0.012 af Inflow=0.07 cfs 0.012 af
Outflow=0.00 cfs 0.000 af

Pond 206: Stone Filled Basin C (Lined) Peak Elev=142.31' Storage=0.021 af Inflow=0.49 cfs 0.102 af
Primary=0.00 cfs 0.000 af Secondary=0.17 cfs 0.102 af Tertiary=0.00 cfs 0.000 af Outflow=0.17 cfs 0.102 af

Pond 304: Stone Filled Basin D Peak Elev=188.38' Storage=0.032 af Inflow=0.18 cfs 0.032 af
Outflow=0.00 cfs 0.000 af

Link 113: DP-1-SE Perimeter Wetland Inflow=0.89 cfs 0.222 af
Primary=0.89 cfs 0.222 af

Link 114: Culvert Under Natick Ave Inflow=0.89 cfs 0.222 af
Primary=0.89 cfs 0.222 af

Link 207: DP-2-NE Abutters Inflow=0.56 cfs 0.084 af
Primary=0.56 cfs 0.084 af

Link 305: DP-3-S Abutters Inflow=0.72 cfs 0.140 af
Primary=0.72 cfs 0.140 af

Link 402: DP-4-Natick Ave UNDETAINED Inflow=0.17 cfs 0.029 af
Primary=0.17 cfs 0.029 af

A3.5.4.3 HydroCAD 10-Year Storm Analysis

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 11: Pre-11 Runoff Area=30.168 ac 0.17% Impervious Runoff Depth=1.18"
Flow Length=1,783' Tc=26.0 min CN=59 Runoff=21.89 cfs 2.962 af

Subcatchment 21: Pre-21 Runoff Area=8.072 ac 2.29% Impervious Runoff Depth=1.24"
Flow Length=1,933' Tc=17.2 min CN=60 Runoff=7.41 cfs 0.836 af

Subcatchment 31: Pre-31 Runoff Area=8.129 ac 0.00% Impervious Runoff Depth=1.24"
Flow Length=1,082' Tc=16.2 min CN=60 Runoff=7.65 cfs 0.842 af

Subcatchment 41: Pre-41 Runoff Area=1.201 ac 5.75% Impervious Runoff Depth=1.45"
Flow Length=658' Tc=11.6 min CN=63 Runoff=1.56 cfs 0.145 af

Link 12: DP-1-SE Perimeter Wetland Inflow=28.22 cfs 3.798 af
Primary=28.22 cfs 3.798 af

Link 13: Culvert Under Natick Ave Inflow=28.22 cfs 3.798 af
Primary=28.22 cfs 3.798 af

Link 22: DP-2-NE Abutters Inflow=7.41 cfs 0.836 af
Primary=7.41 cfs 0.836 af

Link 32: DP-3-S Abutters Inflow=7.65 cfs 0.842 af
Primary=7.65 cfs 0.842 af

Link 42: DP-4-Natick Ave Inflow=1.56 cfs 0.145 af
Primary=1.56 cfs 0.145 af

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment101: Post-101 Runoff Area=10.849 ac 0.20% Impervious Runoff Depth=1.31"
Flow Length=831' Tc=15.7 min CN=61 Runoff=11.05 cfs 1.184 af

Subcatchment102: Post-102 Runoff Area=2.204 ac 1.36% Impervious Runoff Depth=1.18"
Flow Length=345' Tc=10.6 min CN=59 Runoff=2.26 cfs 0.216 af

Subcatchment103: Post-103 Runoff Area=1.217 ac 7.40% Impervious Runoff Depth=1.52"
Tc=6.0 min CN=64 Runoff=2.03 cfs 0.154 af

Subcatchment104: WPost-104 Runoff Area=5.197 ac 0.00% Impervious Runoff Depth=1.31"
Flow Length=975' Tc=13.9 min CN=61 Runoff=5.55 cfs 0.567 af

Subcatchment105: WPost-105 Runoff Area=2.946 ac 0.00% Impervious Runoff Depth=1.31"
Flow Length=714' Tc=9.2 min CN=61 Runoff=3.64 cfs 0.321 af

Subcatchment105A: WPost-105A Runoff Area=3.794 ac 0.00% Impervious Runoff Depth=1.31"
Flow Length=696' Tc=11.1 min CN=61 Runoff=4.40 cfs 0.414 af

Subcatchment106: Post 106 - UNDETAINED Runoff Area=2.929 ac 0.00% Impervious Runoff Depth=1.31"
Flow Length=570' Tc=11.6 min CN=61 Runoff=3.35 cfs 0.320 af

Subcatchment107B: Stone Trench A Runoff Area=0.612 ac 100.00% Impervious Runoff Depth=4.66"
Tc=0.0 min CN=98 Runoff=3.58 cfs 0.238 af

Subcatchment108B: Stone Trench B Runoff Area=0.018 ac 100.00% Impervious Runoff Depth=4.66"
Tc=0.0 min CN=98 Runoff=0.11 cfs 0.007 af

Subcatchment110B: Stone Trench E Runoff Area=0.074 ac 100.00% Impervious Runoff Depth=4.66"
Tc=0.0 min CN=98 Runoff=0.43 cfs 0.029 af

Subcatchment111B: Stone Trench H Runoff Area=0.027 ac 100.00% Impervious Runoff Depth=4.66"
Tc=0.0 min CN=98 Runoff=0.16 cfs 0.010 af

Subcatchment201: Post-201 Runoff Area=5.289 ac 3.12% Impervious Runoff Depth=1.24"
Flow Length=1,350' Tc=14.9 min CN=60 Runoff=5.14 cfs 0.548 af

Subcatchment203: WPost-203-Undetained Runoff Area=2.693 ac 0.74% Impervious Runoff Depth=1.59"
Flow Length=850' Tc=16.2 min CN=65 Runoff=3.46 cfs 0.356 af

Subcatchment204: WPost-204 Runoff Area=0.539 ac 0.00% Impervious Runoff Depth=1.31"
Tc=6.0 min CN=61 Runoff=0.75 cfs 0.059 af

Subcatchment301: Post 301 UNDETAINED Runoff Area=6.495 ac 0.00% Impervious Runoff Depth=1.31"
Flow Length=1,082' Tc=16.0 min CN=61 Runoff=6.58 cfs 0.709 af

Subcatchment302: Post 302 Runoff Area=1.486 ac 0.00% Impervious Runoff Depth=1.31"
Flow Length=208' Tc=8.8 min CN=61 Runoff=1.86 cfs 0.162 af

Subcatchment 401: Post-401 Runoff Area=1.201 ac 5.75% Impervious Runoff Depth=1.38"
Flow Length=658' Tc=11.6 min CN=62 Runoff=1.47 cfs 0.138 af

Pond 107: Stone Trench A Peak Elev=170.68' Storage=0.815 af Inflow=12.13 cfs 1.422 af
Discarded=0.63 cfs 1.422 af Primary=0.00 cfs 0.000 af Outflow=0.63 cfs 1.422 af

Pond 108: Stone Filled Basin B Peak Elev=143.57' Storage=0.067 af Inflow=5.58 cfs 0.574 af
Discarded=0.13 cfs 0.181 af Primary=5.45 cfs 0.393 af Outflow=5.58 cfs 0.574 af

Pond 110: Stone Trench E Peak Elev=184.81' Storage=0.275 af Inflow=4.17 cfs 0.399 af
Discarded=0.08 cfs 0.361 af Primary=0.13 cfs 0.038 af Outflow=0.21 cfs 0.399 af

Pond 111: Stone Filled Basin H Peak Elev=128.86' Storage=0.102 af Inflow=6.83 cfs 1.331 af
Discarded=0.11 cfs 0.200 af Primary=6.57 cfs 1.131 af Outflow=6.68 cfs 1.331 af

Pond 112: Stone Filled Basin G Peak Elev=140.06' Storage=0.091 af Inflow=4.40 cfs 0.452 af
Outflow=2.73 cfs 0.451 af

Pond 205: Stone Trench F (Impervious Peak Elev=115.53' Storage=0.020 af Inflow=0.75 cfs 0.059 af
Outflow=0.28 cfs 0.040 af

Pond 206: Stone Filled Basin C (Lined) Peak Elev=143.72' Storage=0.131 af Inflow=5.14 cfs 0.548 af
Primary=0.00 cfs 0.000 af Secondary=2.43 cfs 0.547 af Tertiary=0.00 cfs 0.000 af Outflow=2.43 cfs 0.547 af

Pond 304: Stone Filled Basin D Peak Elev=188.92' Storage=0.080 af Inflow=1.86 cfs 0.162 af
Outflow=0.20 cfs 0.101 af

Link 113: DP-1-SE Perimeter Wetland Inflow=15.52 cfs 2.239 af
Primary=15.52 cfs 2.239 af

Link 114: Culvert Under Natick Ave Inflow=15.52 cfs 2.239 af
Primary=15.52 cfs 2.239 af

Link 207: DP-2-NE Abutters Inflow=3.46 cfs 0.396 af
Primary=3.46 cfs 0.396 af

Link 305: DP-3-S Abutters Inflow=6.58 cfs 0.810 af
Primary=6.58 cfs 0.810 af

Link 402: DP-4-Natick Ave UNDETAINED Inflow=1.47 cfs 0.138 af
Primary=1.47 cfs 0.138 af

A3.5.4.5 HydroCAD 100-Year Storm Analysis

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment 11: Pre-11 Runoff Area=30.168 ac 0.17% Impervious Runoff Depth=3.75"
Flow Length=1,783' Tc=26.0 min CN=59 Runoff=78.60 cfs 9.422 af

Subcatchment 21: Pre-21 Runoff Area=8.072 ac 2.29% Impervious Runoff Depth=3.87"
Flow Length=1,933' Tc=17.2 min CN=60 Runoff=25.91 cfs 2.601 af

Subcatchment 31: Pre-31 Runoff Area=8.129 ac 0.00% Impervious Runoff Depth=3.87"
Flow Length=1,082' Tc=16.2 min CN=60 Runoff=26.72 cfs 2.620 af

Subcatchment 41: Pre-41 Runoff Area=1.201 ac 5.75% Impervious Runoff Depth=4.23"
Flow Length=658' Tc=11.6 min CN=63 Runoff=4.92 cfs 0.423 af

Link 12: DP-1-SE Perimeter Wetland Inflow=100.80 cfs 12.023 af
Primary=100.80 cfs 12.023 af

Link 13: Culvert Under Natick Ave Inflow=100.80 cfs 12.023 af
Primary=100.80 cfs 12.023 af

Link 22: DP-2-NE Abutters Inflow=25.91 cfs 2.601 af
Primary=25.91 cfs 2.601 af

Link 32: DP-3-S Abutters Inflow=26.72 cfs 2.620 af
Primary=26.72 cfs 2.620 af

Link 42: DP-4-Natick Ave Inflow=4.92 cfs 0.423 af
Primary=4.92 cfs 0.423 af

Summary for Subcatchment 11: Pre-11

Runoff = 78.60 cfs @ 12.39 hrs, Volume= 9.422 af, Depth= 3.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

Area (ac)	CN	Description
26.970	58	Woods/grass comb., Good, HSG B
1.478	82	Dirt roads, HSG B
1.668	61	>75% Grass cover, Good, HSG B
0.052	98	Roofs, HSG B
30.168	59	Weighted Average
30.116	59	99.83% Pervious Area
0.052	98	0.17% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
20.0	100	0.0230	0.08		**Sheet Flow, 11A-11B** Woods: Light underbrush n= 0.400 P2= 3.30"
6.0	1,683	0.0850	4.69		**Shallow Concentrated Flow, 11B-11C** Unpaved Kv= 16.1 fps
26.0	1,783	Total			

Summary for Subcatchment 21: Pre-21

Runoff = 25.91 cfs @ 12.25 hrs, Volume= 2.601 af, Depth= 3.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

Area (ac)	CN	Description
6.957	58	Woods/grass comb., Good, HSG B
0.185	98	Roofs, HSG B
0.725	61	>75% Grass cover, Good, HSG B
0.205	82	Dirt roads, HSG B
8.072	60	Weighted Average
7.887	59	97.71% Pervious Area
0.185	98	2.29% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.4	100	0.1180	0.16		**Sheet Flow, 12A-12B** Woods: Light underbrush n= 0.400 P2= 3.30"
6.8	1,833	0.0788	4.52		**Shallow Concentrated Flow, 12B-12C** Unpaved Kv= 16.1 fps
17.2	1,933	Total			

Summary for Subcatchment 31: Pre-31

Runoff = 26.72 cfs @ 12.23 hrs, Volume= 2.620 af, Depth= 3.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

Area (ac)	CN	Description
5.018	58	Woods/grass comb., Good, HSG B
2.643	61	>75% Grass cover, Good, HSG B
0.468	82	Dirt roads, HSG B
8.129	60	Weighted Average
8.129	60	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.3	100	0.0780	0.14		**Sheet Flow, 1A-21B** Woods: Light underbrush n= 0.400 P2= 3.30"
3.9	982	0.0685	4.21		**Shallow Concentrated Flow, 21B-21C** Unpaved Kv= 16.1 fps
16.2	1,082	Total			

Summary for Subcatchment 41: Pre-41

Runoff = 4.92 cfs @ 12.16 hrs, Volume= 0.423 af, Depth= 4.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

Area (ac)	CN	Description
0.589	58	Woods/grass comb., Good, HSG B
0.053	82	Dirt roads, HSG B
0.069	98	Roofs, HSG B
0.490	61	>75% Grass cover, Good, HSG B
1.201	63	Weighted Average
1.132	60	94.25% Pervious Area
0.069	98	5.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	100	0.1500	0.18		**Sheet Flow, 31A-31B** Woods: Light underbrush n= 0.400 P2= 3.30"
2.2	558	0.0683	4.21		**Shallow Concentrated Flow, 31B-31C** Unpaved Kv= 16.1 fps
11.6	658	Total			

Summary for Link 12: DP-1-SE Perimeter Wetland

Inflow Area = 38.240 ac, 0.62% Impervious, Inflow Depth = 3.77" for 100-Year event
Inflow = 100.80 cfs @ 12.34 hrs, Volume= 12.023 af
Primary = 100.80 cfs @ 12.34 hrs, Volume= 12.023 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link 13: Culvert Under Natick Ave

Inflow Area = 38.240 ac, 0.62% Impervious, Inflow Depth = 3.77" for 100-Year event
Inflow = 100.80 cfs @ 12.34 hrs, Volume= 12.023 af
Primary = 100.80 cfs @ 12.34 hrs, Volume= 12.023 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link 22: DP-2-NE Abutters

Inflow Area = 8.072 ac, 2.29% Impervious, Inflow Depth = 3.87" for 100-Year event
Inflow = 25.91 cfs @ 12.25 hrs, Volume= 2.601 af
Primary = 25.91 cfs @ 12.25 hrs, Volume= 2.601 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link 32: DP-3-S Abutters

Inflow Area = 8.129 ac, 0.00% Impervious, Inflow Depth = 3.87" for 100-Year event
Inflow = 26.72 cfs @ 12.23 hrs, Volume= 2.620 af
Primary = 26.72 cfs @ 12.23 hrs, Volume= 2.620 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link 42: DP-4-Natick Ave

Inflow Area = 1.201 ac, 5.75% Impervious, Inflow Depth = 4.23" for 100-Year event
Inflow = 4.92 cfs @ 12.16 hrs, Volume= 0.423 af
Primary = 4.92 cfs @ 12.16 hrs, Volume= 0.423 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Time span=0.00-72.00 hrs, dt=0.01 hrs, 7201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Dyn-Stor-Ind method - Pond routing by Dyn-Stor-Ind method

Subcatchment101: Post-101 Runoff Area=10.849 ac 0.20% Impervious Runoff Depth=3.99"
Flow Length=831' Tc=15.7 min CN=61 Runoff=37.30 cfs 3.604 af

Subcatchment102: Post-102 Runoff Area=2.204 ac 1.36% Impervious Runoff Depth=3.75"
Flow Length=345' Tc=10.6 min CN=59 Runoff=8.18 cfs 0.688 af

Subcatchment103: Post-103 Runoff Area=1.217 ac 7.40% Impervious Runoff Depth=4.35"
Tc=6.0 min CN=64 Runoff=6.19 cfs 0.441 af

Subcatchment104: WPost-104 Runoff Area=5.197 ac 0.00% Impervious Runoff Depth=3.99"
Flow Length=975' Tc=13.9 min CN=61 Runoff=18.74 cfs 1.727 af

Subcatchment105: WPost-105 Runoff Area=2.946 ac 0.00% Impervious Runoff Depth=3.99"
Flow Length=714' Tc=9.2 min CN=61 Runoff=12.24 cfs 0.979 af

Subcatchment105A: WPost-105A Runoff Area=3.794 ac 0.00% Impervious Runoff Depth=3.99"
Flow Length=696' Tc=11.1 min CN=61 Runoff=14.83 cfs 1.260 af

Subcatchment106: Post 106 - UNDETAINED Runoff Area=2.929 ac 0.00% Impervious Runoff Depth=3.99"
Flow Length=570' Tc=11.6 min CN=61 Runoff=11.28 cfs 0.973 af

Subcatchment107B: Stone Trench A Runoff Area=0.612 ac 100.00% Impervious Runoff Depth=8.46"
Tc=0.0 min CN=98 Runoff=6.38 cfs 0.431 af

Subcatchment108B: Stone Trench B Runoff Area=0.018 ac 100.00% Impervious Runoff Depth=8.46"
Tc=0.0 min CN=98 Runoff=0.19 cfs 0.013 af

Subcatchment110B: Stone Trench E Runoff Area=0.074 ac 100.00% Impervious Runoff Depth=8.46"
Tc=0.0 min CN=98 Runoff=0.77 cfs 0.052 af

Subcatchment111B: Stone Trench H Runoff Area=0.027 ac 100.00% Impervious Runoff Depth=8.46"
Tc=0.0 min CN=98 Runoff=0.28 cfs 0.019 af

Subcatchment201: Post-201 Runoff Area=5.289 ac 3.12% Impervious Runoff Depth=3.87"
Flow Length=1,350' Tc=14.9 min CN=60 Runoff=17.95 cfs 1.704 af

Subcatchment203: WPost-203-Undetained Runoff Area=2.693 ac 0.74% Impervious Runoff Depth=4.47"
Flow Length=850' Tc=16.2 min CN=65 Runoff=10.35 cfs 1.003 af

Subcatchment204: WPost-204 Runoff Area=0.539 ac 0.00% Impervious Runoff Depth=3.99"
Tc=6.0 min CN=61 Runoff=2.50 cfs 0.179 af

Subcatchment301: Post 301 UNDETAINED Runoff Area=6.495 ac 0.00% Impervious Runoff Depth=3.99"
Flow Length=1,082' Tc=16.0 min CN=61 Runoff=22.18 cfs 2.158 af

Subcatchment302: Post 302 Runoff Area=1.486 ac 0.00% Impervious Runoff Depth=3.99"
Flow Length=208' Tc=8.8 min CN=61 Runoff=6.26 cfs 0.494 af

Subcatchment 401: Post-401 Runoff Area=1.201 ac 5.75% Impervious Runoff Depth=4.11"
Flow Length=658' Tc=11.6 min CN=62 Runoff=4.77 cfs 0.411 af

Pond 107: Stone Trench A Peak Elev=171.31' Storage=1.209 af Inflow=39.25 cfs 4.036 af
Discarded=0.63 cfs 1.896 af Primary=28.93 cfs 2.140 af Outflow=29.56 cfs 4.036 af

Pond 108: Stone Filled Basin B Peak Elev=143.77' Storage=0.076 af Inflow=42.00 cfs 3.879 af
Discarded=0.14 cfs 0.205 af Primary=41.85 cfs 3.674 af Outflow=41.99 cfs 3.879 af

Pond 110: Stone Trench E Peak Elev=184.93' Storage=0.310 af Inflow=13.91 cfs 1.181 af
Discarded=0.08 cfs 0.375 af Primary=11.44 cfs 0.806 af Outflow=11.52 cfs 1.181 af

Pond 111: Stone Filled Basin H Peak Elev=131.37' Storage=0.220 af Inflow=41.08 cfs 4.434 af
Discarded=0.18 cfs 0.225 af Primary=40.58 cfs 4.209 af Outflow=40.76 cfs 4.434 af

Pond 112: Stone Filled Basin G Peak Elev=140.34' Storage=0.129 af Inflow=25.64 cfs 2.067 af
Outflow=25.15 cfs 2.067 af

Pond 205: Stone Trench F (Impervious Peak Elev=115.85' Storage=0.032 af Inflow=9.69 cfs 0.513 af
Outflow=9.65 cfs 0.494 af

Pond 206: Stone Filled Basin C (Lined) Peak Elev=144.48' Storage=0.282 af Inflow=17.95 cfs 1.704 af
Primary=8.44 cfs 0.334 af Secondary=3.48 cfs 1.291 af Tertiary=4.91 cfs 0.079 af Outflow=16.83 cfs 1.704 af

Pond 304: Stone Filled Basin D Peak Elev=189.73' Storage=0.159 af Inflow=6.26 cfs 0.494 af
Outflow=2.75 cfs 0.433 af

Link 113: DP-1-SE Perimeter Wetland Inflow=99.04 cfs 10.353 af
Primary=99.04 cfs 10.353 af

Link 114: Culvert Under Natick Ave Inflow=99.04 cfs 10.353 af
Primary=99.04 cfs 10.353 af

Link 207: DP-2-NE Abutters Inflow=19.70 cfs 1.497 af
Primary=19.70 cfs 1.497 af

Link 305: DP-3-S Abutters Inflow=24.59 cfs 2.591 af
Primary=24.59 cfs 2.591 af

Link 402: DP-4-Natick Ave UNDETAINED Inflow=4.77 cfs 0.411 af
Primary=4.77 cfs 0.411 af

Summary for Subcatchment 101: Post-101

Runoff = 37.30 cfs @ 12.22 hrs, Volume= 3.604 af, Depth= 3.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

	Area (ac)	CN	Description
	1.977	58	Woods/grass comb., Good, HSG B
	8.719	61	>75% Grass cover, Good, HSG B
*	0.131	61	Access Road, Good, HSG B
	0.022	98	Roofs, HSG B
	10.849	61	Weighted Average
	10.827	60	99.80% Pervious Area
	0.022	98	0.20% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.4	100	0.0630	0.12		**Sheet Flow, 101A-101B** Woods: Light underbrush n= 0.400 P2= 3.30"
2.3	731	0.1100	5.34		**Shallow Concentrated Flow, 101B-101C** Unpaved Kv= 16.1 fps
15.7	831	Total			

Summary for Subcatchment 102: Post-102

Runoff = 8.18 cfs @ 12.15 hrs, Volume= 0.688 af, Depth= 3.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

Area (ac)	CN	Description
2.077	58	Woods/grass comb., Good, HSG B
0.097	61	>75% Grass cover, Good, HSG B
0.030	98	Roofs, HSG B
2.204	59	Weighted Average
2.174	58	98.64% Pervious Area
0.030	98	1.36% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.6	100	0.1450	0.17		**Sheet Flow, 102A-102B** Woods: Light underbrush n= 0.400 P2= 3.30"
1.0	245	0.0620	4.01		**Shallow Concentrated Flow, 102B-102C** Unpaved Kv= 16.1 fps
10.6	345	Total			

Summary for Subcatchment 103: Post-103

Runoff = 6.19 cfs @ 12.09 hrs, Volume= 0.441 af, Depth= 4.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

	Area (ac)	CN	Description
	0.889	61	>75% Grass cover, Good, HSG B
*	0.238	61	Access Road, Good, HSG B
*	0.090	98	BMP Bottom
	1.217	64	Weighted Average
	1.127	61	92.60% Pervious Area
	0.090	98	7.40% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 104: WPost-104

Runoff = 18.74 cfs @ 12.19 hrs, Volume= 1.727 af, Depth= 3.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	0.078	61	Access Road, Good, HSG B
	5.119	61	>75% Grass cover, Good, HSG B
	5.197	61	Weighted Average
	5.197	61	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.3	100	0.0440	0.16		**Sheet Flow, 104A-104B** Grass: Dense n= 0.240 P2= 3.30"
3.6	875	0.0630	4.04		**Shallow Concentrated Flow, 104B-104C** Unpaved Kv= 16.1 fps
13.9	975	Total			

Summary for Subcatchment 105: WPost-105

Runoff = 12.24 cfs @ 12.13 hrs, Volume= 0.979 af, Depth= 3.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

Area (ac)	CN	Description
2.946	61	>75% Grass cover, Good, HSG B
2.946	61	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.9	100	0.1200	0.24		**Sheet Flow, 105A-105B** Grass: Dense n= 0.240 P2= 3.30"
2.3	614	0.0770	4.47		**Shallow Concentrated Flow, 105B-105C** Unpaved Kv= 16.1 fps
9.2	714	Total			

Summary for Subcatchment 105A: WPost-105A

Runoff = 14.83 cfs @ 12.16 hrs, Volume= 1.260 af, Depth= 3.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

	Area (ac)	CN	Description
	3.688	61	>75% Grass cover, Good, HSG B
*	0.106	61	Access Road, HSG B
	3.794	61	Weighted Average
	3.794	61	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.7	100	0.1400	0.17		**Sheet Flow, 105AA-105AB** Woods: Light underbrush n= 0.400 P2= 3.30"
0.6	168	0.0920	4.88		**Shallow Concentrated Flow, 105AB-105AC** Unpaved Kv= 16.1 fps
0.1	228	0.9000	38.79	349.12	**Channel Flow, 105AC-105AD** Area= 9.0 sf Perim= 12.0' r= 0.75' n= 0.030
0.7	200	0.0885	4.79		**Shallow Concentrated Flow, 105AD-105AE** Unpaved Kv= 16.1 fps
11.1	696	Total			

Summary for Subcatchment 106: Post 106 - UNDETAINED

Runoff = 11.28 cfs @ 12.16 hrs, Volume= 0.973 af, Depth= 3.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

	Area (ac)	CN	Description
	2.495	61	>75% Grass cover, Good, HSG B
*	0.103	61	Access Road, HSG B
	0.331	58	Woods/grass comb., Good, HSG B
	2.929	61	Weighted Average
	2.929	61	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.3	100	0.0430	0.16		**Sheet Flow, 106A-106B** Grass: Dense n= 0.240 P2= 3.30"
1.3	470	0.1316	5.84		**Shallow Concentrated Flow, 106B-106C** Unpaved Kv= 16.1 fps
11.6	570	Total			

Summary for Subcatchment 107B: Stone Trench A Bottom

Runoff = 6.38 cfs @ 12.00 hrs, Volume= 0.431 af, Depth= 8.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	0.612	98	BMP BOTTOM
	0.612	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 108B: Stone Trench B Bottom

Runoff = 0.19 cfs @ 12.00 hrs, Volume= 0.013 af, Depth= 8.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	0.018	98	BMP Bottom
	0.018	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 110B: Stone Trench E Bottom

Runoff = 0.77 cfs @ 12.00 hrs, Volume= 0.052 af, Depth= 8.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	0.074	98	BMP Bottom
	0.074	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 111B: Stone Trench H Bottom

Runoff = 0.28 cfs @ 12.00 hrs, Volume= 0.019 af, Depth= 8.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

	Area (ac)	CN	Description
*	0.027	98	BMP Bottom
	0.027	98	100.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
0.0					**Direct Entry,**

Summary for Subcatchment 201: Post-201

Runoff = 17.95 cfs @ 12.21 hrs, Volume= 1.704 af, Depth= 3.87"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

	Area (ac)	CN	Description
	3.908	58	Woods/grass comb., Good, HSG B
	0.165	98	Roofs, HSG B
	1.055	61	>75% Grass cover, Good, HSG B
*	0.161	61	Access Road, HSG B
	5.289	60	Weighted Average
	5.124	59	96.88% Pervious Area
	0.165	98	3.12% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
10.4	100	0.1190	0.16		**Sheet Flow, 12A-12B** Woods: Light underbrush n= 0.400 P2= 3.30"
4.5	1,250	0.0830	4.64		**Shallow Concentrated Flow, 12B-12C** Unpaved Kv= 16.1 fps
14.9	1,350	Total			

Summary for Subcatchment 203: WPost-203-Undetained

Runoff = 10.35 cfs @ 12.22 hrs, Volume= 1.003 af, Depth= 4.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

	Area (ac)	CN	Description
	0.483	61	>75% Grass cover, Good, HSG B
	2.055	66	Woods, Poor, HSG B
*	0.135	61	Access Road, Good, HSG B
	0.020	98	Roofs, HSG B
	2.693	65	Weighted Average
	2.673	65	99.26% Pervious Area
	0.020	98	0.74% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
13.2	100	0.0650	0.13		**Sheet Flow, 203A-203B** Woods: Light underbrush n= 0.400 P2= 3.30"
3.0	750	0.0680	4.20		**Shallow Concentrated Flow, 203B-203C** Unpaved Kv= 16.1 fps
16.2	850	Total			

Summary for Subcatchment 204: WPost-204

Runoff = 2.50 cfs @ 12.09 hrs, Volume= 0.179 af, Depth= 3.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

Area (ac)	CN	Description
0.539	61	>75% Grass cover, Good, HSG B
0.539	61	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0					**Direct Entry,**

Summary for Subcatchment 301: Post 301 UNDETAINED

Runoff = 22.18 cfs @ 12.22 hrs, Volume= 2.158 af, Depth= 3.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

Area (ac)	CN	Description
2.968	58	Woods/grass comb., Good, HSG B
3.157	61	>75% Grass cover, Good, HSG B
0.370	82	Dirt roads, HSG B
6.495	61	Weighted Average
6.495	61	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.1	100	0.0800	0.14		**Sheet Flow, 301A-301B** Woods: Light underbrush n= 0.400 P2= 3.30"
3.9	982	0.0682	4.20		**Shallow Concentrated Flow, 301B-302C** Unpaved Kv= 16.1 fps
16.0	1,082	Total			

Summary for Subcatchment 302: Post 302

Runoff = 6.26 cfs @ 12.13 hrs, Volume= 0.494 af, Depth= 3.99"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

Area (ac)	CN	Description
1.486	61	>75% Grass cover, Good, HSG B
1.486	61	100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.4	100	0.0730	0.20		**Sheet Flow, 302A-302B** Grass: Dense n= 0.240 P2= 3.30"
0.4	108	0.0900	4.83		**Shallow Concentrated Flow, 302B-203C** Unpaved Kv= 16.1 fps
8.8	208	Total			

Summary for Subcatchment 401: Post-401

Runoff = 4.77 cfs @ 12.16 hrs, Volume= 0.411 af, Depth= 4.11"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.70"

	Area (ac)	CN	Description
	0.589	58	Woods/grass comb., Good, HSG B
*	0.053	61	Access Road, Good, HSG B
	0.069	98	Roofs, HSG B
	0.490	61	>75% Grass cover, Good, HSG B
	1.201	62	Weighted Average
	1.132	59	94.25% Pervious Area
	0.069	98	5.75% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
9.4	100	0.1500	0.18		**Sheet Flow, 31A-31B** Woods: Light underbrush n= 0.400 P2= 3.30"
2.2	558	0.0683	4.21		**Shallow Concentrated Flow, 31B-31C** Unpaved Kv= 16.1 fps
11.6	658	Total			

Summary for Pond 107: Stone Trench A

Inflow Area = 11.461 ac, 5.53% Impervious, Inflow Depth = 4.23" for 100-Year event
Inflow = 39.25 cfs @ 12.22 hrs, Volume= 4.036 af
Outflow = 29.56 cfs @ 12.37 hrs, Volume= 4.036 af, Atten= 25%, Lag= 9.2 min
Discarded = 0.63 cfs @ 10.09 hrs, Volume= 1.896 af
Primary = 28.93 cfs @ 12.37 hrs, Volume= 2.140 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 171.31' @ 12.37 hrs Surf.Area= 0.612 ac Storage= 1.209 af

Plug-Flow detention time= 366.5 min calculated for 4.035 af (100% of inflow)
Center-of-Mass det. time= 366.7 min (1,203.1 - 836.5)

Volume	Invert	Avail.Storage	Storage Description
#1	168.00'	0.393 af	**Custom Stage Data (Prismatic)**Listed below (Recalc) 1.181 af Overall x 33.3% Voids
#2	170.00'	1.087 af	**Custom Stage Data (Prismatic)**Listed below (Recalc) -Impervious
		1.480 af	Total Available Storage

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
168.00	0.164	0.000	0.000
168.09	0.164	0.015	0.015
168.10	0.612	0.004	0.019
170.00	0.612	1.163	1.181

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
170.00	0.621	0.000	0.000
171.75	0.621	1.087	1.087

Device	Routing	Invert	Outlet Devices
#1	Primary	171.10'	**125.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88
#2	Discarded	168.00'	**1.020 in/hr Exfiltration over Surface area below 178.09'** Phase-In= 0.01'

Discarded OutFlow Max=0.63 cfs @ 10.09 hrs HW=168.10' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.63 cfs)

Primary OutFlow Max=28.91 cfs @ 12.37 hrs HW=171.31' TW=143.77' (Dynamic Tailwater)
└**1=Broad-Crested Rectangular Weir** (Weir Controls 28.91 cfs @ 1.09 fps)

Summary for Pond 108: Stone Filled Basin B

Inflow Area = 16.676 ac, 3.91% Impervious, Inflow Depth = 2.79" for 100-Year event
Inflow = 42.00 cfs @ 12.36 hrs, Volume= 3.879 af
Outflow = 41.99 cfs @ 12.36 hrs, Volume= 3.879 af, Atten= 0%, Lag= 0.1 min
Discarded = 0.14 cfs @ 12.36 hrs, Volume= 0.205 af
Primary = 41.85 cfs @ 12.36 hrs, Volume= 3.674 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 143.77' @ 12.36 hrs Surf.Area= 0.137 ac Storage= 0.076 af

Plug-Flow detention time= 17.8 min calculated for 3.879 af (100% of inflow)
Center-of-Mass det. time= 17.9 min (866.8 - 848.9)

Volume	Invert	Avail.Storage	Storage Description
#1	140.00'	0.087 af	**Custom Stage Data (Prismatic)**Listed below (Recalc) 0.262 af Overall x 33.3% Voids

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
140.00	0.021	0.000	0.000
142.00	0.046	0.067	0.067
144.00	0.149	0.195	0.262

Device	Routing	Invert	Outlet Devices
#1	Discarded	140.00'	**1.020 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	143.50'	**100.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Primary	143.21'	**6.00" Round Culvert X 2.00** L= 40.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 143.21' / 136.00' S= 0.1803 '/' Cc= 0.900 n= 0.012, Flow Area= 0.20 sf

Discarded OutFlow Max=0.14 cfs @ 12.36 hrs HW=143.77' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.14 cfs)

Primary OutFlow Max=41.82 cfs @ 12.36 hrs HW=143.77' TW=0.00' (Dynamic Tailwater)
├**2=Broad-Crested Rectangular Weir** (Weir Controls 40.88 cfs @ 1.49 fps)
└**3=Culvert** (Inlet Controls 0.94 cfs @ 2.38 fps)

Summary for Pond 110: Stone Trench E

Inflow Area = 3.495 ac, 5.55% Impervious, Inflow Depth = 4.06" for 100-Year event
Inflow = 13.91 cfs @ 12.12 hrs, Volume= 1.181 af
Outflow = 11.52 cfs @ 12.20 hrs, Volume= 1.181 af, Atten= 17%, Lag= 4.9 min
Discarded = 0.08 cfs @ 9.85 hrs, Volume= 0.375 af
Primary = 11.44 cfs @ 12.20 hrs, Volume= 0.806 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 184.93' @ 12.20 hrs Surf.Area= 0.074 ac Storage= 0.310 af

Plug-Flow detention time= 477.6 min calculated for 1.181 af (100% of inflow)
Center-of-Mass det. time= 477.9 min (1,315.5 - 837.7)

Volume	Invert	Avail.Storage	Storage Description
#1	181.50'	0.049 af	**Custom Stage Data (Prismatic)** Listed below (Recalc) 0.148 af Overall x 33.3% Voids
#2	183.50'	0.280 af	**Custom Stage Data (Prismatic)** Listed below (Recalc) -Impervious
		0.330 af	Total Available Storage

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
181.50	0.074	0.000	0.000
183.50	0.074	0.148	0.148

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
183.50	0.074	0.000	0.000
185.00	0.300	0.280	0.280

Device	Routing	Invert	Outlet Devices
#1	Discarded	181.50'	**1.020 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#2	Primary	184.80'	**100.0' long x 5.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.34 2.50 2.70 2.68 2.68 2.66 2.65 2.65 2.65 2.65 2.67 2.66 2.68 2.70 2.74 2.79 2.88

Discarded OutFlow Max=0.08 cfs @ 9.85 hrs HW=181.54' (Free Discharge)
└**1=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=11.43 cfs @ 12.20 hrs HW=184.93' TW=140.34' (Dynamic Tailwater)
└**2=Broad-Crested Rectangular Weir** (Weir Controls 11.43 cfs @ 0.86 fps)

Summary for Pond 111: Stone Filled Basin H

Inflow Area = 10.262 ac, 2.15% Impervious, Inflow Depth = 5.19" for 100-Year event
Inflow = 41.08 cfs @ 12.23 hrs, Volume= 4.434 af
Outflow = 40.76 cfs @ 12.24 hrs, Volume= 4.434 af, Atten= 1%, Lag= 0.8 min
Discarded = 0.18 cfs @ 12.24 hrs, Volume= 0.225 af
Primary = 40.58 cfs @ 12.24 hrs, Volume= 4.209 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 131.37' @ 12.24 hrs Surf.Area= 0.178 ac Storage= 0.220 af

Plug-Flow detention time= 27.1 min calculated for 4.434 af (100% of inflow)
Center-of-Mass det. time= 27.1 min (913.4 - 886.3)

Volume	Invert	Avail.Storage	Storage Description
#1	124.00'	0.259 af	**Custom Stage Data (Prismatic)**Listed below (Recalc) 0.779 af Overall x 33.3% Voids

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
124.00	0.027	0.000	0.000
126.00	0.055	0.082	0.082
128.00	0.087	0.142	0.224
130.00	0.135	0.222	0.446
132.00	0.198	0.333	0.779

Device	Routing	Invert	Outlet Devices
#1	Primary	131.00'	**20.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#2	Discarded	124.00'	**1.020 in/hr Exfiltration over Surface area** Phase-In= 0.01'
#3	Primary	128.00'	**18.00" Round Culvert X 2.00** L= 62.0' CPP, end-section conforming to fill, Ke= 0.500 Inlet / Outlet Invert= 128.00' / 118.00' S= 0.1613 '/' Cc= 0.900 n= 0.012, Flow Area= 1.77 sf

Discarded OutFlow Max=0.18 cfs @ 12.24 hrs HW=131.37' (Free Discharge)
└**2=Exfiltration** (Exfiltration Controls 0.18 cfs)

Primary OutFlow Max=40.57 cfs @ 12.24 hrs HW=131.37' TW=0.00' (Dynamic Tailwater)
├**1=Broad-Crested Rectangular Weir** (Weir Controls 13.03 cfs @ 1.76 fps)
└**3=Culvert** (Inlet Controls 27.54 cfs @ 7.79 fps)

Summary for Pond 112: Stone Filled Basin G

Inflow Area = 7.289 ac, 2.66% Impervious, Inflow Depth = 3.40" for 100-Year event
Inflow = 25.64 cfs @ 12.19 hrs, Volume= 2.067 af
Outflow = 25.15 cfs @ 12.21 hrs, Volume= 2.067 af, Atten= 2%, Lag= 1.2 min
Primary = 25.15 cfs @ 12.21 hrs, Volume= 2.067 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Peak Elev= 140.34' @ 12.21 hrs Surf.Area= 0.274 ac Storage= 0.129 af

Plug-Flow detention time= 25.3 min calculated for 2.067 af (100% of inflow)
Center-of-Mass det. time= 25.2 min (879.8 - 854.6)

Volume	Invert	Avail.Storage	Storage Description
#1	138.00'	0.083 af	**Custom Stage Data (Prismatic)**Listed below (Recalc) 0.248 af Overall x 33.3% Voids
#2	140.00'	0.333 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)
		0.416 af	Total Available Storage

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
138.00	0.117	0.000	0.000
140.00	0.131	0.248	0.248

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
140.00	0.131	0.000	0.000
142.00	0.202	0.333	0.333

Device	Routing	Invert	Outlet Devices
#1	Primary	140.00'	**48.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74
#2	Primary	138.00'	**6.00" Round Culvert** L= 31.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 138.00' / 137.00' S= 0.0323 '/' Cc= 0.900 n= 0.012, Flow Area= 0.20 sf

Primary OutFlow Max=25.12 cfs @ 12.21 hrs HW=140.34' TW=131.32' (Dynamic Tailwater)
- **1=Broad-Crested Rectangular Weir** (Weir Controls 24.04 cfs @ 1.47 fps)
- **2=Culvert** (Inlet Controls 1.08 cfs @ 5.50 fps)

Summary for Pond 205: Stone Trench F (Impervious Check Dams)

Inflow Area = 5.828 ac, 2.83% Impervious, Inflow Depth = 1.06" for 100-Year event
Inflow = 9.69 cfs @ 12.26 hrs, Volume= 0.513 af
Outflow = 9.65 cfs @ 12.27 hrs, Volume= 0.494 af, Atten= 0%, Lag= 0.7 min
Primary = 9.65 cfs @ 12.27 hrs, Volume= 0.494 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 115.85' @ 12.27 hrs Surf.Area= 0.114 ac Storage= 0.032 af

Plug-Flow detention time= 24.4 min calculated for 0.494 af (96% of inflow)
Center-of-Mass det. time= 5.6 min (785.7 - 780.1)

Volume	Invert	Avail.Storage	Storage Description
#1	115.00'	0.038 af	**Custom Stage Data (Prismatic)**Listed below (Recalc) 0.114 af Overall x 33.3% Voids

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
115.00	0.114	0.000	0.000
116.00	0.114	0.114	0.114

Device	Routing	Invert	Outlet Devices
#1	Primary	115.50'	**16.5' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32

Primary OutFlow Max=9.65 cfs @ 12.27 hrs HW=115.84' TW=0.00' (Dynamic Tailwater)
↑—**1=Broad-Crested Rectangular Weir** (Weir Controls 9.65 cfs @ 1.70 fps)

Summary for Pond 206: Stone Filled Basin C (Lined)

Inflow Area = 5.289 ac, 3.12% Impervious, Inflow Depth = 3.87" for 100-Year event
Inflow = 17.95 cfs @ 12.21 hrs, Volume= 1.704 af
Outflow = 16.83 cfs @ 12.27 hrs, Volume= 1.704 af, Atten= 6%, Lag= 3.6 min
Primary = 8.44 cfs @ 12.27 hrs, Volume= 0.334 af
Secondary = 3.48 cfs @ 12.27 hrs, Volume= 1.291 af
Tertiary = 4.91 cfs @ 12.27 hrs, Volume= 0.079 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 144.48' @ 12.27 hrs Surf.Area= 0.530 ac Storage= 0.282 af

Plug-Flow detention time= 43.8 min calculated for 1.703 af (100% of inflow)
Center-of-Mass det. time= 43.9 min (893.9 - 850.0)

Volume	Invert	Avail.Storage	Storage Description
#1	142.00'	0.155 af	**Custom Stage Data (Prismatic)**Listed below (Recalc) 0.465 af Overall x 33.3% Voids
#2	144.00'	0.272 af	**Custom Stage Data (Prismatic)**Listed below (Recalc)
		0.426 af	Total Available Storage

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
142.00	0.206	0.000	0.000
144.00	0.259	0.465	0.465

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
144.00	0.259	0.000	0.000
145.00	0.284	0.272	0.272

Device	Routing	Invert	Outlet Devices
#1	Secondary	142.00'	**6.00" Round Culvert** L= 41.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 142.00' / 141.80' S= 0.0049 '/' Cc= 0.900 n= 0.012, Flow Area= 0.20 sf
#2	Primary	144.17'	**17.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#3	Secondary	142.75'	**10.00" Round Culvert** L= 58.0' CPP, projecting, no headwall, Ke= 0.900 Inlet / Outlet Invert= 142.75' / 141.80' S= 0.0164 '/' Cc= 0.900 n= 0.012, Flow Area= 0.55 sf
#4	Tertiary	144.40'	**88.0' long x 8.0' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 1.20 1.40 1.60 1.80 2.00 2.50 3.00 3.50 4.00 4.50 5.00 5.50 Coef. (English) 2.43 2.54 2.70 2.69 2.68 2.68 2.66 2.64 2.64 2.64 2.65 2.65 2.66 2.66 2.68 2.70 2.74

Primary OutFlow Max=8.44 cfs @ 12.27 hrs HW=144.48' TW=115.84' (Dynamic Tailwater)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 8.44 cfs @ 1.60 fps)

Secondary OutFlow Max=3.48 cfs @ 12.27 hrs HW=144.48' TW=131.35' (Dynamic Tailwater)
├─**1=Culvert** (Barrel Controls 1.10 cfs @ 5.61 fps)
└─**3=Culvert** (Inlet Controls 2.38 cfs @ 4.36 fps)

Tertiary OutFlow Max=4.90 cfs @ 12.27 hrs HW=144.48' TW=131.35' (Dynamic Tailwater)
└─**4=Broad-Crested Rectangular Weir** (Weir Controls 4.90 cfs @ 0.69 fps)

Summary for Pond 304: Stone Filled Basin D

Inflow Area = 1.486 ac, 0.00% Impervious, Inflow Depth = 3.99" for 100-Year event
Inflow = 6.26 cfs @ 12.13 hrs, Volume= 0.494 af
Outflow = 2.75 cfs @ 12.41 hrs, Volume= 0.433 af, Atten= 56%, Lag= 16.6 min
Primary = 2.75 cfs @ 12.41 hrs, Volume= 0.433 af

Routing by Dyn-Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs
Peak Elev= 189.73' @ 12.41 hrs Surf.Area= 0.305 ac Storage= 0.159 af

Plug-Flow detention time= 130.0 min calculated for 0.433 af (88% of inflow)
Center-of-Mass det. time= 73.4 min (915.6 - 842.3)

Volume	Invert	Avail.Storage	Storage Description
#1	188.00'	0.187 af	**Custom Stage Data (Prismatic)** Listed below (Recalc) 0.561 af Overall x 33.3% Voids

Elevation (feet)	Surf.Area (acres)	Inc.Store (acre-feet)	Cum.Store (acre-feet)
188.00	0.247	0.000	0.000
190.00	0.314	0.561	0.561

Device	Routing	Invert	Outlet Devices
#1	Primary	189.75'	**30.0' long x 0.5' breadth Broad-Crested Rectangular Weir** Head (feet) 0.20 0.40 0.60 0.80 1.00 Coef. (English) 2.80 2.92 3.08 3.30 3.32
#2	Primary	188.70'	**12.00" Round Culvert** L= 21.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 188.70' / 188.00' S= 0.0333 '/' Cc= 0.900 n= 0.012, Flow Area= 0.79 sf

Primary OutFlow Max=2.75 cfs @ 12.41 hrs HW=189.73' TW=0.00' (Dynamic Tailwater)
└─**1=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)
└─**2=Culvert** (Inlet Controls 2.75 cfs @ 3.50 fps)

Summary for Link 113: DP-1-SE Perimeter Wetland

Inflow Area = 38.388 ac, 2.76% Impervious, Inflow Depth = 3.24" for 100-Year event
Inflow = 99.04 cfs @ 12.33 hrs, Volume= 10.353 af
Primary = 99.04 cfs @ 12.33 hrs, Volume= 10.353 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link 114: Culvert Under Natick Ave

Inflow Area = 38.388 ac, 2.76% Impervious, Inflow Depth = 3.24" for 100-Year event
Inflow = 99.04 cfs @ 12.33 hrs, Volume= 10.353 af
Primary = 99.04 cfs @ 12.33 hrs, Volume= 10.353 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link 207: DP-2-NE Abutters

Inflow Area = 8.521 ac, 2.17% Impervious, Inflow Depth = 2.11" for 100-Year event
Inflow = 19.70 cfs @ 12.26 hrs, Volume= 1.497 af
Primary = 19.70 cfs @ 12.26 hrs, Volume= 1.497 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link 305: DP-3-S Abutters

Inflow Area = 7.981 ac, 0.00% Impervious, Inflow Depth = 3.90" for 100-Year event
Inflow = 24.59 cfs @ 12.23 hrs, Volume= 2.591 af
Primary = 24.59 cfs @ 12.23 hrs, Volume= 2.591 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Summary for Link 402: DP-4-Natick Ave UNDETAINED

Inflow Area = 1.201 ac, 5.75% Impervious, Inflow Depth = 4.11" for 100-Year event
Inflow = 4.77 cfs @ 12.16 hrs, Volume= 0.411 af
Primary = 4.77 cfs @ 12.16 hrs, Volume= 0.411 af, Atten= 0%, Lag= 0.0 min

Primary outflow = Inflow, Time Span= 0.00-72.00 hrs, dt= 0.01 hrs

Watershed Maps

Legend

- Woods - A Soils
- Woods - B Soils
- Woods - C Soils
- Woods - D Soils
- Grass - A Soils
- Grass - B Soils
- Grass - C Soils
- Grass - D Soils
- Gravel - A Soils
- Gravel - B Soils
- Gravel - C Soils
- Gravel - D Soils
- Impervious

Legend

- Tc Line (With Elevations)
- Subcat Area
- Soil Boundary
- Subcatchment
- Drainage Pond/Bio Retention/ Infiltrating Swale
- Drainage Structure/Pond with Insignificant Storage
- Swale
- Design Point
- Reach

Scale: 1"=100'

0 50' 100' 200'

Pre-Watershed Map

Natick Avenue Solar

DiPrete Engineering

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Legend

- Woods - A Soils
- Woods - B Soils
- Woods - C Soils
- Woods - D Soils
- Grass - A Soils
- Grass - B Soils
- Grass - C Soils
- Grass - D Soils
- Gravel - A Soils
- Gravel - B Soils
- Gravel - C Soils
- Gravel - D Soils
- Impervious

Legend

- Tc Line (With Elevations) — 1A (37.2) — 1B
- Subcat Area
- Soil Boundary
- Subcatchment — 100
- Drainage Pond/Bio Retention/ Infiltrating Swale — 100
- Drainage Structure/Pond with Insignificant Storage — 100
- Swale — 100
- Design Point — DP
- Reach

Scale: 1"=100'

0 50' 100' 200'

Post-Watershed Map

Natick Avenue Solar

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