PARE PROJECT NO. 17177.00

ENVIRONMENTAL NOTIFICATION FORM

pursuant to

The Regulations of the Massachusetts Environmental Policy Act

Northeastern University
Coastal Sustainability Institute
Nahant, Massachusetts

Applicant:

Northeastern University
360 Huntington Avenue
Boston, Massachusetts 02115

May 2019

PARE
CORPORATION

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PARE CORPORATION

May 31, 2019

Secretary Kathleen A. Theoharides
Massachusetts Executive Office of Energy and Environmental Affairs
Attn: MEPA Office
100 Cambridge Street, Suite 900
Boston, MA 02114

Re: **Environmental Notification Form**
Coastal Sustainability Institute
Northeastern University Marine Science Center
Nahant, MA
Pare Project No. 17177.00

Dear Secretary Theoharides,

On behalf of Northeastern University (NU), Pare Corporation (Pare) has prepared the following Environmental Notification Form (ENF) addressing the proposed Coastal Sustainability Institute project on the Northeastern University Marine Science Center campus in Nahant, including proposed seawater system upgrades. One copy of the ENF is being sent concurrently to each of the entities listed on the Distribution List. All parties who submitted comments on EEA #15793 are being notified via email with instructions on how to download an electronic copy of this ENF.

The bound ENF includes the following materials:

- A completed MEPA Environmental Notification Form;
- A Distribution List and Public Notice of Environmental Review;
- A detailed Project Narrative
- Figures, including a Site Location Map, Annotated Aerial Photos, and NFHDL Map;
- Cultural Resources Coordination; and
- Project Plans (separate volume).

The following materials are provided on the CD:

- Wetland Delineation and Bathymetric Survey reports;
- Original permits for the existing seawater system;
- Water temperature monitoring data summary;
- CORMIX model summary;
- Alternate building schemes;
- Preliminary Traffic Impact Study; and
- Stormwater Report.

8 BLACKSTONE VALLEY PLACE LINCOLN, RI 02865
T 401.334.4100 F 401.334.4108

10 LINCOLN ROAD, SUITE 210 FOXBORO, MA 02035
T 508.543.1755 F 508.543.1881

Public notice of the ENF submission will be published in the Lynn Daily Item newspaper on or before June 10, 2019.

The anticipated scope of work exceeds the following ENF review threshold for Wetlands, Waterways and Tidelands:

- 11.03(3)(b)(6): Construction, reconstruction or Expansion of an existing solid fill structure of 1,000 or more sf base area…provided the structure occupies flowed tidelands or other waterways.

Note that this threshold applies to the seawater system. The CSI development itself does not exceed any MEPA thresholds and does not require a state action.

Local, State and Federal permits anticipated to be required for the project include Wetlands Protection Act Orders of Conditions, a Chapter 91 Waterways License, and authorization under the Army Corps of Engineers General Permits for Massachusetts as a Pre-Construction Notification Activity.

Construction is anticipated to commence in early Winter 2019 and will be complete by the Summer of 2021. In water work is expected to occur in July 2020 during the Time of Year Work Window for Winter Flounder.

Thank you for your consideration in this matter and please feel free to contact me with questions at (401) 334-4100.

Sincerely,
Pare Corporation

Briscoe B. Lang, P.W.S.
Principal Environmental Scientist

BBL/sjp

cc: Distribution List
Timothy MacKay, Northeastern University

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Distribution List
and
Public Notice of Environmental Review

DISTRIBUTION LIST
Environmental Notification Form
Northeastern University Coastal Sustainability Institute
Nahant, Massachusetts
May 2019

Secretary Kathleen A. Theoharides
Executive Office of Energy and
Environmental Affairs
Attn: MEPA Office
100 Cambridge Street, Suite 900
Boston, MA 02114

Department of Environmental Protection
Commissioner's Office
One Winter Street
Boston, MA 02108

Department of Environmental Protection
Northeast Regional Office
Attn: MEPA Coordinator
205B Lowell Street
Wilmington, MA 01887

Department of Environmental Protection
Waterways Regulation Program
One Winter Street, 5th floor
Boston, MA 02108

Massachusetts Department of
Transportation
Public/Private Development Unit
10 Park Plaza
Boston, MA 02116

Massachusetts DOT District Office District #4
Attn: MEPA Coordinator
519 Appleton Street
Arlington, MA 02476

Massachusetts Historical Commission
The MA Archives Building
220 Morrissey Boulevard
Boston, MA 02125

Metropolitan Area Planning Council
60 Temple Place/6th floor
Boston, MA 02111

Nahant Board of Selectmen
c/o Mr. Francis J. Barile, Chair
334 Nahant Road
Nahant, MA 01908

Nahant Planning Board
c/o Mr. Richard Synder, Chair
334 Nahant Road
Nahant, MA 01908

Nahant Conservation Commission
c/o Ms. Ellen Steeves, Conservation Chair
334 Nahant Road
Nahant, MA 01908

Nahant Health Department
c/o John Coulon, Health Agent
334 Nahant Road
Nahant, MA 01908

Coastal Zone Management
Attn: Project Review Coordinator
251 Causeway Street, Suite 800
Boston, MA 02114

Division of Marine Fisheries, North Shore
Attn: Environmental Reviewer
30 Emerson Avenue
Gloucester, MA 01930

Massachusetts Water Resources Authority
Attn: MEPA Coordinator
100 First Avenue
Charlestown Navy Yard
Boston, MA 02129

US Army Corps of Engineers
Regulatory Office New England District
Attn: Environmental Review
US Army Corp of Engineers
696 Virginia Road
Concord, MA 01742-2751

DISTRIBUTION LIST
Environmental Notification Form
Northeastern University Coastal Sustainability Institute
Nahant, Massachusetts
May 2019

Cathy Vakalopoulos
Department of Environmental Protection
1 Winter St., Boston, MA 02108

Danielle Gaito
Water Permits Branch EPA Region 1
5 Post Office Square Suite 100 (OEP06-4)
Boston, MA 02109

Todd Callahan
Department of Environmental Protection
1 Winter St., Boston, MA 02108

Mike Johnson
NOAA Fisheries
55 Great Republic Drive
Gloucester, MA 01930

Zach Jylkka
NOAA Fisheries
55 Great Republic Drive
Gloucester, MA 01930

Beth Casoni
Massachusetts Lobstermen's Association
8 Otis Place
Scituate, MA 02066-1323

SUPPLEMENT TO DISTRIBUTION LIST
Environmental Notification Form
Northeastern University Coastal Sustainability Institute
Nahant, Massachusetts
May 2019

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This list includes email addresses for all who commented on the previous Seawater ENF EEA #15793. Prior to the Monitor publication date, emails will be sent to each of the above with information on where an electronic copy of this ENF may be accessed for download.

Commonwealth of Massachusetts
Executive Office of Environmental Affairs

MEPA Office

100 Cambridge St., Suite 900
Boston, MA 02114
Telephone 617-626-1020

The following should be completed and submitted to a local newspaper:

PUBLIC NOTICE OF ENVIRONMENTAL REVIEW

PROJECT: Northeastern University Coastal Sustainability Institute

LOCATION: 430 Nahant Road

Nahant, Massachusetts

PROPONENT: Northeastern University

The undersigned is submitting an Environmental Notification Form ("ENF") to the Secretary of Environmental Affairs on or before May 31, 2019

This will initiate review of the above project pursuant to the Massachusetts Environmental Policy Act ("MEPA", M.G.L. c. 30, s.s. 61, 62 62H). Copies of the ENF may be obtained from:
Briscoe Lang, Pare Corporation, 8 Blackstone Valley Place, Lincoln RI 02865, 401-334-4100

Copies of the ENF are also being sent to the Conservation Commission and Planning Board of Nahant **where they may be inspected.**

The Secretary of Environmental Affairs will publish notice of the ENF in the Environmental Monitor, will receive public comments on the project for 20 days, and will then decide, within ten days, if an environmental Impact Report is needed. A site visit and consultation session on the project may also be scheduled. All persons wishing to comment on the project, or to be notified of a site visit or consultation session, should write to the Secretary of Environmental Affairs, 100 Cambridge St., Suite 900, Boston, Massachusetts 02114, Attention: MEPA Office, referencing the above project.

By Northeastern University

Environmental Notification Form

SECTION 2

Commonwealth of Massachusetts

Executive Office of Energy and Environmental Affairs
Massachusetts Environmental Policy Act (MEPA) Office

Environmental Notification Form

For Office Use Only

EEA#: _____

MEPA Analyst: _____

The information requested on this form must be completed in order to submit a document electronically for review under the Massachusetts Environmental Policy Act, 301 CMR 11.00.

Project Name: Northeastern University Coastal Sustainability Institute		
Street Address: 430 Nahant Road		
Municipality: Nahant	Watershed: North Coastal	
Universal Transverse Mercator Coordinates:	Latitude: 42.416713 Longitude: -70.906807	
Estimated commencement date: August 2019	Estimated completion date: October 2021	
Project Type: Educational Facility	Status of project design: 15 %complete	
Proponent: Northeastern University		
Street Address: 360 Huntington Avenue		
Municipality: Boston	State: MA	Zip Code: 02115-500
Name of Contact Person: Briscoe B. Lang		
Firm/Agency: Pare Corporation	Street Address: 8 Blackstone Valley Place	
Municipality: Lincoln	State: RI	Zip Code: 02865
Phone: 401-334-4100	Fax: 401-334-4108	E-mail: blang@parecorp.com

Does this project meet or exceed a mandatory EIR threshold (see 301 CMR 11.03)?
☐Yes ☒No

If this is an Expanded Environmental Notification Form (ENF) (see 301 CMR 11.05(7)) or a Notice of Project Change (NPC), are you requesting:

a Single EIR? (see 301 CMR 11.06(8)) ☐Yes ☒No
a Special Review Procedure? (see 301CMR 11.09) ☐Yes ☒No
a Waiver of mandatory EIR? (see 301 CMR 11.11) ☐Yes ☒No
a Phase I Waiver? (see 301 CMR 11.11) ☐Yes ☒No
(Note: Greenhouse Gas Emissions analysis must be included in the Expanded ENF.)

Which MEPA review threshold(s) does the project meet or exceed (see 301 CMR 11.03)?

11.03(3)(b)(6): Construction, reconstruction or Expansion of an existing solid fill structure of 1,000 or more sf base area…provided the structure occupies flowed tidelands or other waterways.

Which State Agency Permits will the project require?

Ch. 91 Waterways License

Identify any financial assistance or land transfer from an Agency of the Commonwealth, including the Agency name and the amount of funding or land area in acres: **None**

Summary of Project Size & Environmental Impacts	Existing	Change	Total
LAND			
Total site acreage	20.4±		
New acres of land altered		3.7±	
Acres of impervious area	2.4±	1.3±	3.7±
Square feet of new bordering vegetated wetlands alteration		0	
Square feet of new other wetland alteration		LUO: 2,038± perm LSCSF: 813± perm, 31,507± temp Coastal Bank 820± temp	
Acres of new non-water dependent use of tidelands or waterways		0	
STRUCTURES			
Gross square footage	52,318±	61,664±	113,982±
Number of housing units	0	0	0
Maximum height (feet)	11'-7"	5'-2"	16'-9"
TRANSPORTATION			
Vehicle trips per day	175	175	350
Parking spaces	26	96	122
WASTEWATER			
Water Use (Gallons per day)*	929	1,094±	2,023±
Water withdrawal (GPD)	0	0	0
Wastewater generation/treatment (GPD)	844	995±	1,839±
Length of water mains (miles)	0.18±	0.33±	0.51±
Length of sewer mains (miles)	0.25±	0.12±	0.37±

Has this project been filed with MEPA before?
☒ Yes (EEA # 15793) ☐ No

Has any project on this site been filed with MEPA before?
☐ Yes (EEA #_____) ☒ No (None Known)

*Potable water

GENERAL PROJECT INFORMATION – all proponents must fill out this section

The following Project Description is a summary of the Project Narrative included as Section 3 of the ENF. The reviewer is referred to the Project Narrative for a more comprehensive discussion of the project. This Environmental Notification Form (ENF) has been prepared to document the environmental impacts, alternatives, and mitigation associated with the proposed Coastal Sustainability Institute (CSI) at the Northeastern University (NU) Marine Science Center (MSC) in Nahant including the expansion of the Murphy Bunker, seawater system upgrade, and associated site improvements. The seawater system upgrade was the subject of a previous ENF that was submitted in January 2018 (EEA #15793). The 2018 ENF was withdrawn without prejudice to allow NU the opportunity to investigate and address a number of issues raised by the regulatory agencies and local Nahant residents. At the request of the MEPA office both the seawater system upgrade project and the CSI project are now being addressed in this ENF. Program refinements made since the 2018 ENF include reducing the proposed seawater intake flow rate from 2,400 gallons per minute (gpm) to 600 gpm; eliminating the proposal to utilize a portion of the seawater flow to indirectly cool or heat the new CSI building; the currently proposed seawater outfall will consist of an offshore subsurface outfall diffuser system; and temporary impacts to BVW have been eliminated. In addition, NU proposes to construct an onsite lobster hatchery to annually raise and release Stage IV lobster larvae into the source water as mitigation for potential lobster larvae mortality attributable to the new seawater intake structures. NU has also engaged in an outreach effort to inform the public of the goals and intentions of the project and has refined several key design parameters to achieve a result that better responds to the landscape, the marine environment, and the community. NU remains committed to continuing community involvement as the CSI moves forward in the design process. **Existing Conditions:** The MSC is located at East Point in Nahant, Massachusetts on a 20.4± acre site at the end of Nahant Road east of Swallows Cave Road. Lodge Park, a public open space owned by the Town of Nahant, is located to the east of the site. Northeastern acquired the property in 1966 from the US government for the purpose of creating a marine research and teaching center. The Northeastern University Marine Science Institute opened at the site in 1967 and has operated at this location since then. The MSC incorporated remnant military facilities into the campus and over the years has helped clean up the former military site, enhancing the environment of East Point and the Nahant community. The site has approximately 3,500 feet of ocean frontage including Canoe Beach to the north and on Bathing Beach to the south. These two shelving beaches are composed of coarse sand and cobbles. The remainder of the shoreline is exposed bedrock with numerous tidepools and channels. The portion of the site east of the Murphy Bunker supports a mix of upland vegetation, a considerable portion of which are invasive. There is no mapped Estimated Habitat or Priority Habitat in the area, the site is not located in any Area of Critical Environmental Concern, and the waters of Canoe Beach Cove and Bathing Beach Cove are not Outstanding Resource Waters. Site access is provided by an existing driveway located off of Nahant Road and a total of 26 formal parking spaces are located east of the Edwards Lab. A preliminary traffic impact study undertaken in November 2018 estimated that the campus generates an average of approximately 175 vehicle trips per day. Northeastern has agreed to work with the Town to perform two additional traffic studies in the spring and summer. There is minimal drainage infrastructure onsite. Stormwater runoff that is collected discharges offsite via a 15" pipe at the Bathing Beach seawall. This pipe also serves as the existing seawater system discharge location. The existing drainage system provides minimal treatment and peak rate mitigation. Coastal and Inland Wetland resource areas present on the site include Land Under the Ocean (LUO), Coastal Bank, Land Subject to Coastal Storm Flowage (LSCSF), Coastal Beach, and a small Bordering Vegetated Wetland (BVW) dominated by Phragmites. The 100-foot Buffer Zone to Coastal Bank and BVW extends into upland portions of the site. The primary concentration of current research initiatives focusses on local and regional invertebrates. Researchers use ambient seawater to support flow through experiments to replicate actual oceanic conditions. The vast majority of the work involves no manipulation of water properties. At times, researchers may elevate water temperatures in isolated experiments two or three degrees Celsius to represent future predicted increases in sea surface temperatures. The existing seawater system on the MSC campus draws ambient seawater from Bathing Beach Cove and pumps it uphill to two (2) 20,000 gallon storage tanks, from there the seawater is gravity fed to the research facilities at the Edwards Laboratory and Murphy Bunker via an underground PVC piping network. After flowing through the research tanks the seawater is discharged through the 15" pipe at the Bathing Beach seawall. The existing seawater intake system consists of two 6" outside diameter HDPE intake pipes that extend approximately 350' from the seawall into Bathing Beach Cove. Installation of the existing intake pipes was completed in 2011 following receipt of approvals from the Nahant Conservation

Commission, the MassDEP Waterways Program, and the US Army Corps of Engineers. The pipes are anchored to the sea floor with concrete ballast blocks and the concrete intake boxes ate located at a water depth of approximately -15 feet MLW. The existing intake pipes are significantly impacted by biofouling, a natural phenomenon by which marine organisms rapidly settle and fasten themselves to substrates (in this case the interior of the intake pipes and structures) and grow rapidly due to the constant flow of fresh, food-rich seawater, restricting flows to less than a 25% of design capacity. At the MSC, blue mussels (*Mytilus edulis*) have been the biggest biofouling challenge. The biofouling creates very high friction loss on the suction side of the seawater intake pumps resulting in pump cavitation, a physical phenomenon that can destroy a robust marine pump in a single season. To control biofouling without the use of chemicals two seawater intake pipes are typically cycled so that one is active while the other is inactive. Inactivity results in a lack of food and oxygenated seawater that eventually leads to the death of the biofouling organisms. Anaerobic bacteria digest all of the organic matter in the pipe, including the byssal threads that mussels use to attach themselves, and the pipe can then be backflushed clean before being put back into service as the active line. It has been noted that biofouling in the existing system has reduced the original design flow rate of approximately 550 gpm per pump to as low as 78 gpm. To compensate (unsuccessfully) for the reduced flow rate provided by a single seawater pump the NU Maintenance Staff has been forced to operate both pumps simultaneously to meet the seawater needs of the researchers which does not allow the lines to be cycled from active to anoxic. As a result, both intake pipes are routinely completely clogged with mussels resulting in drastic reductions of flow rates. NU's only option has been to shut down one pump and attempt to relieve the clog using a roto-rooter cutting head and high pressure hose. This provides only temporary improvements until the biofouling organisms quickly grow back. Based on data collected from March 1, 2018 through January 23, 2019, the average daily flow rate, with both pumps operating, was approximately 291 gpm. The seawater system discharges through the existing 15" pipe in the Bathing Beach seawall with velocity ranging from approximately 2 to 3 ft/sec. The cobble beach is very dynamic and can seasonally accumulate to the top of the seawall after a large storm. NU will occasionally use existing authorization from the Nahant Conservation Commission to remove the cobbles in front of the outfall pipe with a small excavator working from the top of the seawall. MSC researchers tracked water temperatures at critical locations from March through November 2018. During this period the average flow rate was 248 gpm and the average temperature differential between ambient seawater at the intakes and discharge locations was 0.367 degrees F. Researchers utilized CORMIX Modeling software to attempt to model the thermal effects on the surrounding waters. Using the actual measured flowrates and temperatures the CORMIX program was unable to produce any measurable results. To create any measurable thermal plume the modelers needed to insert a theoretical flow rate of 1,050 gpm (more than 4 times the observed average flow rate) and an anomalous 5.7° F temperature differential with the ambient Cove seawater temperature, into the CORMIX model. These values far exceed any existing or proposed use of the seawater system. NU has reviewed the data and modeling with DEP and EPA and there appeared to be agreement that the existing seawater system discharges were not adversely impacting the receiving waters. NU will continue to coordinate with those agencies regarding the proposed seawater system and its potential effects. **Proposed Conditions:** The Northeastern University *Coastal Sustainability Institute* is a direct outgrowth of the university-wide Urban Coastal Sustainability Initiative (UCSI) launched in 2012. The CSI will focus on three research priorities: Global Change Science and Modeling Across the Land-Sea Interface - this theme will be supported research expertise in biogeochemistry, coastal dynamics and oceanography, ecosystem science and modeling, and urban/landscape ecology; Security and Sustainability of Coastal Resources - this theme will be supported research expertise in fisheries science and policy, social-ecological coupling, and environmental conservation and economics; and Environmental Sensing & Big Data - this theme will be supported research expertise in environmental genomics, bioinformatics, and climate sensing and modeling. The new CSI building will consist of approximately 55,000 square feet (sf) of new academic, research, and meeting space as well as offices and support facilities integrated with the Murphy Bunker and will aim to achieve a LEED Gold Certification. Utilizing the existing bunker as its foundation will limit the footprint of the building beyond that of the bunker and preserving open space on site and allowing mechanical spaces to be below-grade limiting visible rooftop equipment. The building is outside of all documented regulatory zones and setbacks and above anticipated future sea level rise. Height and massing are in accordance with zoning requirements. Following completion of the CSI development the population of the campus is expected to double from the current 114 faculty staff and students to 228. Site access will be provided via a reconfigured entrance in essentially the same location as the existing entrance. The project will

include reconstruction and minor realignment of the existing site driveways in their existing locations. No new internal driveways are proposed. New parking areas are proposed on the northerly side of the site near the entrance, on the southerly side of the site, and adjacent to the northeast side of the Edwards Laboratory. A total of 122 new parking spaces will be provided, which represents a net increase of 94 over the existing 26 spaces. NU believes that this count complies with Nahant zoning but is substantially higher than required for operational needs. Northeastern would like to reduce the parking as much as possible and would consider such alternatives as shuttles from the Boston Campus or offsite parking facilities. With the doubling of faculty, staff and students the existing 175 vehicle trips per day are also expected to double to 350. The proposed project will result in a net increase in overall impervious area of approximately 80,650 sf. New or expanded water, sewer, gas, electric and telecommunication utilities will be installed in existing developed portions of the site. Proposed stormwater management systems will be designed in accordance with the MassDEP Stormwater Management Standards. To enable the new building to meet NU's sustainability goals and to be Net-Zero Ready for the future a geothermal heating and cooling system is proposed rather than an outdoor cooling tower and gas-fired hot water boilers. The geothermal wells will likely need to be located to the east of the building in order to stay out of the flood plain. The existing project site is dominated by invasive species that do not offer unique or significantly important wildlife habitat. NU proposes to meaningfully restore and enhance plant and wildlife habitat and has developed a replanting plan that will create a mosaic of habitat features to benefit wildlife and species diversity. The CSI project was designed to minimize work within jurisdictional resource areas. Work within Coastal Bank is limited to temporary disturbance of 820 sf for the installation of utilities and associated pavement repair within Nahant Road. Work within the Coastal Bank Buffer Zone will total 70,700± sf for a portion of a new parking lot, realignment of an existing driveway, utility work, and vegetation restoration. Work within the BVW Buffer Zone will total 13,890± sf for a portion of the new southern parking lot, a bioretention basin, utility work, and roadway repairs. Temporary impacts to LSCSF total 25,620± sf for new utilities, new drainage connection, realignment of an existing driveway and surface restoration. Permanent impacts total 380± sf of new impervious surface. The *proposed seawater system* is an essential upgrade to the existing system and would be absolutely critical for the MSC's research operations even if the CSI project was not being proposed. NU currently proposes a 600 gpm system, 75% less capacity than previously proposed. The proposed seawater intakes will be 2-14" HDPE pipes that will extend approximately 400 feet from the seawall into Bathing Beach Cove to the same general location as the existing intake lines. According to investigations performed by CLE Engineering the sea floor in this area consists of areas of sand and cobbles interspersed with localized bedrock outcrops. No eelgrass was observed. The lines will be directionally drilled below the existing seawall and under the beach to a location just seaward of Mean Low Water. The intake lines will be secured to the ocean floor using concrete ballast blocks affecting 1,073± sf of LUO. The new intake structures will consist of 2 slotted fiberglass cylinders with a ½" plastic mesh designed to reduce the slot entrance velocity to minimize potential entrapment of small organisms. Each intake structure will be mounted on a concrete pad, resulting in 352± sf of additional impact to the ocean bottom. NU's calculation of lobsters **potentially** lost through the operation of the 600 gpm seawater system is 5 market sized lobsters per year. This potential loss will be mitigated by developing a lobster hatchery to annually produce and release 90,000± Stage IV larvae, which translates into the addition of 45± market sized lobsters per year. The existing dive locker and indoor aquatics lab and the southwest end of the Edwards Laboratory will be demolished and replaced with a new pump house, the finished floor elevation of which will be located approximately 4'-9" above the base flood elevation. The below grade pump room will be approximately 7'-3" below the base flood elevation. To address sea level rise and coastal resiliency, the team has considered flood mitigation and waterproofing from a building siting and material selection standpoint. The seawater discharged through 2 alternating 16" HDPE outfall pipes with a series of offshore flow diffusers to ensure rapid mixing with the receiving waters. Having 2 outfall pipes also serves to control biofouling The discharge pipes will be directionally drilled under the seawall and beach and will emerge just seaward of mean low water. The discharge pipes will be secured to the Cove bottom in the same manner as the seawater intakes by using concrete ballast blocks that will affect 613± sf of LUO. NU ran the CORMIX model for the diffuser system using a theoretical discharge flow rate of 1050 gpm with temperature differential of +5.7° F relative to the receiving ambient waters, which are far greater than the proposed system will produce. The model showed an immediate dissipation of the temperature differential between the discharge temperature and the receiving water resulting in no adverse effect. Wetland impacts will include 6,700± sf temporary and permanent impacts to LSCSF and 2,038 sf permanent impacts to LUO. **Alternatives:** Alternatives considered for the CSI

development included the no-build alternative; 3 building location and layout schemes of which 1 became the preferred alternative; alternative parking layouts; alternatives for stormwater management; and alternatives to the proposed geothermal heating and cooling system. Alternatives for the proposed seawater system included the no-action alternative; alternative system sizes; a subsea floor intake system; directional drilling for the entire length of the Intake and Discharge Lines; and retaining the existing seawater discharge location through the Bathing Beach seawall. **Permitting:** The CSI development will require an Order of Conditions from the Nahant Conservation Commission, a Building Permit from the Nahant Building Inspector, and NPDES coverage under the Construction Stormwater General Permit. The proposed seawater system will require an Order of Conditions from the Nahant Conservation Commission, a MassDEP Chapter 91 Waterways License for a water dependent project in flowed tidelands, and US Army Corps of Engineers Section 10 and Section 404 authorization as a Pre-Construction Notification activity under Massachusetts General Permit #9. **Phasing:** Construction phasing is not proposed. NU anticipates commencing construction in early winter of 2019. In water work for the new seawater system is expected to take place in July 2020, during the Time of Year work window for Winter Flounder. The project will be complete in the Summer of 2021. **Mitigation:** Mitigation for unavoidable impacts associated with the CSI development will include habitat improvements east of the Murphy Bunker, stormwater improvements, additional traffic studies, and additional assistance to the Town of Nahant to offset greater needs of the Town resulting from the CSI. **:** Mitigation for unavoidable impacts associated with the new seawater system will include r*emoving the existing and former intake lines*, developing a *Lobster Hatchery* to mitigate for the potential annual loss of 5 mature lobsters, and e*nvironmental monitoring* to adjust the system as necessary to limit the potential environmental impacts associated with its use.

AREAS OF CRITICAL ENVIRONMENTAL CONCERN:
Is the project within or adjacent to an Area of Critical Environmental Concern?
☐Yes (Specify_____)
☒No
if yes, does the ACEC have an approved Resource Management Plan? ___ Yes ___ No;
If yes, describe how the project complies with this plan.
_____
Will there be stormwater runoff or discharge to the designated ACEC? ___ Yes ___ No;
If yes, describe and assess the potential impacts of such stormwater runoff/discharge to the designated ACEC.
_____

RARE SPECIES:
Does the project site include Estimated and/or Priority Habitat of State-Listed Rare Species? (see http://www.mass.gov/dfwele/dfw/nhesp/regulatory_review/priority_habitat/priority_habitat_home.htm)
☐Yes (Specify_____) ☒No

HISTORICAL /ARCHAEOLOGICAL RESOURCES:
Does the project site include any structure, site or district listed in the State Register of Historic Place or the inventory of Historic and Archaeological Assets of the Commonwealth?
☐Yes (Specify_____) ☒No
If yes, does the project involve any demolition or destruction of any listed or inventoried historic or archaeological resources? ☐Yes (Specify_____) ☒No

WATER RESOURCES:
Is there an Outstanding Resource Water (ORW) on or within a half-mile radius of the project site? ___Yes _X_No;
if yes, identify the ORW and its location. _____

(NOTE: Outstanding Resource Waters include Class A public water supplies, their tributaries, and bordering wetlands; active and inactive reservoirs approved by MassDEP; certain waters within Areas of Critical Environmental Concern, and certified vernal pools. Outstanding resource waters are listed in the Surface Water Quality Standards, 314 CMR 4.00.)

Are there any impaired water bodies on or within a half-mile radius of the project site? _X_Yes ___No; if yes, identify the water body and pollutant(s) causing the impairment: Nahant Bay and Lynn Harbor Enterococcus and Fecal Coliform .

Is the project within a medium or high stress basin, as established by the Massachusetts Water Resources Commission? ___Yes _X_No

STORMWATER MANAGEMENT:

Generally describe the project's stormwater impacts and measures that the project will take to comply with the standards found in MassDEP's Stormwater Management Regulations: Post-Construction runoff will be treated in accordance with the Massachusetts Stormwater Standards.

MASSACHUSETTS CONTINGENCY PLAN:
Has the project site been, or is it currently being, regulated under M.G.L.c.21E or the Massachusetts Contingency Plan? Yes ___ No ___ ; if yes, please describe the current status of the site (including Release Tracking Number (RTN), cleanup phase, and Response
Action Outcome classification):_None Known__

Is there an Activity and Use Limitation (AUL) on any portion of the project site? Yes ___ No _X_;
if yes, describe which portion of the site and how the project will be consistent with the AUL:
_____.

Are you aware of any Reportable Conditions at the property that have not yet been assigned an RTN?
Yes ___ No _X_ ; if yes, please describe:_____

SOLID AND HAZARDOUS WASTE:

If the project will generate solid waste during demolition or construction, describe alternatives considered for re-use, recycling, and disposal of, e.g., asphalt, brick, concrete, gypsum, metal, wood: Solid waste will be Managed in accordance with state and federal regulations.
(NOTE: Asphalt pavement, brick, concrete and metal are banned from disposal at Massachusetts landfills and waste combustion facilities and wood is banned from disposal at Massachusetts landfills. See 310 CMR 19.017 for the complete list of banned materials.)

Will your project disturb asbestos containing materials? Yes ___ No _X_ ;
if yes, please consult state asbestos requirements at http://mass.gov/MassDEP/air/asbhom01.htm

Describe anti-idling and other measures to limit emissions from construction equipment: Construction equipment emissions shall be in accordance with state and federal standards.

DESIGNATED WILD AND SCENIC RIVER:

Is this project site located wholly or partially within a defined river corridor of a federally designated Wild and Scenic River or a state designated Scenic River? Yes ___ No _X_ ;
if yes, specify name of river and designation:

If yes, does the project have the potential to impact any of the "outstandingly remarkable" resources of a federally Wild and Scenic River or the stated purpose of a state designated Scenic River?
Yes ___ No ___ ; if yes, specify name of river and designation: _____;
if yes, will the project will result in any impacts to any of the designated "outstandingly remarkable" resources of the Wild and Scenic River or the stated purposes of a Scenic River.
Yes ___ No ___ ;
if yes,describe the potential impacts to one or more of the "outstandingly remarkable" resources or stated purposes and mitigation measures proposed.

ATTACHMENTS:

1. List of all attachments to this document.
2. U.S.G.S. map (good quality color copy, 8-½ x 11 inches or larger, at a scale of 1:24,000) indicating the project location and boundaries.
3.. Plan, at an appropriate scale, of existing conditions on the project site and its immediate environs, showing all known structures, roadways and parking lots, railroad rights-of-way, wetlands and water bodies, wooded areas, farmland, steep slopes, public open spaces, and major utilities.
4 Plan, at an appropriate scale, depicting environmental constraints on or adjacent to the project site such as Priority and/or Estimated Habitat of state-listed rare species, Areas of Critical Environmental Concern, Chapter 91 jurisdictional areas, Article 97 lands, wetland resource area delineations, water supply protection areas, and historic resources and/or districts.
5. Plan, at an appropriate scale, of proposed conditions upon completion of project (if construction of the project is proposed to be phased, there should be a site plan showing conditions upon the completion of each phase).
6. List of all agencies and persons to whom the proponent circulated the ENF, in accordance with 301 CMR 11.16(2).
7. List of municipal and federal permits and reviews required by the project, as applicable.

LAND SECTION – all proponents must fill out this section

I. Thresholds / Permits

A. Does the project meet or exceed any review thresholds related to **land** (see 301 CMR 11.03(1)
___ Yes _X_ No; if yes, specify each threshold:

II. Impacts and Permits

A. Describe, in acres, the current and proposed character of the project site, as follows:

	Existing	Change	Total
Footprint of buildings	0.1±	+0.9±	1.0±
Internal roadways	0.7±	0.0 ±	0.7±
Parking and other paved areas	1.6±	+0.4±	2.0±
Other altered areas	0	0	0
Undeveloped areas	18.0±	-1.3±	16.7±
Total: Project Site Acreage	20.4±	0	20.4±

B. Has any part of the project site been in active agricultural use in the last five years?
___ Yes _X_ No; if yes, how many acres of land in agricultural use (with prime state or locally important agricultural soils) will be converted to nonagricultural use?

C. Is any part of the project site currently or proposed to be in active forestry use?
___ Yes _X_ No; if yes, please describe current and proposed forestry activities and indicate whether any part of the site is the subject of a forest management plan approved by the Department of Conservation and Recreation:

D. Does any part of the project involve conversion of land held for natural resources purposes in accordance with Article 97 of the Amendments to the Constitution of the Commonwealth to any purpose not in accordance with Article 97? ___ Yes _X_ No; if yes, describe:

E. Is any part of the project site currently subject to a conservation restriction, preservation restriction, agricultural preservation restriction or watershed preservation restriction? ___ Yes_X_ No; if yes, does the project involve the release or modification of such restriction? ___ Yes ___ No; if yes, describe:

F. Does the project require approval of a new urban redevelopment project or a fundamental change in an existing urban redevelopment project under M.G.L.c.121A? ___ Yes _X_ No; if yes, describe:

G. Does the project require approval of a new urban renewal plan or a major modification of an existing urban renewal plan under M.G.L.c.121B? Yes ___ No _X_; if yes, describe:

III. Consistency

A. Identify the current municipal comprehensive land use plan
Title:__Nahant Open Space Master Plan__ Date__November 2016_

B. Describe the project's consistency with that plan with regard to:
1) economic development __Not Applicable_____
2) adequacy of infrastructure _Not Applicable_____
3) open space impacts __Not Applicable_____
4) compatibility with adjacent land uses__Not Applicable_

The Project is in conformance with local zoning.

C. Identify the current Regional Policy Plan of the applicable Regional Planning Agency (RPA)
RPA: __Metropolitan Area Planning Council____

Title:_MetroFuture_____ Date___May 2008___

D. Describe the project's consistency with that plan with regard to:
1) economic development _Unidentified_____
2) adequacy of infrastructure _Unidentified_____
3) open space impacts _Unidentified_____

RARE SPECIES SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **rare species or habitat** (see 301 CMR 11.03(2))? ___ Yes _X_ No; if yes, specify, in quantitative terms:

(NOTE: If you are uncertain, it is recommended that you consult with the Natural Heritage and Endangered Species Program (NHESP) prior to submitting the ENF.)

B. Does the project require any state permits related to **rare species or habitat**? ___ Yes _X_ No

C. Does the project site fall within mapped rare species habitat (Priority or Estimated Habitat?) in the current Massachusetts Natural Heritage Atlas (attach relevant page)? ___ Yes _X_ No.

D. If you answered "No" to all questions A, B and C, proceed to the **Wetlands, Waterways, and Tidelands Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Rare Species section below.

II. Impacts and Permits

A. Does the project site fall within Priority or Estimated Habitat in the current Massachusetts Natural Heritage Atlas (attach relevant page)? ___ Yes ___ No. If yes,
1. Have you consulted with the Division of Fisheries and Wildlife Natural Heritage and Endangered Species Program (NHESP)? ___Yes ___No; if yes, have you received a determination as to whether the project will result in the "take" of a rare species? ___ Yes ___ No; if yes, attach the letter of determination to this submission.

2. Will the project "take" an endangered, threatened, and/or species of special concern in accordance with M.G.L. c.131A (see also 321 CMR 10.04)? ___ Yes ___ No; if yes, provide a summary of proposed measures to minimize and mitigate rare species impacts

3. Which rare species are known to occur within the Priority or Estimated Habitat?

4. Has the site been surveyed for rare species in accordance with the Massachusetts Endangered Species Act? ___ Yes ___ No

4. If your project is within Estimated Habitat, have you filed a Notice of Intent or received an Order of Conditions for this project? ___ Yes ___ No; if yes, did you send a copy of the Notice of Intent to the Natural Heritage and Endangered Species Program, in accordance with the Wetlands Protection Act regulations? ___ Yes ___ No

B. Will the project "take" an endangered, threatened, and/or species of special concern in accordance with M.G.L. c.131A (see also 321 CMR 10.04)? ___ Yes ___ No; if yes, provide a summary of proposed measures to minimize and mitigate impacts to significant habitat:

WETLANDS, WATERWAYS, AND TIDELANDS SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **wetlands, waterways, and tidelands** (see 301 CMR 11.03(3))? _X_ Yes ___ No; if yes, specify, in quantitative terms:

310 CMR 11.03(3)(b)6. Construction of a solid fill structure of 1,000 or more sf base area provided the structure occupies flowed tidelands or other waterways.

B. Does the project require any state permits (or a local Order of Conditions) related to **wetlands, waterways, or tidelands**? _X_ Yes ___ No; if yes, specify which permit:

Order of Conditions

C. If you answered "No" to both questions A and B, proceed to the **Water Supply Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Wetlands, Waterways, and Tidelands Section below.

II. Wetlands Impacts and Permits

A. Does the project require a new or amended Order of Conditions under the Wetlands Protection Act (M.G.L. c.131A)? _X_ Yes ___ No; if yes, has a Notice of Intent been filed? ___ Yes _X_No; if yes, list the date and MassDEP file number: _____; if yes, has a local Order of Conditions been issued? ___ Yes _X_ No; Was the Order of Conditions appealed? ___ Yes _X_ No. Will the project require a Variance from the Wetlands regulations? ___ Yes _X_ No.

B. Describe any proposed permanent or temporary impacts to wetland resource areas located on the project site:

Concrete intake structure pads and anchor blocks for seawater intake and outfall pipes will occupy

C. Estimate the extent and type of impact that the project will have on wetland resources, and indicate whether the impacts are temporary or permanent:

Coastal Wetlands	Area (square feet) or Length (linear feet)	Temporary or Permanent Impact?
Land Under the Ocean	2,038	Permanent
Designated Port Areas		
Coastal Beaches		
Coastal Dunes		
Barrier Beaches		
Coastal Banks	810	Temporary
Rocky Intertidal Shores		
Salt Marshes		
Land Under Salt Ponds		
Land Containing Shellfish	2,038	Permanent
Fish Runs		
Land Subject to Coastal Storm Flowage	813; 31,507	Permanent; Temporary
Inland Wetlands		
Bank (lf)		
Bordering Vegetated Wetlands		
Isolated Vegetated Wetlands		
Land under Water		
Isolated Land Subject to Flooding		
Borderi ng Land Subject to Flooding		
Riverfront Area		

D. Is any part of the project:

1. proposed as a **limited project**? ___ Yes _X_ No; if yes, what is the area (in sf)?__
2. the construction or alteration of a **dam**? ___ Yes _X_ No; if yes, describe:
3. fill or structure in a **velocity zone** or **regulatory floodway**? ___ Yes _X_ No
4. dredging or disposal of dredged material? ___ Yes _X_ No; if yes, describe the volume of dredged material and the proposed disposal site:
5. a discharge to an **Outstanding Resource Water (ORW)** or an **Area of Critical Environmental Concern (ACEC)**? ___ Yes _X_ No
6. subject to a wetlands restriction order? ___ Yes _X_ No; if yes, identify the area (in sf):
7. located in buffer zones? _X_Yes ___No; if yes, how much (in sf) _99,795_

E. Will the project:

1. be subject to a local wetlands ordinance or bylaw? ___ Yes _X_ No
2. alter any federally-protected wetlands not regulated under state law? ___ Yes _X_ No; if yes, what is the area (sf)?

III. Waterways and Tidelands Impacts and Permits

A. Does the project site contain waterways or tidelands (including filled former tidelands) that are subject to the Waterways Act, M.G.L.c.91? _X_ Yes ___ No; if yes, is there a current Chapter 91 License or Permit affecting the project site? _X_ Yes ___ No; if yes, list the date and license or permit number and provide a copy of the historic map used to determine extent of filled tidelands: **License No. 12627 dated January 6, 2010. According to MassGIS data there are no filled tidelands on the site.**

B. Does the project require a new or modified license or permit under M.G.L.c.91? _X_ Yes ___ No; if yes, how many acres of the project site subject to M.G.L.c.91 will be for non-water-dependent use? Current _0_ Change _0_ Total _0_

If yes, how many square feet of solid fill or pile-supported structures (in sf)?

C. For non-water-dependent use projects, indicate the following:

Area of filled tidelands on the site:_____

Area of filled tidelands covered by buildings:_____

For portions of site on filled tidelands, list ground floor uses and area of each use:

_____

Does the project include new non-water-dependent uses located over flowed tidelands? Yes ___ No ___

Height of building on filled tidelands_____

Also show the following on a site plan: Mean High Water, Mean Low Water, Water-dependent Use Zone, location of uses within buildings on tidelands, and interior and exterior areas and facilities dedicated for public use, and historic high and historic low water marks.

D. Is the project located on landlocked tidelands? ___ Yes _X_ No; if yes, describe the project's impact on the public's right to access, use and enjoy jurisdictional tidelands and describe measures the project will implement to avoid, minimize or mitigate any adverse impact:

E. Is the project located in an area where low groundwater levels have been identified by a municipality or by a state or federal agency as a threat to building foundations? ___Yes _X_ No; if yes, describe the project's impact on groundwater levels and describe measures the project will implement to avoid, minimize or mitigate any adverse impact:

F. Is the project non-water-dependent **and** located on landlocked tidelands **or** waterways or tidelands subject to the Waterways Act **and** subject to a mandatory EIR? __ Yes _X No;
(NOTE: If yes, then the project will be subject to Public Benefit Review and Determination.)

G. Does the project include dredging? ___ Yes _X_ No; if yes, answer the following questions:

What type of dredging? Improvement ___ Maintenance ___ Both ____

What is the proposed dredge volume, in cubic yards (cys) _____

What is the proposed dredge footprint ____length (ft) ___width (ft)____depth (ft);

Will dredging impact the following resource areas?

Intertidal Yes__ No__; if yes, ___ sq ft

Outstanding Resource Waters Yes__ No__; if yes, ___ sq ft

Other resource area (i.e. shellfish beds, eel grass beds) Yes__ No__; if yes __ sq ft

If yes to any of the above, have you evaluated appropriate and practicable steps to: 1) avoidance; 2) if avoidance is not possible, minimization; 3) if either avoidance or minimize is not possible, mitigation?

If no to any of the above, what information or documentation was used to support this determination?

Provide a comprehensive analysis of practicable alternatives for improvement dredging in accordance with 314 CMR 9.07(1)(b). Physical and chemical data of the sediment shall be included in the comprehensive analysis.

Sediment Characterization

Existing gradation analysis results? __Yes ___No: if yes, provide results.

Existing chemical results for parameters listed in 314 CMR 9.07(2)(b)6? ___Yes ____No; if yes, provide results.

Do you have sufficient information to evaluate feasibility of the following management options for dredged sediment? If yes, check the appropriate option.

Beach Nourishment ___

Unconfined Ocean Disposal ___

Confined Disposal:

Confined Aquatic Disposal (CAD) ___

Confined Disposal Facility (CDF) ___

Landfill Reuse in accordance with COMM-97-001 ___

Shoreline Placement ___

Upland Material Reuse____

In-State landfill disposal____

Out-of-state landfill disposal ____

(NOTE: This information is required for a 401 Water Quality Certification.)

IV. Consistency:

A. Does the project have effects on the coastal resources or uses, and/or is the project located within the Coastal Zone? _X_ Yes ___ No; if yes, describe these effects and the projects consistency with the policies of the Office of Coastal Zone Management:

B. Is the project located within an area subject to a Municipal Harbor Plan? ___ Yes _X_ No; if yes, identify the Municipal Harbor Plan and describe the project's consistency with that plan:

WATER SUPPLY SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **water supply** (see 301 CMR 11.03(4))? ___ Yes _X_ No; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **water supply**? ___ Yes _X_ No; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Wastewater Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Water Supply Section below.

II. Impacts and Permits

A. Describe, in gallons per day (gpd), the volume and source of water use for existing and proposed activities at the project site:

	Existing	Change	Total
Municipal or regional water supply	_____	_____	_____
Withdrawal from groundwater	_____	_____	_____
Withdrawal from surface water	_____	_____	_____
Interbasin transfer	_____	_____	_____

(NOTE: Interbasin Transfer approval will be required if the basin and community where the proposed water supply source is located is different from the basin and community where the wastewater from the source will be discharged.)

B. If the source is a municipal or regional supply, has the municipality or region indicated that there is adequate capacity in the system to accommodate the project? ___ Yes ___ No

C. If the project involves a new or expanded withdrawal from a groundwater or surface water source, has a pumping test been conducted? ___ Yes ___ No; if yes, attach a map of the drilling sites and a summary of the alternatives considered and the results. _____

D. What is the currently permitted withdrawal at the proposed water supply source (in gallons per day)? _____Will the project require an increase in that withdrawal? ___Yes ___No; if yes, then how much of an increase (gpd)? _____

E. Does the project site currently contain a water supply well, a drinking water treatment facility, water main, or other water supply facility, or will the project involve construction of a new facility? ___ Yes ___No. If yes, describe existing and proposed water supply facilities at the project site:

	Permitted Flow	Existing Avg Daily Flow	Project Flow	Total
Capacity of water supply well(s) (gpd)	_____	_____	_____	_____
Capacity of water treatment plant (gpd)	_____	_____	_____	_____

F. If the project involves a new interbasin transfer of water, which basins are involved, what is the direction of the transfer, and is the interbasin transfer existing or proposed?

G. Does the project involve:

1. new water service by the Massachusetts Water Resources Authority or other agency of the Commonwealth to a municipality or water district? ___ Yes ___ No
2. a Watershed Protection Act variance? ___ Yes ___ No; if yes, how many acres of alteration?
3. a non-bridged stream crossing 1,000 or less feet upstream of a public surface drinking

water supply for purpose of forest harvesting activities? ___ Yes ___ No

III. Consistency

Describe the project's consistency with water conservation plans or other plans to enhance water resources, quality, facilities and services:

WASTEWATER SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **wastewater** (see 301 CMR 11.03(5))? ___ Yes _X_ No; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **wastewater**? ___ Yes _X_ No; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Transportation -- Traffic Generation Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Wastewater Section below.

II. Impacts and Permits

A. Describe the volume (in gallons per day) and type of disposal of wastewater generation for existing and proposed activities at the project site (calculate according to 310 CMR 15.00 for septic systems or 314 CMR 7.00 for sewer systems):

	Existing	Change	Total
Discharge of sanitary wastewater	_____	_____	_____
Discharge of industrial wastewater	_____	_____	_____
TOTAL	_____	_____	_____

	Existing	Change	Total
Discharge to groundwater	_____	_____	_____
Discharge to outstanding resource water	_____	_____	_____
Discharge to surface water	_____	_____	_____
Discharge to municipal or regional wastewater facility	_____	_____	_____
TOTAL	_____	_____	_____

B. Is the existing collection system at or near its capacity? ___ Yes ___ No; if yes, then describe the measures to be undertaken to accommodate the project's wastewater flows:

C. Is the existing wastewater disposal facility at or near its permitted capacity? ___ Yes___ No; if yes, then describe the measures to be undertaken to accommodate the project's wastewater flows:

D. Does the project site currently contain a wastewater treatment facility, sewer main, or other wastewater disposal facility, or will the project involve construction of a new facility? ___ Yes ___ No; if yes, describe as follows:

	Permitted	Existing Avg Daily Flow	Project Flow	Total
Wastewater treatment plant capacity (in gallons per day)	_____	_____	_____	_____

E. If the project requires an interbasin transfer of wastewater, which basins are involved, what is the direction of the transfer, and is the interbasin transfer existing or new?

(NOTE: Interbasin Transfer approval may be needed if the basin and community where wastewater will be discharged is different from the basin and community where the source of water supply is located.)

F. Does the project involve new sewer service by the Massachusetts Water Resources Authority (MWRA) or other Agency of the Commonwealth to a municipality or sewer district? ___ Yes ___ No

G. Is there an existing facility, or is a new facility proposed at the project site for the storage, treatment, processing, combustion or disposal of sewage sludge, sludge ash, grit, screenings, wastewater reuse (gray water) or other sewage residual materials? ___ Yes ___ No; if yes, what is the capacity (tons per day):

	Existing	Change	Total
Storage	_____	_____	_____
Treatment	_____	_____	_____
Processing	_____	_____	_____
Combustion	_____	_____	_____
Disposal	_____	_____	_____

H. Describe the water conservation measures to be undertaken by the project, and other wastewater mitigation, such as infiltration and inflow removal.

III. Consistency

A. Describe measures that the proponent will take to comply with applicable state, regional, and local plans and policies related to wastewater management:

B. If the project requires a sewer extension permit, is that extension included in a comprehensive wastewater management plan? ___ Yes ___ No; if yes, indicate the EEA number for the plan and whether the project site is within a sewer service area recommended or approved in that plan:

TRANSPORTATION SECTION (TRAFFIC GENERATION)

I. Thresholds / Permit

A. Will the project meet or exceed any review thresholds related to **traffic generation** (see 301 CMR 11.03(6))? ___ Yes _X_ No; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **state-controlled roadways**? ___ Yes _X_ No; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Roadways and Other Transportation Facilities Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Traffic Generation Section below.

II. Traffic Impacts and Permits

A. Describe existing and proposed vehicular traffic generated by activities at the project site:

	Existing	Change	Total
Number of parking spaces	_____	_____	_____
Number of vehicle trips per day	_____	_____	_____
ITE Land Use Code(s):	_____	_____	_____

B. What is the estimated average daily traffic on roadways serving the site?

Roadway	Existing	Change	Total
1. _____	_____	_____	_____
2. _____	_____	_____	_____
3. _____	_____	_____	_____

C. If applicable, describe proposed mitigation measures on state-controlled roadways that the project proponent will implement:

D. How will the project implement and/or promote the use of transit, pedestrian and bicycle facilities and services to provide access to and from the project site?

C. Is there a Transportation Management Association (TMA) that provides transportation demand management (TDM) services in the area of the project site? ____ Yes ____ No; if yes, describe if and how will the project will participate in the TMA:

D. Will the project use (or occur in the immediate vicinity of) water, rail, or air transportation facilities? ____ Yes ____ No; if yes, generally describe:

E. If the project will penetrate approach airspace of a nearby airport, has the proponent filed a Massachusetts Aeronautics Commission Airspace Review Form (780 CMR 111.7) and a Notice of Proposed Construction or Alteration with the Federal Aviation Administration (FAA) (CFR Title 14 Part 77.13, forms 7460-1 and 7460-2)?

III. Consistency

Describe measures that the proponent will take to comply with municipal, regional, state, and federal plans and policies related to traffic, transit, pedestrian and bicycle transportation facilities and services:

TRANSPORTATION SECTION (ROADWAYS AND OTHER TRANSPORTATION FACILITIES)

I. Thresholds

A. Will the project meet or exceed any review thresholds related to **roadways or other transportation facilities** (see 301 CMR 11.03(6))? ___ Yes _X_ No; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **roadways or other transportation facilities**? ___ Yes _X_ No; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Energy Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Roadways Section below.

II. Transportation Facility Impacts

A. Describe existing and proposed transportation facilities in the immediate vicinity of the project site:

B. Will the project involve any

1. Alteration of bank or terrain (in linear feet)? _____
2. Cutting of living public shade trees (number)? _____
3. Elimination of stone wall (in linear feet)? _____

III. Consistency -- Describe the project's consistency with other federal, state, regional, and local plans and policies related to traffic, transit, pedestrian and bicycle transportation facilities and services, including consistency with the applicable regional transportation plan and the Transportation Improvements Plan (TIP), the State Bicycle Plan, and the State Pedestrian Plan:

ENERGY SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **energy** (see 301 CMR 11.03(7))? ___ Yes _X_ No; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **energy**? ___ Yes _X_ No; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Air Quality Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Energy Section below.

II. Impacts and Permits

A. Describe existing and proposed energy generation and transmission facilities at the project site:

	Existing	Change	Total
Capacity of electric generating facility (megawatts)	_____	_____	_____
Length of fuel line (in miles)	_____	_____	_____
Length of transmission lines (in miles)	_____	_____	_____
Capacity of transmission lines (in kilovolts)	_____	_____	_____

B. If the project involves construction or expansion of an electric generating facility, what are:

1. the facility's current and proposed fuel source(s)?
2. the facility's current and proposed cooling source(s)?

C. If the project involves construction of an electrical transmission line, will it be located on a new, unused, or abandoned right of way? ___Yes ___No; if yes, please describe:

D. Describe the project's other impacts on energy facilities and services:

III. Consistency

Describe the project's consistency with state, municipal, regional, and federal plans and policies for enhancing energy facilities and services:

AIR QUALITY SECTION

I. Thresholds

A. Will the project meet or exceed any review thresholds related to **air quality** (see 301 CMR 11.03(8))? ___ Yes _X_ No; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **air quality**? ___ Yes _X_ No; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Solid and Hazardous Waste Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Air Quality Section below.

II. Impacts and Permits

A. Does the project involve construction or modification of a major stationary source (see 310 CMR 7.00, Appendix A)? ___ Yes ___ No; if yes, describe existing and proposed emissions (in tons per day) of:

	Existing	Change	Total
Particulate matter	_____	_____	_____
Carbon monoxide	_____	_____	_____
Sulfur dioxide	_____	_____	_____
Volatile organic compounds	_____	_____	_____
Oxides of nitrogen	_____	_____	_____
Lead	_____	_____	_____
Any hazardous air pollutant	_____	_____	_____
Carbon dioxide	_____	_____	_____

B. Describe the project's other impacts on air resources and air quality, including noise impacts:

III. Consistency

A. Describe the project's consistency with the State Implementation Plan:

B. Describe measures that the proponent will take to comply with other federal, state, regional, and local plans and policies related to air resources and air quality:

SOLID AND HAZARDOUS WASTE SECTION

I. Thresholds / Permits

A. Will the project meet or exceed any review thresholds related to **solid or hazardous waste** (see 301 CMR 11.03(9))? ___ Yes _X_ No; if yes, specify, in quantitative terms:

B. Does the project require any state permits related to **solid and hazardous waste**? ___ Yes _X_ No; if yes, specify which permit:

C. If you answered "No" to both questions A and B, proceed to the **Historical and Archaeological Resources Section**. If you answered "Yes" to either question A or question B, fill out the remainder of the Solid and Hazardous Waste Section below.

II. Impacts and Permits

A. Is there any current or proposed facility at the project site for the storage, treatment, processing, combustion or disposal of solid waste? ___ Yes ___ No; if yes, what is the volume (in tons per day) of the capacity:

	Existing	Change	Total
Storage	_____	_____	_____
Treatment, processing	_____	_____	_____
Combustion	_____	_____	_____
Disposal	_____	_____	_____

B. Is there any current or proposed facility at the project site for the storage, recycling, treatment or disposal of hazardous waste? ___ Yes ___ No; if yes, what is the volume (in tons or gallons per day) of the capacity:

	Existing	Change	Total
Storage	_____	_____	_____
Recycling	_____	_____	_____
Treatment	_____	_____	_____
Disposal	_____	_____	_____

C. If the project will generate solid waste (for example, during demolition or construction), describe alternatives considered for re-use, recycling, and disposal:

D. If the project involves demolition, do any buildings to be demolished contain asbestos?
___ Yes ___ No

E. Describe the project's other solid and hazardous waste impacts (including indirect impacts):

III. Consistency

Describe measures that the proponent will take to comply with the State Solid Waste Master Plan:

HISTORICAL AND ARCHAEOLOGICAL RESOURCES SECTION

I. Thresholds / Impacts

A. Have you consulted with the Massachusetts Historical Commission? _X_ Yes ___ No; if yes, attach correspondence. For project sites involving lands under water, have you consulted with the Massachusetts Board of Underwater Archaeological Resources? _X_ Yes ___ No; if yes, attach correspondence

B. Is any part of the project site a historic structure, or a structure within a historic district, in either case listed in the State Register of Historic Places or the Inventory of Historic and Archaeological Assets of the Commonwealth? ___ Yes _X_ No; if yes, does the project involve the demolition of all or any exterior part of such historic structure? ___ Yes ___ No; if yes, please describe:

C. Is any part of the project site an archaeological site listed in the State Register of Historic Places or the Inventory of Historic and Archaeological Assets of the Commonwealth? ___ Yes _X_ No; if yes, does the project involve the destruction of all or any part of such archaeological site? ___ Yes ___ No; if yes, please describe:

D. If you answered "No" to all parts of both questions A, B and C, proceed to the **Attachments and Certifications** Sections. If you answered "Yes" to any part of either question A or question B, fill out the remainder of the Historical and Archaeological Resources Section below.

II. Impacts

Describe and assess the project's impacts, direct and indirect, on listed or inventoried historical and archaeological resources:

III. Consistency

Describe measures that the proponent will take to comply with federal, state, regional, and local plans and policies related to preserving historical and archaeological resources:

CERTIFICATIONS:

1. The Public Notice of Environmental Review has been/will be published in the following newspapers in accordance with 301 CMR 11.15(1):

   (Name) Lynn Daily Item (Date) June 10, 2019

2. This form has been circulated to Agencies and Persons in accordance with 301 CMR 11.16(2).

Signatures:

	05.13.19		5/13/2019
Date	Signature of Responsible Officer or Proponent	Date	Signature of person preparing ENF (if different from above)

James Cahill, AIA	Briscoe B. Lang, PWS
Name (print or type)	Name (print or type)
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Municipality/State/Zip	Municipality/State/Zip
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Phone	Phone

Project Narrative

SECTION 3

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INTRODUCTION

This Environmental Notification Form (ENF) has been prepared to document the environmental impacts, alternatives, and mitigation associated with the proposed Coastal Sustainability Institute (CSI) at the Northeastern University (Northeastern or NU) Marine Science Center (MSC) in Nahant including the expansion of the Murphy Bunker, proposed seawater system upgrade, and associated site improvements. The seawater system upgrade was the subject of a previous ENF that was submitted in January 2018 (EEA #15793). The 2018 ENF was withdrawn without prejudice to allow NU the opportunity to investigate and address a number of issues raised by the regulatory Agencies and local Nahant residents. At the request of the MEPA office both the seawater system upgrade project and the CSI project are being addressed in a single ENF.

In addition to incorporating the CSI project, program modifications and refinements that have been made since the 2018 ENF include:

- Reducing the proposed seawater intake flow rate from 2,400 gallons per minute (gpm) to 600 gpm.
- Eliminating the proposal to utilize a portion of the proposed seawater flow to indirectly cool or heat the new CSI building.
- Modifying the previously proposed seawater outfall system through the Bathing Beach seawall to eliminate beach erosion. The current proposal is for an offshore underwater outfall diffuser system that will reduce environmental impacts.
- Eliminating a temporary Bordering Vegetated Wetland disturbance for seawater piping.
- Proposing to construct an onsite lobster hatchery to release Stage IV lobster larvae into the source water as mitigation for potential lobster larvae mortality due to the proposed seawater intakes.

Studies undertaken since original ENF include:

- Water temperature monitoring in Bathing Beach Cove that included intake, discharge, and ambient water temperatures.
- Development of larval lobster entrapment estimates for various flow rates.

- Development of a CORMIX model to assess existing and proposed conditions temperature impacts to the receiving water from seawater discharge.

Over the course of the last 18 months, during which the university sought to understand the conceptual options of a potential addition to existing buildings on the Nahant campus, numerous outlets were employed to inform the public of the goals and intentions of the project. The University has conducted two public forums to illustrate to the town what an addition to the Murphy Bunker may look like and has used the input gathered to influence design decisions to mitigate concerns raised by Nahant residents. In addition, NU established lines of communication through various mailings, a website established for projects updates and FAQs, and provided email access to members of university leadership. Through this process, NU has refined several key design parameters to achieve a result that better responds to the landscape, the marine environment, and the community. NU remains committed to continuing community involvement as the CSI moves forward in the design process.

EXISTING CONDITIONS

Existing Site and Facilities

The Northeastern University Marine Science Center (MSC) is located at East Point in Nahant, Massachusetts. The campus occupies an approximately 20.4± acre site at the end of Nahant Road east of Swallow Cave Road. Lodge Park, a public open space owned by the Town of Nahant, is located to the east of the site.

Northeastern acquired the property from the United States government in in 1966 for the purpose of creating a marine research and teaching center. Prior to that time the site was operated as a coastal defense site (East Point Military Reservation) during the first and second world wars and, from 1955 to 1962, as a Nike missile base[1]. The Northeastern University Marine Science Institute opened at the site in 1967 and has operated at this location since then. The MSC incorporated

[1] https://en.wikipedia.org/wiki/East_Point_Military_Reservation

remnant military facilities including the main research building in the northwest portion of the site (the Edwards Laboratory) and an underground bunker in the north-central portion of the site (the Murphy Bunker). Over the years, NU has helped clean up the former military site, enhancing the environment of East Point and the Nahant community.

The site has approximately 3,500 feet of ocean frontage including Canoe Beach to the north and on Bathing Beach to the south. These two shelving beaches are composed of coarse sand and

cobbles. The remainder of the shoreline is exposed bedrock with numerous tidepools and channels.

Site topography is variable ranging from Mean Low Water (elevation -4.91 NAVD88) to a maximum elevation of approximately 64 above the Murphy Bunker. Higher elevations on the west and east sides of the site border a central valley oriented on a north-south axis between Canoe Beach and Bathing Beach.

Site Soils include Hollis-Urban land-rock outcrop complex 15-35% slopes (HSG D) in the western portion of the site, Chatfield-Hollis-Rock Outcrop complex, sloping (HSG B) in the eastern and extreme southern parts of the site, and Udorthents, Smoothed (HSG Unclassified) in the central portion of the site. Most of the beach and rocky shore areas are not classified.

The central portion of the site includes a large grassed lawn area to the north and a wetland area to the south. The eastern portion of the site east of the Murphy Bunker supports a mix of upland vegetation species, a considerable portion of which are invasive. The CSI project footprint is dominated by invasive species that form dense shrub thickets that include Morrow's honeysuckle (*Lonicera morrowii*), multiflora rose (*Rosa multiflora*), and autumn olive (*Elaeagnus umbellata*) shrubs and Asiatic bittersweet (*Celastrus orbiculata*) entanglements. Two prominent Japanese knotweed (*Fallopia japonica*) stands occur within the Limit of Work along with intermittent garlic mustard (*Alliaria petiolata*). Norway maple (*Acer platanoides*) and black locust (*Robinia pseudoacacia*) trees/saplings occur sporadically with mature hardwood tree growth more prevalent on the East Bunker, most notably the west-facing slope. Non-native crab apple (*Malus* spp.) are also intermittently dispersed throughout, while Japanese black pine (*Pinus thunbergii*) trees occur on or proximate to the East Bunker.

Native woody vegetation within the Limit of Work is primarily limited to sporadic black cherry (*Prunus serotina*), eastern red cedar (*Juniperus virginiana*), and American elm (*Ulmus americana*) trees and saplings along with variable patches of staghorn sumac (*Rhus typhina*). Asiatic bittersweet has been observed to encase the native trees and all invasive species will continue to pose threats to native vegetation over time. While the existing meadow within the northeastern portion of the Limit of Work contains native grasses and wildflowers, invasive species, including Asiatic bittersweet, multiflora rose, and autumn olive, have begun to encroach.

There are no areas with NHESP Estimated Habitat of Rare Wildlife or Priority Habitats of Rare Species within or near the Project site. The site is not located in any Area of Critical Environmental

Concern, and the waters of Canoe Beach Cove and Bathing Beach Cove are not Outstanding Resource Waters.

The main laboratory buildings (the Edwards Laboratory and associated temporary trailers) are located on the western portion of the site near Swallow Cave Road and contain the principal teaching and research facilities of the MSC. Facilities include research laboratories, a classroom, a general use molecular biology laboratory, lab and office space supporting the Ocean Genome Legacy offices, a wet lab with flowing seawater, and a dive locker. The Murphy Bunker, located to the east of the Edwards Laboratory, was originally constructed by the military in the 1940's. The building now provides space for research and teaching and includes one large classroom, and laboratories supporting research in underwater robotics, climate change science, and coastal dynamics. The Murphy Bunker also supports touch tanks that are used primarily by the Outreach Program.

Site access is provided by an existing driveway located off of Nahant Road. An internal network of driveways provides vehicular and pedestrian access to the various campus buildings and to Lodge Park. A total of 26 formal parking spaces are located east of the Edwards Lab. When more than 26 vehicles are on the site, they park opportunistically alongside the access drives. A preliminary traffic impact study was undertaken in early November 2018 during perceived normalized traffic patterns. This was done so summer beach traffic would not dilute the percentage of traffic ultimately destined for the Marine Science Center. As currently calculated, the traffic entering the Marine Science Center gate is approximately 175 vehicle trips per day with morning and evening peaks of 30 and 22 vehicles per hour respectively. This represents only 2% of the traffic arriving or departing Nahant at the causeway. Northeastern has agreed to work with the Town to perform two additional traffic studies in the spring and summer to further develop these assessments and anticipates that the number of vehicle trips attributable to the Marine Science Center will be smaller during the spring and summer studies.

Drainage and Stormwater

There is minimal drainage infrastructure onsite. Stormwater runoff from some roof areas is collected below grade and piped to a small closed drainage system that discharges offsite through an existing 15” pipe that penetrates the Bathing Beach seawall. There are limited catch basins onsite and the majority of the site flows overland to either low points onsite or directly to the Atlantic Ocean or Nahant Bay. The existing drainage system provides minimal treatment and peak rate mitigation.

Wetland Resource Areas

Coastal and Inland Wetland resource areas in the vicinity of the proposed work include Land Under the Ocean (LUO) extending seaward from the Mean Low Water (MLW) mark, Coastal Bank, Land Subject to Coastal Storm Flowage (LSCSF), Coastal Beach, and a small wetland identified by CLE Engineering, Inc., as a Bordering Vegetated Wetland located just east of the Edwards Laboratory. The BVW consists of a small basin depression dominated by Phragmites. The basin was reportedly used in the past as a seawater discharge area and a single 15” concrete pipe extends from the southwest corner of the wetland through the existing Bathing Beach seawall. Although seawater discharge flows to the wetland have ceased, the 15” pipe continues to serve as the discharge location for the seawater system onto Bathing Beach. The 100-foot Buffer Zone associated with the Coastal Bank extends into the upland portion of the site. On the south side of the site CLE Engineering, Inc., classified the Coastal Bank as an area downgradient from the seawall adjacent to Bathing Beach; however, to maintain consistency with previous permit application filings for this site the Coastal Bank is herein presumed to be the seaward face of the seawall.

Current MSC Research

To address major issues confronting coastal communities today such as collapsing fisheries, microplastics pollution, loss of biodiversity, and sea-level rise, the institute aims to utilize the

unique topography and ecology in the surrounding waters off East Point. As such, the primary concentration of current research initiatives is focused on local and regional invertebrates. Researchers use ambient seawater to support flow through experiments to replicate actual ocean conditions. The vast majority of the work involves no manipulation of water properties. At times, researchers may elevate water temperatures in isolated experiments by two or three degrees C to represent future predicted increases in sea surface temperatures.

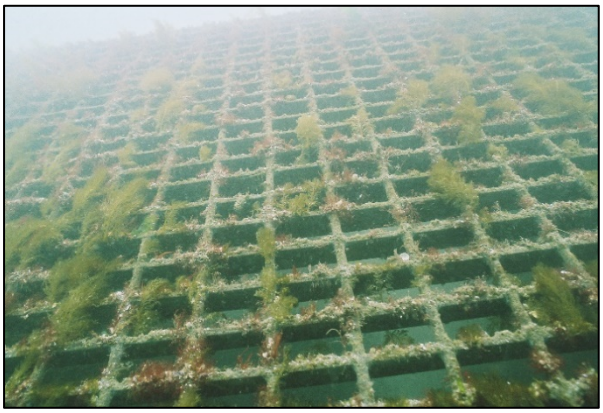
EXISTING SEAWATER SYSTEM

The existing seawater system on the MSC campus draws ambient seawater from Bathing Beach Cove and pumps it uphill to two (2) 20,000 gallon storage tanks. From there the seawater is gravity fed to the research facilities at the Edwards Laboratory and Murphy Bunker via an underground PVC piping network. After the seawater flows through the researcher's tanks, it is collected by an underground seawater PVC pipe drainage system and is discharged back into the cove through the existing 15" pipe at the Bathing Beach seawall.

In 2017 CLE Engineering performed a bathymetric and eelgrass survey of Bathing Beach Cove to establish the existing bathymetric conditions in the project area. According to survey documentation prepared by CLE the sea floor in the vicinity of the intake lines consists of areas of sand and cobbles that are interspersed with localized bedrock outcrops. While no eelgrass was observed, other subtidal vegetation was encountered in the work area including; Bladder Wrack, Kelp, and Sea Hair.

Existing Intake System

The existing seawater intake system consists of two (2) 6” outside diameter (o.d.) HDPE intake pipes that extend approximately 350’ from the seawall bordering Bathing Beach into Bathing Beach Cove south of the site. Installation of the existing intake pipes was completed in 2011 following receipt of approvals from the Nahant Conservation Commission, the MassDEP Waterways Program, and the US Army Corps of Engineers. The pipes are anchored to the sea floor using 2’ x 2’ x 2’ concrete ballast blocks that are embedded with stainless steel pipe friction clamps that hold the pipes firmly to the ballast blocks. Seawater is drawn into the terminal end of each intake pipe through concrete 4’ x 4’ x 2’ intake boxes located at a water depth of approximately -15 feet Mean Low Water. The intake boxes each have a 2” Fibergrate Screen to prevent large floating debris from being drawn into the intakes.



2” Fibergrate Screen at inlet box

The existing intake pipes are significantly impacted by a condition known as biofouling. Biofouling is a natural phenomenon by which marine organisms rapidly settle and fasten themselves to substrates (in this case the interior of the intake pipes and structures). Biofouling growth in the intake pipes is encouraged by the constant flow of fresh, food-rich (e.g., phytoplankton) seawater. At the MSC, blue mussels (*Mytilus edulis*) have been the biggest biofouling challenge, although other organisms are present as well. With growth rates up to 2” in a single season, blue mussels create significant problem for the MSC Seawater System. First and foremost, their “rough” profile creates very high friction loss on the suction side of the seawater intake pumps creating a condition known as pump cavitation, a physical phenomenon that can destroy a robust marine pump in a single season. Second, mussels can quickly occupy the entire inside diameter of the

seawater pipe thus restricting the flow of seawater to less than a 25% of the system's design capacity.

To control biofouling in a marine system without the use of chemicals, two seawater intake pipes are typically cycled so that one is active while the other is inactive. Inactivity results in a lack of food and oxygenated seawater that eventually leads to the death of the biofouling organisms. Eventually, anaerobic bacteria will digest all of the organic matter in the pipe, including the byssal threads that mussels use to attach themselves to the interior wall of the pipe. The pipe can then be backflushed clean of any remaining biofouling debris before being put back into service as the active line. Because of biofouling in the existing system, the original design flow rate of approximately 550 gallons per minute (gpm) has been reduced to as low as 78 gpm (recorded in January of 2017).

Biofouling by Blue Mussels

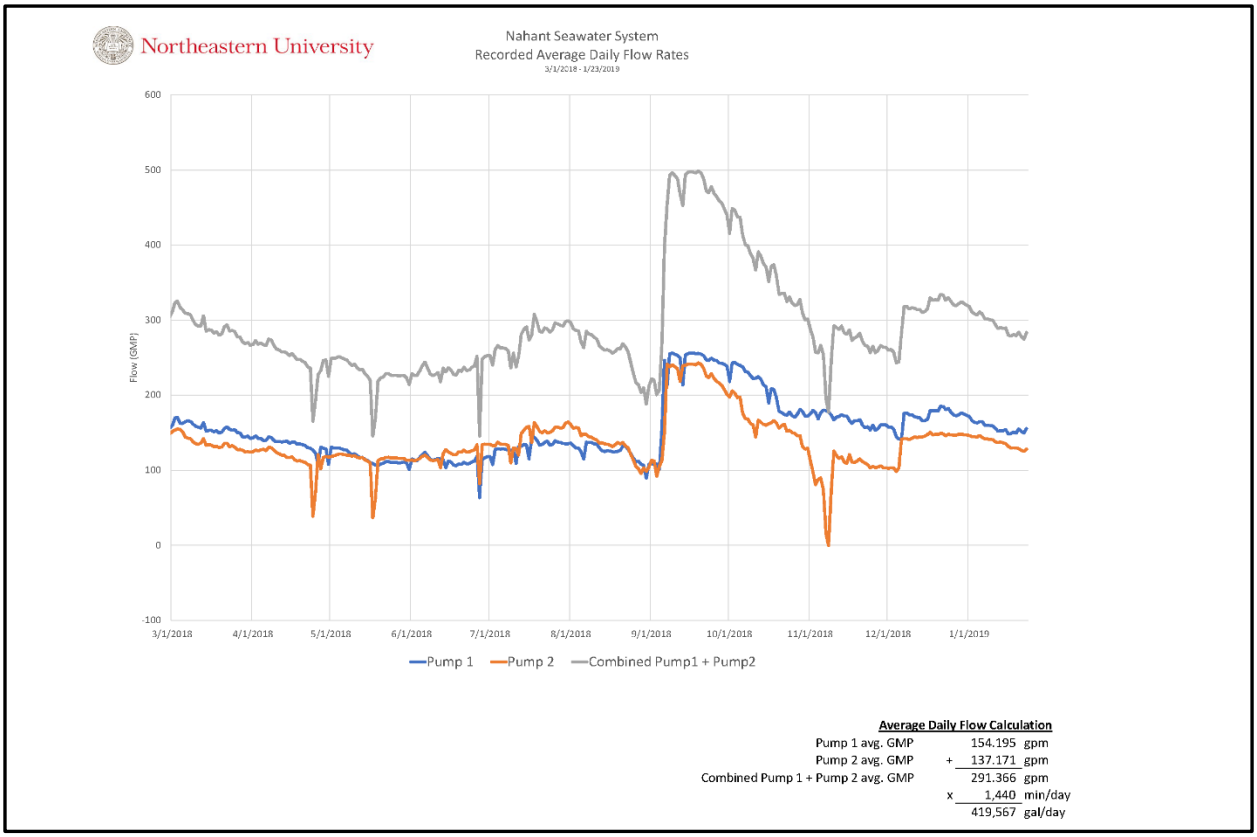
Existing Pump House

The existing seawater pump house, located just north of the Bathing Beach Seawall, contains two (2) 15 hp seawater pumps that each have a maximum theoretical flow capacity of 550 gpm. The initial intent was to have one seawater pump and one intake line in operation to provide the seawater flow rate necessary to support the MSC's research requirements while the second pump would serve as a backup pump and provide a means of cycling the piping and intake systems between the active and inactive states to control biofouling.

The severe and rapid biofouling of the intake lines has increased the dynamic friction losses as the seawater passes by them, creating a very high vacuum pressure on the suction side of the pump resulting in cavitation, the implosion of gas bubbles at the tip of the pump's impeller. This is a very violent physical reaction that creates rapid wear on the pump's impeller and also results in heavy vibrations that shake and wear other pump components, eventually leading to premature failure of the pump. This problem is further compounded by ongoing research that requires constant and reliable supply of seawater. To compensate (unsuccessfully) for the reduced flow rate provided by a single seawater pump the NU Maintenance Staff has been forced to operate both pumps simultaneously to meet the seawater flow rates required by the researchers. This approach has led to even more damaging results because it does not allow the lines to be cycled from active to anoxic to control the biofouling. Hence both seawater intake pipes are routinely completely clogged with mussels resulting in drastic reductions of seawater flow rates. NU's only option has been to shut down one pump and attempt to relieve the clog by mechanical intervention using a roto-rooter cutting head and high pressure hose, which provides some temporary seawater flow improvements until the biofouling organisms quickly grow back.

Rooting and Jetting Intake

Based on data collected from March 1, 2018 through January 23, 2019, the average daily flow rate, with both pumps operating, was approximately 291 gpm (419,567 GPD).



Average Daily Seawater Pumping Rates March 1, 2018 to January 23, 2019

Existing Storage and Distribution

Each seawater pump has a 6" HDPE discharge pipe that delivers seawater to the elevated 20,000 gallon storage tanks located on the southwest corner of the campus. To conserve energy and minimize seawater consumption, the seawater pumping system was designed to be a variable flow system with flow rates dependent on actual usage by various research projects. As seawater is fed by gravity from the elevated storage tanks into the various research tanks on the campus, the

Seawater Storage Tank Enclosure

water level drops in the storage tanks. This change is monitored by a water level sensor that sends a signal to the seawater pump's variable frequency devices (VFD's) that either speed up or slow down the seawater pumping rates depending on demand.

Because of the relatively short retention time of seawater in the storage tanks, settlement of suspended sediments is limited, so the raw ambient seawater remains virtually unchanged before it flows downstream to the research tanks. Moreover, the storage tanks are enclosed within a building thus preventing the seawater from warming from sun exposure. The 12" thick concrete walls of the tanks themselves also serve as good insulators allowing the seawater to retain its desirable ambient temperature. The retention time in the storage tanks varies with demand. At 200 gpm the retention time is 200 mins (3 hrs 20 mins) and at 500 gpm the retention time is 80 mins (1 hr 20 mins).

The flow rates to individual research tanks are based on several factors that include the mass of specimens being held in a specific tank, the minimum turnover rates required to maintain high water quality for marine species, and dynamic water velocities that replicate the natural ocean conditions that particular organisms typically experience. Unlike typical aquaculture systems, MSC research projects do not involve significant animal biomass or unusually high densities; the lower densities minimize unwanted stress upon the specimens being studied and represent a more natural condition. Typically, a minimum turn-over rate of research tank water is approximately one to two times per hour. Thus, if a tank has a 400 gallon capacity the flow rate to that tank will be approximately 7 to 14 gpm while a 1,000 gallon tank would have a flow rate of approximately 16 to 32 gpm. Flow monitoring from March 2018 through January 2019 indicates that the current research at the MSC utilizes an average of 291 gpm. This usage is expected to double once the CSI becomes operational.

Existing Discharge

Seawater discharged from the research tanks connect via a gravity flow network of underground PVC pipes that ultimately discharge through the single 15” reinforced concrete pipe on the south face of the Bathing Beach Seawall. Before seawater is discharged it comingles with stormwater runoff, a condition that seems to be a relic of the original system installed when the MSC was first established. Depending on the seawater demands of the campus research projects, the velocity in the outfall pipe ranges from approximately 2 to 3 ft/sec. During a normal tide cycle the outfall discharge encounters the ambient cove water within a distance of approximately 30 feet at high tide and approximately 110 feet at low tide. The round cobbles on the beach are very dynamic, moving in and out depending upon wave and current actions and can seasonally accumulate to the top of the seawall after a large storm. When the cobbles pile up against the seawall the outfall water typically runs down thru the voids between the cobbles. To keep the outlet open NU periodically discharges a surge of water to displace the cobbles at the outlet. On occasion, typically after large storms, NU will use existing authorization from the Nahant Conservation Commission to remove the cobbles in front of the outfall pipe with a small excavator working from the top of the seawall.

Existing 18” Discharge Pipe at Seawall

Thermal Effects of Existing Discharge

MSC researchers tracked intake and discharge temperatures as well as ambient water temperatures throughout Bathing Beach Cove to Shag Rocks from March through November 2018. During this period, the average seawater flow rate was 248 gpm and the average temperature differential between ambient seawater at the intakes and seawater discharged onto Bathing Beach was 0.367 degrees F. Using these parameters, researchers utilized CORMIX

Modeling software (an advanced information system that delivers a comprehensive analysis of regulatory mixing zones, including evaluation of critical ecological impacts) to attempt to model the effects of seawater discharged seawater on the surrounding waters. Using the actual measured flowrates and temperatures the CORMIX program was unable to produce any measurable results based on the negligible thermal effects within the Near Field Region. To create any measurable thermal plume in the waters of Bathing Beach Cove the modelers needed to insert a theoretical flow rate of 1,050 gpm (more than 4 times the observed average flow rate) and an anomalous 5.7° F temperature differential with the ambient Cove seawater temperature, into the CORMIX model. These values far exceed any intended use of the proposed seawater system. NU has reviewed the data and modeling with DEP and EPA and there appeared to be agreement that the existing seawater system discharges were not adversely impacting the receiving waters. NU continues to coordinate with those agencies regarding the proposed seawater system and its potential effects.

Since 1985, Dr. Ken Sebens (former MSC Director and now a member of the faculty at Friday Harbor Laboratories) has been monitoring the abundance of lobster (and other species) at three locations around East Point (Dive Beach), and inside and outside of Shag Rocks. Each year, lobster abundance was counted by SCUBA divers along 25 m x 1 m transects, a common approach to sampling of mobile benthic animals. Analysis of these data indicate that lobster abundance has not changed significantly over time at these sites. These data also show that there is considerable variability in lobster abundance over this 33-year period, with boom and bust years for lobsters. But there is no evidence of sustained long-term lobster decline, and no evidence of decline since renovations to the MSC seawater system in 2011.

PROPOSED CONDITIONS

Coastal Sustainability Institute

The Northeastern University Coastal Sustainability Institute (CSI), a direct outgrowth of the university-wide Urban Coastal Sustainability Initiative (UCSI) launched in 2012.

Coastal ecosystems are among the most economically valuable places on Earth because they provide vital services for planetary health and societal wellbeing. Currently, 40% of the world's population (including two-thirds of the world's megacities) resides along the coast and over 50% of global GDP is produced along the coast. This concentration of human populations and economies along the world's coastlines highlights the fundamental societal and environmental importance of understanding how natural and human dynamics are coupled in urban coastal ecosystems during this era of the Anthropocene – the new era of humans affecting all life on the planet. Indeed, while coastal ecosystems provide vital services (reduced erosion, nutrient cycling, food production), they are increasingly degraded and threatened owing to climate change, overexploitation of fisheries, sea level rise, ocean acidification, habitat loss, intensifying and more frequent coastal storms, and the proliferation of dead zones due to eutrophication.

The overarching goal of the CSI will be to develop cutting-edge methods for identifying, quantifying, and forecasting changes to coupled human-natural coastal ecosystems; to examine likely social, economic, ethical, political and ecological consequences of those changes; and to develop proactive, integrative solutions based on current best practices in science, engineering, and policy to create the next generation of integrated resource management strategies. The CSI will focus on three research priorities that are compelling in their stand-alone and integrative impact.

1. Global Change Science and Modeling Across the Land-Sea Interface

Global change is acting on coupled human-natural ecosystems and imperiling the sustainability of critical human resources and ecosystem functions. Ocean warming and acidification, sea level rise, increased pollution, and the depletion of natural resources are major threats facing coastal communities around the world. These threats will grow exponentially as a consequence of ongoing climate change and global population growth. Nowhere are these challenges as evident as in the world's coastal zones. Understanding how these multi-scale threats act individually and in concert across the land-sea interface is one of the defining challenges of the 21st century.

This theme will be supported research expertise in biogeochemistry, coastal dynamics and oceanography, ecosystem science and modeling, and urban/landscape ecology.

2. Security and Sustainability of Coastal Resources

Sustainable societies require access to energy, clean water, and a stable, secure food supply. These challenges are highly focused in coastal ecosystems and speak to the critical role of the oceans in meeting them. For example, land-based protein production (beef, pork, poultry) is reliant on unsustainable agricultural practices that are accelerating inefficient water use, the degradation of coastal water quality, and greenhouse gas emissions. Seafood presently accounts for 17% of global protein intake and with projected trends in population growth this reliance will exceed 70%. This demand will be increasingly difficult to meet as 60% of the world's largest fisheries are already characterized as heavily or over-exploited. Aquaculture accounts for almost half of seafood production, but present approaches exacerbate other environmental threats (e.g., coastal pollution, habitat degradation). In addition, transitioning from carbon-based energy sources (coal, oil, natural gas) to renewable sources, in particular wind and solar, is a global priority. Offshore wind energy is a compelling solution that benefits from strong, consistent wind and proximity to major urban populations, bypassing the burdens of long-distance energy transmission. New water treatment technologies are also vital for developing cost-effective freshwater supplies and mitigating impacts of wastewater effluent and urban runoff into the coastal zone.

This theme will be supported research expertise in fisheries science and policy, social-ecological coupling, and environmental conservation and economics.

3. Environmental Sensing & Big Data

The planet is changing faster than we are able to observe and interpret. Distributed sensing and big data analysis allow us to solve this problem using the ever-expanding suite of tools, such as the Internet of Things, remote sensing from satellites, aerial and underwater vehicles, and deep

machine learning. Creation of decision support tools and the development of indicators and “early warning systems” are critically needed for effective planning and management of coastal cities and ecosystems.

This theme will be supported research expertise in environmental genomics, bioinformatics, and climate sensing and modeling.

COASTAL SUSTAINABILITY INSTITUTE DEVELOPMENT

Building

Northeastern University is proposing the construction of a new building on the MSC campus to house the Coastal Sustainability Institute. The new CSI building will consist of approximately 55,000 square feet (sf) of new academic research, and meeting space as well as offices and support facilities. The new building will be integrated with the existing Murphy Bunker research facility which will also be partially renovated as part of the project. The proposed CSI development – consistent with all new Northeastern buildings – will aim to achieve a LEED Gold Certification from the US Green Building Counsel.

The new CSI building utilizes the existing Murphy Bunker as its foundation, limiting the footprint of the building beyond that of the bunker and preserving open space on site. By utilizing the bunker’s geometry, program and mechanical spaces can be constructed below-grade limiting visible rooftop equipment. The siting of the building is outside of all documented regulatory zones and setbacks and above anticipated future sea level rise. Height and massing of the building respond to zoning requirements.

Building on the south end of Murphy Bunker minimizes impact on the east meadow and does not interface with the north gun port near the coastal zone buffer. The building is partially screened by landscape from both Lodge Park and the residences along Swallow Cave Road.

Following completion of the CSI development the population of the campus is expected to double from the current 114 faculty staff and students to 228.

Access, Circulation and Parking

Site access will be provided by a reconfigured entrance from Nahant Road located in essentially the same location as the existing entrance. The project will include reconstruction and minor realignment of the existing site driveways in their existing locations, however no new internal driveways are proposed. Three new onsite parking areas are proposed, one on the northerly side of the site near the existing driveway entrance, one on the southerly side of the site southwest of the south entrance to the Murphy Bunker east of the existing BVW, and a row of spaces to be provided adjacent to the northeast side of the Edwards Laboratory. A total of 122 new parking spaces will be provided, which represents a net increase of 96 over the existing 26 spaces. While the proposed parking space count is in compliance with Nahant zoning requirements it is substantially higher than required for operational needs. Northeastern would like to reduce the parking as much as possible and would be willing to consider alternative solutions such as shuttles from the Boston Campus or offsite parking facilities to further reduce required parking on site. No parking structure is being considered.

With the anticipated doubling of faculty, staff and students the existing 175 vehicle trips per day are also expected to double to 350.

The proposed project will result in a net increase in overall impervious area (building and pavement) of approximately 80,650 sf.

Utilities

The proposed building will require new or expanded water, sewer, gas, electric and telecommunication utilities will be installed in existing developed portions of the site.

Lighting

The goal for the project will be to minimize light trespass from the building and site, reduce sky-glow to increase night sky access, improve nighttime visibility through glare reduction and reduce development impact from lighting on nocturnal environments. NU will seek to achieve this by careful selection and placement of fixtures, and the use of internal building window treatment that will limit light emanating from the new building.

Stormwater Management

The project includes the installation of new stormwater management systems designed in accordance with the MassDEP Stormwater Management Standards. Best Management Practices (BMPs) will be used to mitigate changes in runoff associated with increased impervious surfaces, to promote infiltration, and to provide water quality treatment. The Project will also implement long-term pollution prevention and source control measures, including inspections and maintenance of stormwater BMPs. The following BMPs are included in the Stormwater Design:

- Deep Sump Catch Basins: Deep sump and hooded catch basins are proposed to provide pretreatment in the impervious areas of the northern parking lot and driveway.
- Stormtech Infiltration Chambers: Runoff will be collected, treated and infiltrated using Stormtech Chambers designed to meet the recharge requirement of Standard 3.
- Isolator Row: An isolator row is proposed within the Stormtech Infiltration Chamber system to provide pretreatment to stormwater runoff from the deep sump catch basins in the northern parking lot before it enters the Stormtech Infiltration System.
- Bioretention Basin: A bioretention basin is proposed at the southern parking lot to collect and treat stormwater runoff. Stormwater will infiltrate through the bioretention basin media to the Stormtech chambers.
- Proprietary Water Quality Structures: In new vehicular impervious areas where stormwater runoff cannot be directed to an infiltration BMP, it will be collected and treated using a proprietary water quality structure.

Ecological Improvements

The existing project site is dominated by invasive species that do not offer unique or significantly important wildlife habitat. Considering the extent of invasive species, there are significant opportunities to meaningfully restore and enhance plant and wildlife habitat that will serve to increase species diversity on-site. The project team has collaboratively developed a replanting plan that will create a mosaic of habitat features to benefit wildlife and species diversity. The proposed habitat cover types will restore and enhance natural communities present at East Point, including Maritime Shrubland and Grassland habitat containing native species.

Implementing Best Management Practices (BMP's), all invasive species along with soil material that may contain roots, propagules, and/or seed stock shall be dug up, bagged, and brought to an approved facility for proper disposal. BMP's shall also be implemented to reduce the potential for spread of invasive species during construction. Proposed plant species are native to Essex County and have been specifically selected to thrive in the coastal environment and include Eastern Red Cedar (J*uniperus virginiana*), Pitch Pine (*Pinus rigida)*, Black Cherry (*Prunus serotina*), Black Oak (*Quercus velutina*), Red Oak (*Quercus rubra*), Red Maple (*Acer rubrum*), Staghorn sumac (*Rhus typhina*), Bayberry (*Myrica pensylvanica*), Beach Plum (*Prunus maritima*), Arrowwood (*Viburnum dentatum*), Highbush Blueberry (*Vaccinium corymbosum*), Scrub Oak (*Quercus ilicifolia*), and Sweet Fern (*Comptonia peregrina*). Groundcover and proposed Native Grassland species are to be determined.

Geothermal Heating and Cooling System

Northeastern is committed to employing sustainable practices in all of its building projects. For the CSI building a geothermal heating and cooling system has been proposed to enable the new building to meet these sustainability goals and to be Net-Zero Ready for the future. The geothermal system utilizes the earth as a heat exchanger and storage system that drastically reduces the buildings energy usage. For traditional systems to meet the energy code, this project would include an outdoor cooling tower to reject heat in the summer, and gas-fired hot water

boilers to provide heat during the winter. Given the sensitivity of the site, eliminating cooling towers from the project will reduce the visual and auditory impact of large exterior mechanical equipment. An additional benefit is that eliminating the cooling tower from the project reduces the buildings water demand by up to 30% (the cooling tower utilizes water as a heat rejection medium). During the winter, the geothermal heat pumps pull energy from the earth which will reduce the fossil fuel consumption onsite by 64%. During the design process, further site analysis will be required to determine the exact quantity, spacing, and depth of the bore holes for the wells, however the wells will likely need to be located to the east of the building in order to stay out of the flood plain. Once installed, the wells will be invisible and expand the area available for natural planting or open green space which would otherwise be used for the exterior cooling towers.

Wetland Resource Area Impacts

The project was designed to minimize work within jurisdictional resource areas and protect the function of the FEMA Flood Hazard areas.

Work within Coastal Bank will be in conformance with the applicable performance standards set forth in the Regulations of the Massachusetts Wetlands Protection Act (the WPA Regulations) and is limited to the installation of utilities and associated pavement repair within a portion of Nahant Road; no new impervious area or building structures are proposed in the resource area. The proposed work is minimal and will result in the temporary disturbance of only approximately 820 sf to install the new water service and resurface the existing road. No changes in grade or surface cover are proposed and no obstructions to wave action are proposed. Work within the 100-foot Buffer Zone to Coastal Bank will include the construction of a portion of the new northern parking lot, the realignment of an existing driveway, utility work, and the restoration of native vegetation. No structures or buildings are proposed within the Buffer Zone and none of the proposed work in the area will have an adverse effect due to wave action on the movement of sediment. The work within the 100-foot Buffer Zone to Coastal Bank will result in approximately 1,250 sf of new impervious surface. The total area of disturbance is approximately 70,700 sf.

Work within the 100-foot Buffer Zone to BVW will include the construction of a portion of the new southern parking lot, the construction of a bioretention basin, utility work, and associated roadway repairs. These improvements will result in an increase in impervious area of approximately 4,250 sf. The total area of disturbance is approximately 13,890 sf.

The Land Subject to Coastal Storm Flowage consists of land covered by FEMA Zones AE, AO, and VE shown on the existing conditions plan. There are no performance standards for Land Subject to Coastal Storm Flowage under the Wetlands Protection Act regulations. The proposed work in these flood zones is minimal and does not change the surface elevation within the Land Subject to Coastal Storm Flowage. The breakdown of the work provided within each Zone is provided below.

Table 1. CSI Work in LSCSF

Zone	Impact Area (sf)	Activity
AE	3,550	New storm drain connection, new domestic water service, new utility pole, surface restoration, no change in cover type or elevation.
AO	7,500	Realignment/resurfacing existing driveway, 400 sf new impervious, no change in elevation.
VE	14,920	New utilities and roadway restoration, realignment/resurfacing existing driveway with net impervious reduction of 20 sf, no change in elevation.
Total	25,970	380 sf new impervious, all other impacts temporary

PROPOSED SEAWATER SYSTEM

The proposed seawater system is an essential upgrade to the existing system that, as described above, has significant limitations. The proposed seawater system would be absolutely critical for the MSC's current research operations even if the Coastal Sustainability Institute project was not being proposed. Following a complete reevaluation of the current and projected seawater research requirements, NU currently proposes to upgrade the seawater system to operate at 600 gpm, which represents a 75 percent reduction from the previously proposed 2,400 gpm seawater capacity.

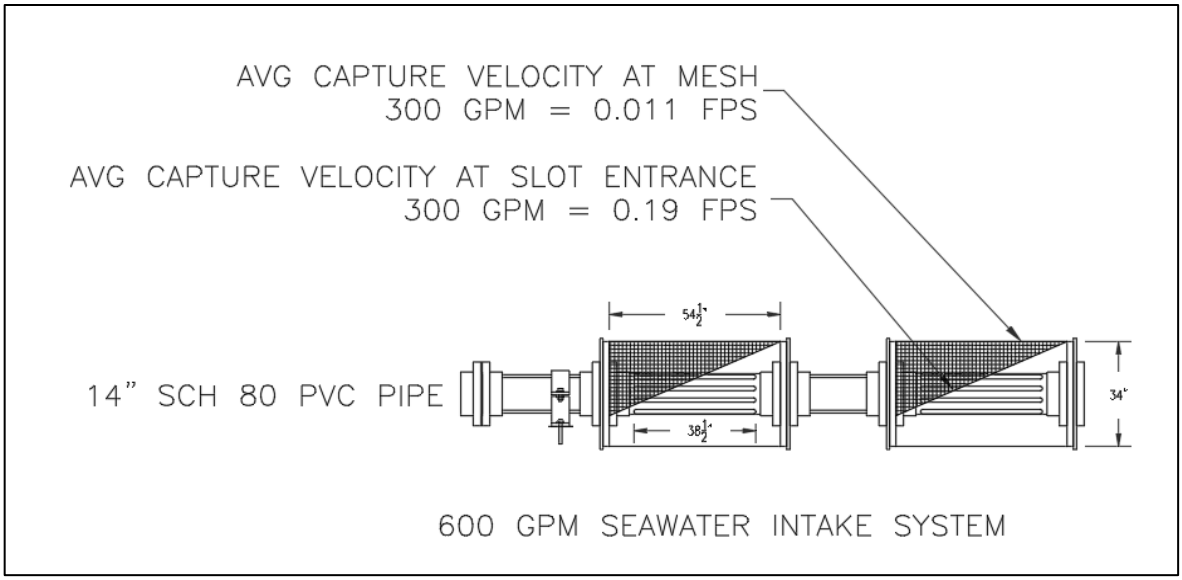
Proposed Intake System

The proposed new seawater intake system will consist of two (2) new 14” DR15.5 HDPE intake pipes that will extend approximately 400 feet from the seawall into Bathing Beach Cove to the same general location as the existing intake lines. Due to the long pipe length from the pump house to the intake site, the intake pipes are oversized to compensate for the friction losses that result from even a small amount of biofouling growth thus avoiding the cavitation problems that the existing seawater pumps are experiencing. The new intake lines will be directionally drilled below the existing seawall and under the beach to a location just seaward of Mean Low Water where they will emerge onto the Cove bottom. This will protect the integrity of the existing stone seawall and, minimize construction phase impacts to Bathing Beach.

The intake pipes will be secured to the Cove bottom using a combination of concrete ballast blocks with either helix anchors if the supporting substratum is sand, or stainless steel threaded rods that will be drilled and epoxied into the bedrock. Depending on their exact location, which may vary slightly from plan due to actual conditions on the ocean floor, the pipes will be secured to the seafloor using a single ballast block 4’-0” long x 6’-5” wide x 2’-9” deep (25.67 sf/block), or separately with individual ballast blocks 4’ long x 3’-10” wide x 2’-9” deep (15.33 sf/block). To conservatively over-estimate the potential impact to the Cove bottom it has been assumed that the pipes will be anchored separately with 70 ballast blocks totaling 1,073± sf.

The new seawater intake structures will consist of two (2) Fiberglass Structural Cylinders that will support a ½" plastic mesh installed at the terminal end of each intake pipe and will be mounted on two (2) separate precast concrete pads. The pads will measure 22' x 8' (176 sf each) resulting in an additional approximately 352 sf of additional impact to the ocean bottom. The purpose of the ½" plastic mesh is to prevent larger suspended material from being drawn into seawater pumping system. The capture velocity at the surface of the plastic mesh is very low so that it does not capture any passing debris such as seaweed or plastic bags. At the interior of the intake system is a series of slots cut into a round pipe. The quantity and open area of the slots is designed to reduce the slot entrance velocity such that small fish and crustaceans that pass thru the ½" mesh can avoid being drawn into the seawater intake system by using their "escape velocity" (natural survival reflex that creates an accelerated burst to avoid being captured) to swim away from the intake slot.

Intake Structure



Flow Rate gpm	Slot Capture Velocity ft/sec	Slot Capture Velocity @ 2" from Slot ft/sec	Capture Velocity at Mesh ft/sec
600	0.192	0.028	0.011

NU's initial calculation of lobsters **potentially** lost through the operation of the seawater system was based on a flow rate of 2,400 gallons per minute and 43.7 lobster larvae per 1,000 m^3 of seawater (the highest value found in the published literature). Hence, this approach likely overestimates adverse impacts of the system because it assumes that "in season" (May thru October) larval density around the intakes is always at peak, which is highly unlikely. This approach translated into an estimated mortality of 102,927 lobster larvae per year. The published estimated survival rate of a lobster from an egg to market size is between 0.004% to 0.02%. Using the larger value of 0.02% results in a calculated loss of approximately 21 market sized lobsters per year at the 2,400 gpm seawater flow rate.

Month	Ambient Temp (F)	Anticipated Flow Rate gpm	Flow Rate ft^3/sec	Total Seawater ft^3/month	Total Seawater m^3/ month	Lobster Larvae Density #/m^3	Lobster Larvae Entrained Per Month
January	41.4	250	0.56	1,443,850	40,891	0.00	0
February	38.8	250	0.56	1,443,850	40,891	0.00	0
March	38.8	250	0.56	1,443,850	40,891	0.00	0
April	43.2	400	0.89	2,310,160	65,425	0.00	0
May	48	600	1.34	3,465,241	98,138	0.04	4289
June	58.1	600	1.34	3,465,241	98,138	0.04	4289
July	65.8	600	1.34	3,465,241	98,138	0.04	4289
August	67.5	600	1.34	3,465,241	98,138	0.04	4289
September	63.9	600	1.34	3,465,241	98,138	0.04	4289
October	57.9	600	1.34	3,465,241	98,138	0.04	4289
November	51.3	400	0.89	2,310,160	65,425	0.00	0
December	46.2	250	0.56	1,443,850	40,891	0.00	0
Yearly Totals				**31,187,166**	**883,239**		**25732**

Note: Lobster Larval Density used in the above calculation was 43.7 larvae/1000m^3 of seawater, the highest density found in the published literature.

At the currently proposed 600 gpm flowrate, losses were calculated to be 25,732 lobster larvae or 5 market sized lobsters per year.

As mitigation for that potential loss, NU is proposing to construct an onsite lobster hatchery that would produce approximately 90,000 Stage IV larvae per year to be released in Bathing Beach Cove or in nearby Nahant waters as recommended by lobstermen that are willing to collaborate on this effort. Published literature estimates that released Stage IV lobster larvae have a survival rate of approximately 0.05%, which translates into the addition of 45 market sized lobsters to the

source waters per year, which substantially offsets the 5 potentially lost each year due to the proposed system. The proposed lobster hatchery is a significant enhancement to the local lobster fishery that, when coupled with the positive environmental implications of MSC and CSI research activities, is consistent with NU's sustainability mission.

The proposed intakes pipes effectively address the existing biofouling issues by properly sizing the intakes pipes to accommodate a season of biofouling growth from May through October without creating cavitation issues for the seawater intake pumps. Importantly, this approach allows the provision of constant flow rates to research tanks throughout the research season so that environmental variability and experimental losses are kept to a minimum. The active intake line will be alternated with the inactive line as necessary but it is anticipated that this will typically occur around the end of October, before the ocean is too cold to dive on the intakes. This approach allows allow NU to manage the biofouling without the use of chemicals by starving the biofouling organisms for oxygen and then promoting anaerobic bacteria to consume the balance of the organic material in the pipe before it is placed back into use prior the start of the new research season.

Proposed Pump House

To accommodate this proposed 600 gpm seawater system, NU proposes to demolish the existing dive locker and indoor aquatics lab and the southwest end of the Edwards Laboratory and replace it with a new pump house. The pump equipment will be housed in the basement level of this new building while the ground level will house the required mechanical/electrical equipment and a dive locker. The finished floor elevation of the proposed dive locker will be located approximately 4'-9" above the base flood elevation and the pump room will be approximately 7'-3" below the base flood elevation. During initial design phases, the siting of the addition was carefully positioned to keep the basement finished floor (pump room) as close to grade as possible and away from the existing foundation of the Edwards Lab while also allowing the path of the new seawater lines to enter the building in a way that would avoid disturbing to the adjacent BVW.

As with the current system, the new seawater pumps will deliver seawater to the existing elevated seawater storage tanks. Two (2) new 600 gpm Drum Filters will be installed up at the seawater storage tank building and will operate only when significant coastal storms disturb the ocean bottom. These storm events often bring in small suspended solids and floating debris that are undesirable because they can clog small valves that are used to control the seawater flow rates to the smaller research tanks. This has been significant issue with the existing seawater system. The drum filters will automatically backwash to keep the screens clean and operational during a storm and the backwash water will return to the ocean along with the other seawater discharges.

To address sea level rise and coastal resiliency concerns the design team has considered flood mitigation and waterproofing from a building siting and material selection standpoint. As the design progresses specialty consultants will advise on the detailing of the building and will specify resilient materials to allow the structure to resist flood loads and protect building infrastructure.

Proposed Storage and Distribution

Other than the two (2) new Drum Filters, no changes are proposed to the existing seawater storage tanks. NU proposes to install new redundant PVC seawater distribution lines from the seawater storage tank to the various research facilities. These will replace the existing undersized lines and also provide the maintenance staff with the capability to cycle the distribution lines from active to anoxic to control biofouling, a feature that is not currently available for the campus and which has created significant challenges. The seawater will not be treated prior to use in the labs.

Proposed Discharge

The seawater discharge will be collected in a new discharge chamber located slightly northeast of the existing pump house. From this location the seawater will be discharged through a subsurface system that will extend into Bathing Beach Cove to a location approximately 275 feet from the face of the existing seawall. The discharge system will consist of two (2) alternating 16” o.d. HDPE outfall pipes with a series of offshore flow diffusers to ensure rapid mixing of discharged

seawater and the receiving waters. Having 2 outfall pipes also serves to control the biofouling using a similar approach as the seawater intake system (i.e., by allowing one outfall pipe to be "active" while the other outfall pipe is sealed off to produce anoxic conditions). As with the intake pipes, the discharge pipes will be directionally drilled under the seawall and beach and will emerge just seaward of mean low water. The discharge pipes will be secured to the Cove bottom in the same manner as the seawater intakes by using concrete ballast blocks to prevent pipe movement from waves and currents. The concrete ballast blocks will occupy approximately 613 sf of area on the cove bottom. The flow diffusers will consist of flanged reducing tees that can be capped by using PVC blind flanges to control biofouling thru the anoxic process.

Thermal Effects of Proposed Discharge

Utilizing a 3-Port subsea discharge diffuser configuration, NU ran the CORMIX model using a theoretical discharge flow rate of 1050 gpm with temperature differential of +5.7 degrees F relative to the receiving ambient Bathing Beach Cove waters. These values were used because a viable model could not be produced using the real parameters consistent with the proposed system. The results showed an immediate dissipation of the temperature differential between the discharge temperature and the receiving Cove water. Again, the maximum proposed flow rate will be 600 gpm, and the average calculated temperature differential over the 10-month study was 0.367 degree F. Based on these values the proposed seawater discharge will not have an adverse thermal effect on the Cove waters.

Wetland Resource Area Impacts

Wetland resource area impacts associated with the new seawater system will include temporary and permanent impacts to Land Subject to Coastal Storm Flowage (LSCSF), and permanent impacts to Land Under the Ocean (LUO). The LSCSF impacts total approximately 6,700 sf, of which approximately 5,887 sf is temporary and 813 sf is permanent. The temporary impacts to LSCSF are associated with trenching and the installation of the new intake, distribution, and discharge lines, following which the ground surface will be returned to pre-construction elevations.

The permanent impacts are associated with the new pump house building. The estimate of impacts to LSCSF is based on National Flood Hazard Data (NFHD) linework obtained from FEMA which indicates that the 100-year AE zone on the site occurs at elevation 13 (NAVD88). When the FEMA linework is imported into the survey file, the AE Zone line does not follow the surveyed elevation 13 contour. If the actual elevation 13 contour is used as the limit of the AE zone the temporary impacts are reduced to 5,327 sf and there are no permanent impacts.

Impacts to Land Under the Ocean (LUO) are associated with the concrete ballast blocks for the intake and discharge lines, and the concrete intake structure pads. The area of LUO affected by the blocks and pads totals approximately 2,038 sf. As part of the project NU proposes to remove the existing and abandoned intake lines and their anchor blocks, which total approximately 175 sf in area.

ALTERNATIVES

Coastal Sustainability Institute

Site Location **–** Alternative sites were not considered for the CSI development. Northeastern University purchased the East Point property from the US Government in 1966 specifically for the purpose of creating an oceanography and teaching center. Over the intervening years, NU researchers in Nahant have conducted groundbreaking work in the fields of marine and environmental science and coastal sustainability. This important work continues to have positive impacts on coastal regions around the world and benefits directly from the MSC's physical location on East Point. The two shelving beaches to the north and south are composed of course sand and cobbles and the exposed bedrock shoreline supports numerous tidepools and channels. East Point is near the southern limit of such rocky outcroppings on the Atlantic Coast and the entire shoreline receives moderate to heavy surf during storms, providing exceptional opportunities for study of high-energy littoral phenomena.

No-Build Alternative **–** Under the no-build alternative, the site would remain in its existing state. This alternative does not meet the needs of the Coastal Sustainability Institute as the current

buildings on site cannot accommodate the program. This alternative would leave existing parking and associated stormwater runoff unimproved. Invasive species that do not offer unique or significantly important wildlife habitat would remain, and restoration and enhancement plant and wildlife habitat would not take place.

Scheme A **–** Under this alternative, a 60,000 GSF building is built on the east side of Murphy Bunker minimizes its visibility to the residential neighborhood to the west. A single floor is constructed along the north-south ridge above the bunker. The building is well screened by landscape from Lodge Park. This alternative keeps the massing of the building entirely to the east of the bunker, however extending north closer to the coastal buffer zone than the proposed design.

Scheme B **–** Scheme B is the preferred alternative proposed herein.

Scheme C **–** Under this alternative, a 44,000 GSF building is built on the east and west sides of the bunker in a similar configuration to the proposed design. In order to minimize the size of the building integrated with the bunker, a second building of 13,000 GSF is constructed behind the existing Edwards Laboratory Building. While this alternative reduces the footprint on top of the bunker, a second building will require disturbing a second site much closer to the residential neighborhood.

Parking **–** Alternative parking layouts that were considered included parking to the east of the Murphy Bunker outside of both the wetland and coastal buffer zones. This alternative would likely receive significant community opposition and would limit opportunities for habitat restoration in this undeveloped portion of the site.

Stormwater Management – Alternative stormwater management could potentially include surface stormwater features such as rain gardens and bioswales to replace the underground storage associated with the two proposed surface parking lots. Surface stormwater management would result in additional impacts within the buffer zones and would take up more space on site.

Cooling Plant **–** The alternative to the proposed geothermal wells would be an onsite combination chiller plant and cooling tower. This alternative would result in the elimination of onsite drilling during construction, however the noise and visual impacts of the cooling towers would negatively impact existing habitat and the aesthetics of the site and likely would receive significant community opposition. Geothermal wells are required to meet LEED Gold certification.

Seawater System

No Action – As documented in earlier sections of this Narrative the existing seawater system is highly problematic. The existing 5" diameter suction lines are too small for the active biofouling which they experience. The biofouling results in increased suction pressure at the pumps which, in turn, results in pump cavitation. The cavitation quickly damages the pumps which frequently need to be replaced or rebuilt. The biofouling also greatly reduces the flow rate capacity of the existing seawater system because a single seawater line cannot produce enough seawater to support the needs of the MSC researchers. As a result, both intake lines must be used simultaneously, which prevents cycling the lines to control the biofouling issues. The biofouling is controlled by rooting and jetting the lines, which is only a temporary solution as the blue mussels regrow and become problematic again within weeks during the warmer months. Under the No-Action alternative the above conditions would continue and would likely eventually result in the complete failure of the seawater system, causing irreparable damage to the ongoing marine research projects at the MSC. The existing seawater system is not viable and must be replaced. The No-Action alternative is not feasible.

Alternative System Sizes – NU previously proposed a larger seawater system with a capacity of 2,400 gpm. Based upon a subsequent reevaluation of its existing and likely future seawater needs, coupled with the desire to address the concerns of the local community, the capacity of the proposed system has been reduced by 75% to the currently proposed 600 gpm. Further reduction in the system capacity is not feasible if NU is going to meet the needs of the current and future MSC and CSI researchers.

Subsea Floor Intake System – Subsea floor seawater intake systems are commonly used for desalinization plants. These systems use a corrosion resistant well screen buried in subtidal gravel and sand, which acts as a filter. The buried intake also reduces intake velocities which prevents larval entrapment. The ocean bottom off Bathing Beach is not conducive to this type of intake because it is very dynamic and unconsolidated material moves frequently with the current and wave action. Any light sands that would be any important aspect of this scheme are too fluid in this environment and more likely to expose the buried intake well screen nullifying its function. Bedrock is also very shallow and often exposed on the bottom which also limits the ability to bury the intake. Even if it were possible to bury an intake and have it remain covered, the overlying sands and gravels would filter out the desirable planktonic organisms from the source water. These plankton are an important aspect of natural seawater required by the the researchers. Because of these limitations the subsea floor intake system was determined to be infeasible.

Intake and Discharge Line Alternatives – An alternative to the proposed concrete ballast block anchor system on the intake and discharge lines is directional drilling for part or all of the pipe runs. After evaluating this option with the assistance of a geotechnical engineer experienced in directional drilling, it was determined to be infeasible due to the presence of shallow bedrock beneath the ocean floor.

Seawater Discharge System – A prior proposal for the new seawater system included discharging the seawater at its existing location through the seawall bordering Bathing Beach. While this outfall has worked satisfactorily for many years, the larger system would have required a commensurately larger outfall, and several of the regulatory agencies expressed concern with beach scour and the need to continuously manage the beach cobbles to keep the outfall open. The current proposal for an off shore subsea outfall and diffuser system will address those concerns. In addition, the diffuser will gradually mix the discharged seawater with the receiving waters of Bathing Beach Cove so that the extremely minor potential temperature differentials are immediately dissipated.

PERMITTING

The following permits are required for the project.

Coastal Sustainability Institute

- Order of Conditions from the Nahant Conservation Commission. The Massachusetts Division of Marine Fisheries (DMF) will have the opportunity to consult with the Conservation Commission as part of its review.
- Building Permit from the Nahant Building Inspector
- Construction Stormwater General Permit from the US EPA National Pollutant Discharge Elimination System (NPDES)

Seawater System

- Order of Conditions from the Nahant Conservation Commission. The Massachusetts Division of Marine Fisheries will have the opportunity to consult with the Conservation Commission as part of its review.
- MassDEP Chapter 91 Waterways License for a water dependent project in flowed tidelands. It is anticipated that MassDEP will coordinate with the Massachusetts Office of Coastal Zone Management (CZM) and the Massachusetts DMF as part of the Licensing process.
- US Army Corps of Engineers Section 10 and Section 404 authorization, Massachusetts General Permit #9, Pre-Construction Notification. It is anticipated that the Massachusetts CZM, the National Marine Fisheries Service (NMFS) and the Massachusetts DMF will provide input to MassDEP as part of the federal review.

PRELIMINARY CONSTRUCTION SEQUENCE

The following preliminary construction sequence is general in nature and was developed using ideal methods and current information. It is subject to change pending outcome of regulatory

findings, weather and other unforeseen conditions. With staging and enabling areas required at various locations around the site, the Coastal Sustainability Institute will be the preliminary driver of the schedule.

Early Winter 2019 – Commence site clearing in early winter to minimize impacts to migratory bird movements.

Spring of 2020 – Place foundations and erect structural steel for CSI building.

Spring of 2020 – Commence construction of new pump house.

July 2020 – Install seawater intake and discharge lines during Winter Flounder TOY work window.

Early Winter 2020 – Building envelope completed.

Spring /Summer 2021 - Final grading / landscaping.

MITIGATION

Coastal Sustainability Institute

Habitat Improvements East of Murphy Bunker – The improvements will consist of removing invasive plant species within the project area and replanting with a mix of native trees, shrubs, and groundcovers.

Stormwater Improvements – provided in accordance with the Massachusetts Stromwater Standards will provide treatment for runoff from the site where none currently exists. This will significantly improve the quality of the stormwater discharged from the site, particularly at the existing discharge pipe at the Bathing Beach seawall.

Additional Traffic Studies – Northeastern has agreed to work with the Town to perform two additional traffic studies in the spring and summer to further evaluate the volumes of traffic in the town attributable to the MSC.

Additional Assistance – Northeastern is negotiating with Town officials to provide additional assistance to the Town and its residents, based on greater needs resulting from the CSI.

Seawater System

Remove Existing and Former Intake Lines – As part of the new seawater project NU will remove the existing seawater system components, as well as those of the prior system which were originally retained to provide redundancy.

Lobster Hatchery – As mitigation to offset the potential loss of 5 mature lobsters per year attributable to the new seawater system NU proposes to construct an onsite lobster hatchery to produce approximately 90,000 Stage IV larvae per year. These would be released in Bathing Beach Cove or in nearby Nahant waters as recommended by lobstermen that are willing to collaborate on this effort and will result in the addition of an estimated 45 market sized lobsters per year.

Environmental Monitoring – NU will continue to monitor intake and discharge flow rates and temperatures at the new intakes and diffusers. This data will be used to adjust the system as necessary to limit the potential environmental impacts associated with its use.

SUMMARY

The Northeastern University Marine Science Center is widely recognized as one of the world's leading coastal sustainability research institutes. In partnership with environmental advocates such as The Nature Conservancy and MassBays, NU faculty have received more than $16.5 million in funding over the last five years from the National Science Foundation and NOAA, among other research agencies and foundations. There is a long history of collaboration between the Town of Nahant and Northeastern to protect ocean and marine life around Nahant and beyond. The faculty have offered many hours of free scientific consultation and have joined forces many times over the years with the town, SWIM, and community stakeholders to secure secondary

sewage treatment, prevent cruise ship discharge off Nahant, and study and manage Boston Harbor's coastal and estuarine ecosystems. The MSC has also monitored water quality around Nahant, led annual Nahant beach cleanups, housed community beekeeping onsite, and provided education and outreach programs for local students.

The proposed Coastal Sustainability Institute will develop cutting-edge methods for identifying, quantifying, and forecasting changes to coupled human-natural coastal ecosystems; to examine likely social, economic, ethical, political and ecological consequences of those changes; and to develop proactive, integrative solutions based on current best practices in science, engineering, and policy to create the next generation of integrated resource management strategies. The CSI will focus on Global Change Science and Modeling Across the Land-Sea Interface, Security and Sustainability of Coastal Resources, and Environmental Sensing & Big Data three research priorities that are compelling in their stand-alone and integrative impact.

Marine research at the MSC is supported by an existing flow through seawater system that exhibits severe limitations and is inadequate for current and future research needs at the facility. This project would equip the MSC with a modern, reliable seawater system that will result in negligible impacts to the waters and life of Bathing Beach Cove.

A number of alternatives for the CSI development and the seawater system have been evaluated. The proposed project represents the least environmentally and socially impactful alternative that meets the needs of Northeastern University, and mitigation has been proposed to address the potential unavoidable impacts.

Figures

SITE LOCATION MAP

SCALE:1"=2,000'

8 BLACKSTONE VALLEY PLACE
LINCOLN, RI 02865
(401) 334-4100

10 LINCOLN ROAD, SUITE 210
FOXBORO, MA 02035
(508) 543-1755

PARE PROJECT No. 17177.00 MAY 2019

FIGURE 1

NORTHEASTERN UNIVERSITY
COASTAL SUSTAINABILITY INSTITUTE
NAHANT, MA

MASS GIS

ANNOTATED AERIAL PHOTOGRAPH

SCALE:1"=300'

N W E S

8 BLACKSTONE VALLEY PLACE
LINCOLN, RI 02865
(401) 334-4100

10 LINCOLN ROAD, SUITE 210
FOXBORO, MA 02035
(508) 543-1755

PARE PROJECT No. 17177.00 MAY 2019

FIGURE 2

NORTHEASTERN UNIVERSITY
COASTAL SUSTAINABILITY INSTITUTE
NAHANT, MA

National Flood Hazard Layer FIRMette

FEMA

42°25'15.53"N

70°54'44.99"W

70°54'7.54"W

42°24'48.97"N

Feet 1:6,000

0 250 500 1,000 1,500 2,000

Legend

SEE FIS REPORT FOR DETAILED LEGEND AND INDEX MAP FOR FIRM PANEL LAYOUT

SPECIAL FLOOD HAZARD AREAS
- Without Base Flood Elevation (BFE) *Zone A, V, A99*
- With BFE or Depth *Zone AE, AO, AH, VE, AR*
- Regulatory Floodway

OTHER AREAS OF FLOOD HAZARD
- 0.2% Annual Chance Flood Hazard, Areas of 1% annual chance flood with average depth less than one foot or with drainage areas of less than one square mile *Zone X*
- Future Conditions 1% Annual Chance Flood Hazard *Zone X*
- Area with Reduced Flood Risk due to Levee. See Notes. *Zone X*
- Area with Flood Risk due to Levee *Zone D*

OTHER AREAS
- NO SCREEN Area of Minimal Flood Hazard *Zone X*
- Effective LOMRs
- Area of Undetermined Flood Hazard *Zone D*

GENERAL STRUCTURES
- Channel, Culvert, or Storm Sewer
- Levee, Dike, or Floodwall

OTHER FEATURES
- 20.2 / 17.5 Cross Sections with 1% Annual Chance Water Surface Elevation
- Coastal Transect
- 513 Base Flood Elevation Line (BFE)
- Limit of Study
- Jurisdiction Boundary
- Coastal Transect Baseline
- Profile Baseline
- Hydrographic Feature

MAP PANELS
- Digital Data Available
- No Digital Data Available
- Unmapped

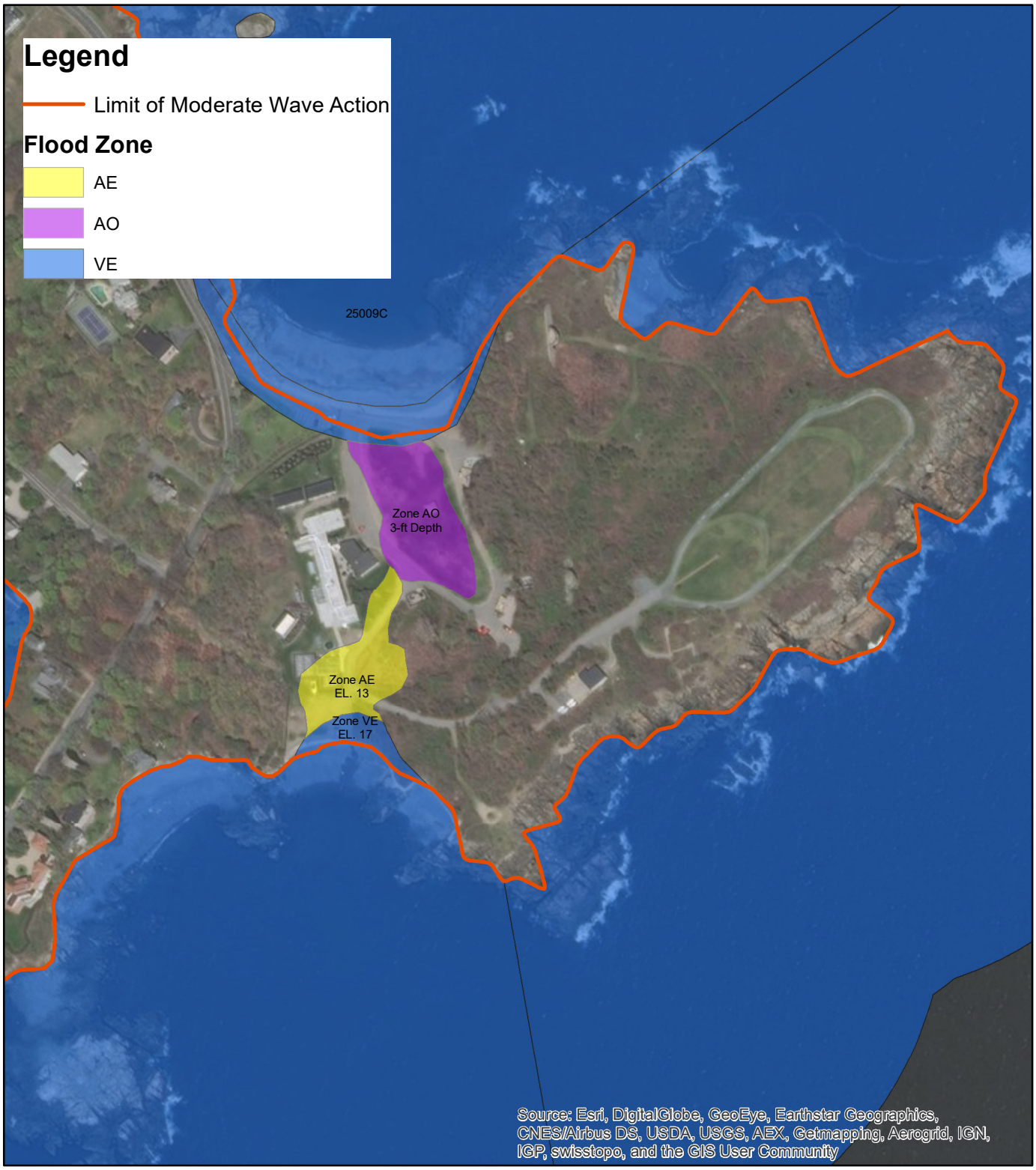
N

The pin displayed on the map is an approximate point selected by the user and does not represent an authoritative property location.

This map complies with FEMA's standards for the use of digital flood maps if it is not void as described below. The basemap shown complies with FEMA's basemap accuracy standards

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 5/13/2019 at 3:24:02 PM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

This map image is void if the one or more of the following map elements do not appear: basemap imagery, flood zone labels, legend, scale bar, map creation date, community identifiers, FIRM panel number, and FIRM effective date. Map images for unmapped and unmodernized areas cannot be used for regulatory purposes.



NATIONAL FLOOD HAZARD LAYER DATA
FLOOD ZONES

SCALE:1"=300'

8 BLACKSTONE VALLEY PLACE
LINCOLN, RI 02865
(401) 334-4100

10 LINCOLN ROAD, SUITE 210
FOXBORO, MA 02035
(508) 543-1755

PARE PROJECT No. 17177.00 MAY 2019

FIGURE 4

NORTHEASTERN UNIVERSITY
COASTAL SUSTAINABILITY INSTITUTE
NAHANT, MA

Cultural Resources Coordination

SECTION 5

Engineers | Scientists | Planners

PARECORP.COM

PARE CORPORATION

May 31, 2019

Ms. Brona Simon, Executive Director
Massachusetts Historical Commission
220 Morrissey Boulevard
Boston, MA 02125

Re: **Project Notification Form**
Northeastern University
Seawater Intake Replacement and Coastal Sustainability Institute
Nahant, Massachusetts
Pare Project No. 17177.00

Dear Ms. Simon,

On behalf of Northeastern University (NU), Pare Corporation (Pare) respectfully submits the attached Project Notification Form (PNF) and supporting documentation in connection with the proposed Coastal Sustainability Institute (CSI) and seawater intake replacement in Nahant, MA. This project will be reviewed under the Massachusetts Environmental Policy Act and by the US Army Corps of Engineers under Sections 10 and 404 of the Clean Water Act.

Ongoing research at Northeastern's Marine Science Center is supported by an existing seawater intake, distribution, circulation, and discharge system which does not have sufficient capacity to adequately serve the current needs at the facility. Under current conditions, two 6" diameter intake pipes extend into Nahant Bay from the seawall. The pipes are secured to the sea floor with anchor blocks and rock clamps. The existing pump house, located just north of the seawall, pumps seawater to two 20,000-gallon storage tanks located west of the main laboratory building (Edwards Laboratory). From the storage tanks, seawater is distributed by gravity to the Edwards and Frank Massa Laboratories, and to the Outdoor Mesocosm Facility which includes thirty-two, 100-gallon seawater tables.

NU proposes to increase the capacity of the system to 600 GPM. This upgrade will require the placement of new intake pipes, construction of a new pumphouse, new distribution piping, and new discharge piping, as shown on the attached plans.

NU is also proposing to construct a new building on the MSC campus to house the Coastal Sustainability Institute (CSI). The new CSI building will consist of approximately 55,000 square feet of new academic research, and meeting space as well as offices and support facilities. The new building will be integrated with the existing Murphy Bunker research facility which will also be partially renovated as part of the project. The new CSI building utilizes the existing Murphy Bunker as its foundation, limiting the footprint of the building beyond that of the bunker and preserving open space on site. New associated site access and parking are shown on the attached plans.

8 BLACKSTONE VALLEY PLACE LINCOLN, RI 02865
T 401.334.4100 F 401.334.4108

10 LINCOLN ROAD, SUITE 210 FOXBORO, MA 02035
T 508.543.1755 F 508.543.1881

On behalf of Northeastern University, we request that the MHC, THPOs and BUAR provide information related to cultural resources that may be affected by the proposed work. Written comments should be submitted to: Pare Corporation, 8 Blackstone Valley Place, Lincoln, RI 02865 Attn: Briscoe Lang, Principal Environmental Scientist.

Thank you for your consideration. If you have any questions or require additional information please feel free to contact me at 401-334-4100 or by email at: blang@parecorp.com.

Sincerely,
Pare Corporation

Briscoe B. Lang, PWS
Principal Environmental Scientist

Attachments:

Project Notification Form
Figure 1 – Site Location Map
Existing Conditions: C-101 & C-1
Proposed Work: C-400 – C-402; C-3

cc: Massachusetts BUAR
THPO Wampanoag Tribe of Gay Head
THPO Mashpee Wampanoag Tribe
Northeastern University
File

Z:\JOBS\17 Jobs\17177.00 NU - New Seawater Intake Permitting Nahant - MA\Permits\MHC PNF - 2019\MHC PNF Letter.doc

APPENDIX A

MASSACHUSETTS HISTORICAL COMMISSION
220 MORRISSEY BOULEVARD
BOSTON, MASS. 02125
617-727-8470, FAX: 617-727-5128

PROJECT NOTIFICATION FORM

Project Name: Northeastern University Seawater Intake Replacement and Coastal Sustainability Institute

Location / Address: 430 Nahant Road

City / Town: Nahant

Project Proponent

Name: Northeastern University

Address: 360 Huntington Avenue

City/Town/Zip/Telephone: Boston, MA 02115-500

Agency license or funding for the project (list all licenses, permits, approvals, grants or other entitlements being sought from state and federal agencies).

Agency Name	Type of License or funding (specify)
Nahant Coservation Commission/DEP	Order of Conditions
Ch 91/Waterways	Chapter 91 Waterways License
MEPA	Secretary Certificate
ACOE	General Permit

Project Description (narrative):

Replacement of an existing sea water intake system and construction of a new Coastal Sustainability Institute (CSI) at Northeastern University in Nahant. Additional information is provided in the attached cover letter.

Does the project include demolition? If so, specify nature of demolition and describe the building(s) which are proposed for demolition.

Partial demolition of the Murphy Bunker is necessary to integrate the new CSI building. Partial demolition of the Edwards Laboratory building is necessary to incorporate the new seawater pumphouse.

Does the project include rehabilitation of any existing buildings? If so, specify nature of rehabilitation and describe the building(s) which are proposed for rehabilitation.

No

Does the project include new construction? If so, describe (attach plans and elevations if necessary).

Yes, a new pumphouse and CSI building are proposed to be constructed. Please refer to the attached plans.

APPENDIX A (continued)

To the best of your knowledge, are any historic or archaeological properties known to exist within the project's area of potential impact? If so, specify.

What is the total acreage of the project area?

Woodland	0	acres	Productive Resources:		
Wetland	0.05*	acres	Agriculture	0	acres
Floodplain	0.02	acres	Forestry	0	acres
Open space	0	acres	Mining/Extraction	0	acres
Developed	3.63	acres	Total Project Acreage	3.7	acres

*limited to Land Under the Ocean. No work will occur within the BVW onsite.

What is the acreage of the proposed new construction? 3.7 acres

What is the present land use of the project area?

Northeastern University Marine Science Center

Please attach a copy of the section of the USGS quadrangle map which clearly marks the project location.

This Project Notification Form has been submitted to the MHC in compliance with 950 CMR 71.00.

Signature of Person submitting this form: Bric B. Lang Date: 5/14/2019

Name: Briscoe B. Lang, PWS

Address: 8 Blackstone Valley Place

City/Town/Zip: Lincoln, RI 02865

Telephone: 401-334-4100

REGULATORY AUTHORITY

950 CMR 71.00: M.G.L. c. 9, §§ 26-27C as amended by St. 1988, c. 254.

Sections included on CD

Section 6	Wetland Delineation and Bathymetric Survey Reports
Section 7	Original Seawater System Permits
Section 8	Water Temperature Monitoring Data Summary
Section 9	CORMIX Model Summary
Section 10	Alternate Building Schemes
Section 11	Preliminary Traffic Impact Analysis
Section 12	Stormwater Report

cleengineering

15 Creek Road | Marion, Massachusetts 02738
t: 508.748.0937 | 800.668.3220 | f: 508.748.1363

November 7, 2017

Sent electronically via email only

Mr. Denis Seguin, PLS
Director of Land Surveying
Nitsch Engineering
2 Center Plaza, Suite 430
Boston, MA 02108

Re: Wetland Delineation, Northeastern University Marine Sciences Campus, Nahant, Massachusetts
Ref: CLE JN 17227.00, Nitsch Project Number 12392.1
Plan entitled "Plot Plan – Northeastern University, Nahant, Mass" by R.E. Cameron & Associates, Inc., revised October 2, 1992.

Dear Mr. Seguin:

CLE Engineering, Inc. (CLE) is pleased to submit this Wetland Delineation Report on the above referenced project.

Project Location:
The Northeastern University Marine Sciences Campus is located at the eastern end of Nahant Road in Nahant, Massachusetts. It is on a point of land within Nahant Bay and Broad Sound. CLE understands all the activity is to be located above the top of the existing coastal bluffs around the perimeter of the site.

Wetland Jurisdiction:
CLE reviewed local, federal and state wetland regulations for definitions of regulated wetland resources that might be found on or adjacent to the work area.

The Town of Nahant's "Guide to the Wetland Protection Act in Nahant" uses the same definitions of wetland resources that are provided in the Massachusetts Wetlands Protection Act (MGL Ch. 131, Sec. 40) and the Massachusetts Wetlands Protection Act Regulations (310 CMR 10.00).

The federal Clean Water Act also describes wetlands as "waters of the United States" that are located below the "high tide line" and adjacent wetlands. Federal inland wetlands are areas that are periodically or permanently inundated or saturated by surface or ground water and support vegetation adapted for life in saturated soils. Additionally, federal permits are required for work in, under or over navigable waters of the United States.

The project site is within the North Shore Massachusetts Coastal Zone as shown on the

Massachusetts Coastal Zone Boundary Map available on-line.

The Massachusetts Wetlands Protection Act and Regulations define a number of wetland resources that are potentially associated with coastal water bodies adjacent to the site such as:

- Land Under the Ocean
- Designated Port Area
- Coastal Beaches
- Coastal Banks
- Land Containing Shellfish
- Banks of or Land under the Ocean that that underlie Anadromous/Catadromous Fish Runs
- Estimated Habitat of Rare Wildlife

The MassGIS maps of the resources on the site is attached. It depicts the Coastal Beach, the Coastal Bank Bluff or Sea Cliff and Rocky Intertidal Shore as the coastal wetland resources and Shallow Marsh Meadow or Fen as the inland wetlands on the site. The attached FEMA Flood Plain map shows the perimeter of the site to be partially within the 100 year Flood Plain of varying Velocity Zone elevations which is regulated as Land Subject to Coastal Storm Flowage.

The Natural Resources and Conservation Services (NRCS) soil map (attached) indicates the inland wetland areas to be underlain by the Hollis-Urban land complex (southwest corner of site) and Udorthents defined as areas of disturbed soils where the upper soil material has been removed, filled or graded (south central area of site).

Field Investigation:

I met the Nitsch Engineering survey crew party chief and rodman at the Northeastern University Marine Sciences Campus (Site) at approximately 8:00 AM on October 11, 2017. We reviewed my scope of work and the location of the proposed topographic survey. The surveyors had hung orange flags indicating where they had previously located the top of the northern coastal bank as based on the obvious break in slope. The toe of the Coastal Beach along the beach were yet to be located by field survey and/or a drone flight survey. I then walked the entire shoreline for the presence of coastal wetland resources. Based on my field observations it was determined that the accurate location of the top of Coastal Bank and the associated 100' Buffer Zone offset could only be determined from CLE's review of the topographic plan that was subsequently provided to CLE on October 26, 2017 as an AutoCAD file and field flagging was not necessary as the surveyors will be responsible for locating the observable break in slope at the top of the Coastal Bank.

Additionally, the interior of the entire site was inspected for inland, freshwater wetland resources. Both the MassGIS wetland map and the Town of Nahant representation of the MassGIS data on their GIS map indicates that the area on the southwestern corner of the site adjacent to Shallow Cove Road and a larger area in the south central area of the site as vegetated

wetlands. The vegetated wetland resource delineation was conducted in accordance with the *Delineating Bordering Vegetated Wetlands Under the Massachusetts Wetlands Protection Act* handbook produced by the Massachusetts Department of Environmental Protection (Handbook). It generally consists of a visual inspection of the landform, hydrology, vegetation and soils when needed. Pink numbered flags were tied in the vegetation at approximately 30' spacing to delineate resource areas. The identification of steam banks, isolated lands subject to flooding, flood plains and any buffer zones are based on elevations and distances and were outside the scope of this field investigation as are the observations and documentation required to certify the presence of vernal pools.

Findings:
The attached figure "CLE BVW Location Sketch" depicts the location of the areas inspected for the presence of wetland resources. The areas inspected are described below:

1) My field inspection indicated that the area at the southwest corner of the site is an approximately 30' diameter shallow depression within a disturbed site that does not contain or is adjacent to a waterbody. The predominant vegetation is Japanese Knotweed (*Polyganum cuspidatum)*, with some bittersweet (*Celastrus orbiculatus)* and Staghorn sumac (*Rhus typhina);* all of which are non-wetland species. Therefore that area is not considered a Bordering Vegetated Wetland as defined in the Wetlands Protection Act Regulations (310 CMR 10.55)
2) A number of drainage pipes were flagged within the depression at the southcentral portion of the site. There are 2 inlet pipes on the northern and western perimeter and one outlet pipe discharging to the Coastal Beach on the southern perimeter. A drainage ditch with evidence of intermittent flow was observed along the western side of the depression that drained the site through the outlet pipe. As described in Chapter 3 of the Handbook, because the vegetation within the depression at the south central area of the site consists predominantly of the wetland indicator species Common Reed (*Phragmites australis)* and the slope was distinct between the upland and wetland plant communities, soil test pits were determined not to be necessary and vegetation was used as the sole criteria for the delineation of the Bordering Vegetated Wetland (BVW). A series of 12 numbered pink flags labeled "BVW" were hung to delineate the BVW which I identified for the surveyors. Additionally two pink flags labeled "Transect 1 Obs Plot 1" and Transect 1 Obs Plot 2" were hung to locate the site of the observation plots where the attached DEP Bordering Vegetated Wetland Delineation Field Data Forms were completed.
3) The following Coastal Wetlands were observed:
   a) Land Subject to Coastal Storm Flowage which is defined as land subject to any inundation caused by coastal storms up to and including that caused by the 100-year storm, surge of record or storm of record, whichever is greater (310 CMR 10.04). The boundary of Land Subject to Coastal Storm Flowage is shown on the attached FEMA Flood Plain map.
   b) Coastal Beach defined as the land between Mean Low Water (MLW) and engineered

coastal structures (stone revetments or seawalls) and the Coastal Bank (310 CMR 10.29).

c) Rocky Intertidal Shore is a naturally occurring rocky areas between the MLW and Mean High Water (MHW) as defined in 310 CMR 10.31.

d) Coastal Bank defined as the seaward face or side of any elevated landform, other than a coastal dune, which lies at the landward edge of a coastal beach, land subject to tidal action or other wetland (310 CMR 10.30.

   i) The Massachusetts DEP Wetlands Program Policy 92-1: Coastal Banks provides the means by which to determine the top of Coastal Banks by relating the slope of the landform and the predicted 100 year flood elevation as provided on the FEMA Flood Map. CLE calculated the slope of the Beach, the stone seawalls (engineered coastal structure) and the vegetated land form above the seawalls. The slopes along fourteen (14) representative transects extending from the edge of water to the perimeter roadway or other flat sections of the site were calculated. The location of the transects are shown on the AutoCAD file attached to this e-mail. Additionally the slope calculations are presented on the attached spreadsheet entitled "Coastal Bank and Beach Determination, Northeastern University, Nahant, Massachusetts." Based on the slope analysis and comparison to the Figures on the DEP Coastal Bank Policy, the top of the Coastal Banks was delineated in the AutoCAD from which the 100' offset is to be drawn and labeled as "Buffer Zone" by Nitsch. The transects used to calculated slopes are saved as their own drawing layer and is not to be plotted on the site plan.

CLE appreciates the opportunity to provide this Wetland Delineation Report to Nitsch and ask that if you have any questions, please do not hesitate to call me.

Sincerely,
CLE Engineering, Inc.

Jeffrey W. Oakes

Jeffrey Oakes, P.E.
Senior Project Manager
Enc.

MORIS

LIVER: MassGIS's Online Mapping Tool OLIVER Updates Please take the OLIVER survey!

Search for a location

Zoom to a town

EAST POINT

GREAT LEDGE

Swallow Cave Rd

409 421 427 26 38 0 32 36 33 24 20 0 3 430 49 ft.

50 m
100 ft
Scale = 1:4,514
249,524.55m 907,486.15m
MassGIS Topographic Features Basemap

Basemaps

Available Data Layers

Search data layers

Active Data Layers

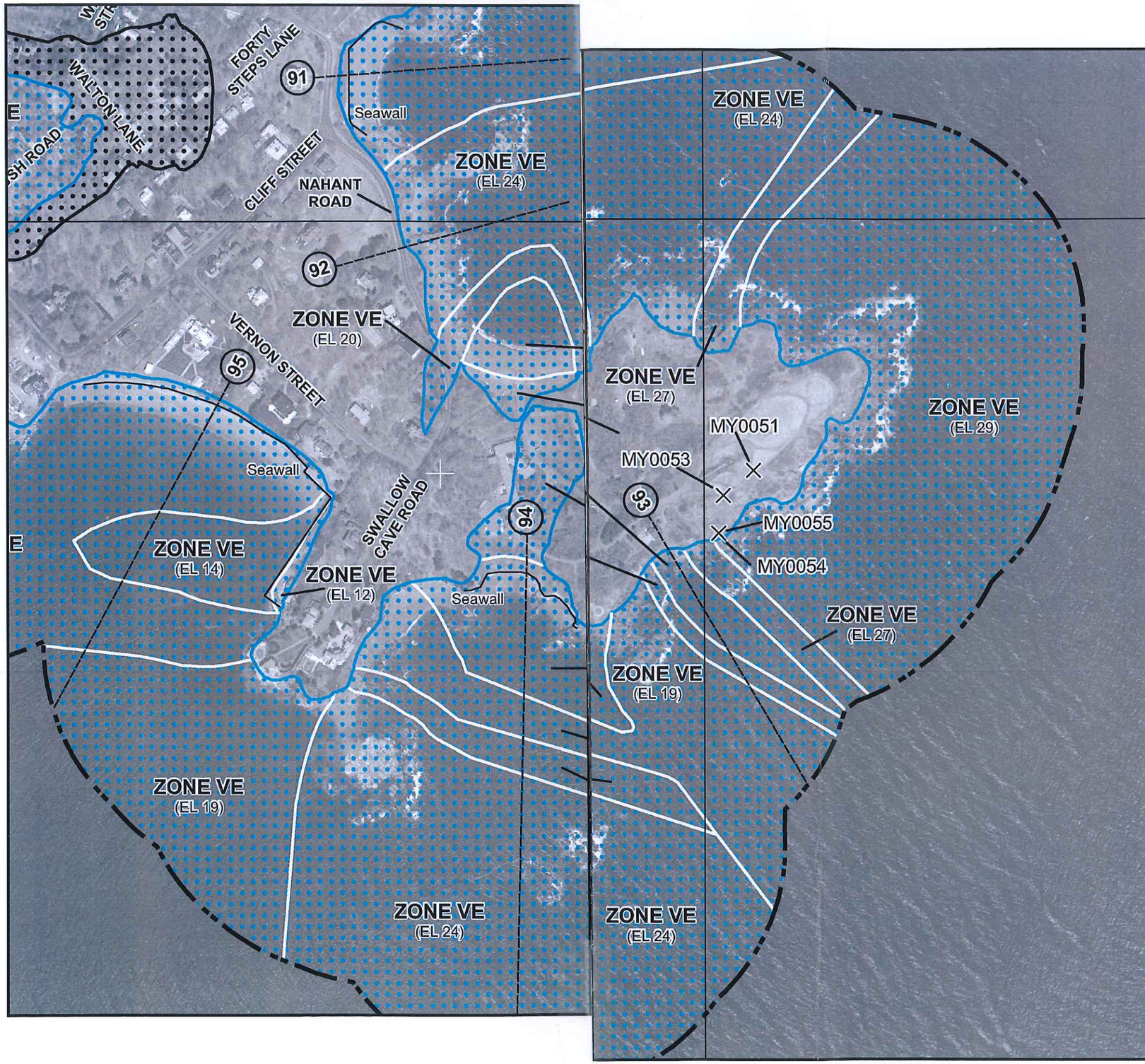
Check all | Uncheck all | Remove

Legend

DCP Wetlands Detailed With Outlines

- Barrier Beach System
- Barrier Beach-Deep Marsh
- Barrier Beach-Wooded Swamp Mixed Trees
- Barrier Beach-Coastal Beach
- Barrier Beach-Coastal Dune
- Barrier Beach-Marsh
- Barrier Beach-Salt Marsh
- Barrier Beach-Shrub Swamp
- Barrier Beach-Wooded Swamp Coniferous
- Barrier Beach-Wooded Swamp Deciduous
- Bog
- Coastal Bank Bluff or Sea Cliff
- Coastal Beach
- Coastal Dune
- Cranberry Bog
- Deep Marsh
- Barrier Beach-Open Water
- Open Water
- Rocky Intertidal Shore
- Salt Marsh
- Shallow Marsh Meadow or Fen
- Shrub Swamp
- Tidal Flat
- Wooded Swamp Coniferous
- Wooded Swamp Deciduous
- Wooded Swamp Mixed Trees

Tax Parcels for Query



MAP SCALE 1" = 500'

250 0 500 1000 FEET

METERS

NFIP

NATIONAL FLOOD INSURANCE PROGRAM

PANEL 0542F

FIRM

FLOOD INSURANCE RATE MAP

ESSEX COUNTY, MASSACHUSETTS (ALL JURISDICTIONS)

PANEL 542 OF 600

(SEE MAP INDEX FOR FIRM PANEL LAYOUT)

CONTAINS:

COMMUNITY	NUMBER	PANEL	SUFFIX
NAHANT, TOWN OF	250095	0542	F

Notice to User: The **Map Number** shown below should be used when placing map orders; the **Community Number** shown above should be used on insurance applications for the subject community.

MAP NUMBER 25009C0542F

EFFECTIVE DATE JULY 3, 2012

Federal Emergency Management Agency

This is an official copy of a portion of the above referenced flood map. It was extracted using F-MIT On-Line. This map does not reflect changes or amendments which may have been made subsequent to the date on the title block. For the latest product information about National Flood Insurance Program flood maps check the FEMA Flood Map Store at www.msc.fema.gov

Custom Soil Resource Report
Soil Map

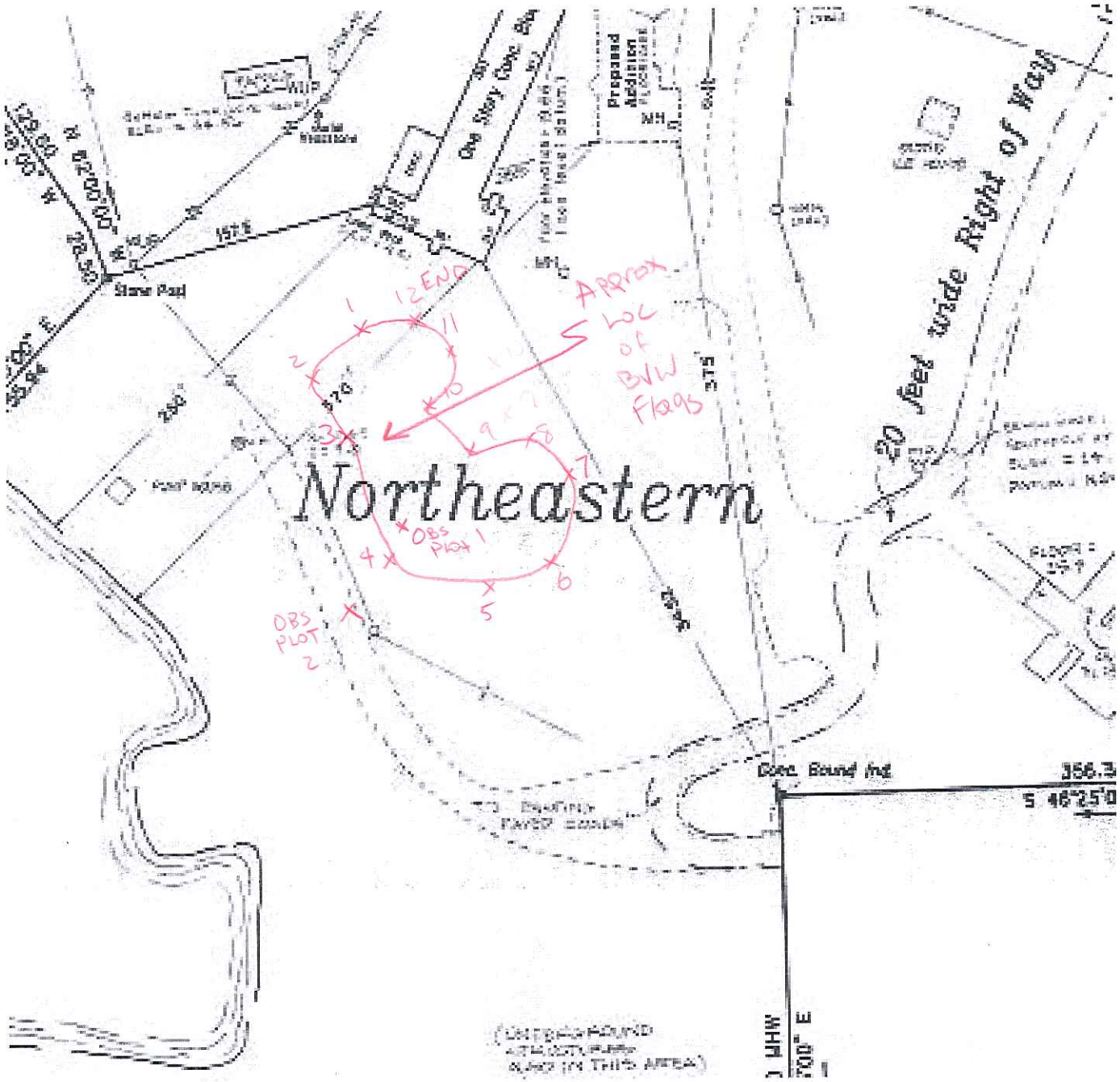
Map Scale: 1:1,600 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0 20 40 80 120

Feet: 0 50 100 200 300

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



10/11/17

CLE BVW LOCATION SKETCH

From Plan by R.E Cameron & Associates, Inc Oct 2, 1992

MassDEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Data Form

Applicant:_____ Prepared by: _Jeff Oakes, CLE Engineering, Inc.___ Project location: Nahant Road, Nahant DEP File #:_____

Check all that apply:

- X Vegetation alone presumed adequate to delineate BVW boundary: fill out Section I only
- ❑ Vegetation and other indicators of hydrology usedto delineateBVW boundary: fill out Sections I and II
- ❑ Method other than dominance test used (attach additional information)

Section I.

Vegetation	Observation Plot Number: 1		Transect Number: 1	Date of Delineation: 10/11/17
A. Sample Layer & Plant Species (by common/scientific name)	B. Percent Cover (or basal Area)	C. Percent Dominance	D. Dominant Plant (yes or no)	E. Wetland Indicator Category*
TREES	NONE			
SHRUBS	NONE			
HERBACEOUS LAYER				
Common Reed *(Phragmites australis)*	100	100	yes	FACW

* *Use an asterisk to mark wetland indicator plants: plant species listed in the Wetlands Protection Act (MGL c.131, s.40); plants in the genus Sphagnum; plants listed as FAC, FAC+, FACW-, FACW, FACW+, or OBL; or plants with physiological or morphological adaptations. If any plants are identified as wetland indicator plants due to physiological or morphological adaptations, describe the adaptation next to the asterisk.*

Vegetation conclusion:

Number of dominant wetland indicator plants: 1 Number of dominant non-wetland indicator plants: 0

Is the number of dominant wetland plants equal to or greater than the number of dominant non-wetland plants? **YES**

If vegetation alone is presumed adequate to delineate the BVW boundary, submit this form with the Request for Determination of Applicability or Notice of Intent

Section II. Indicators of Hydrology

Hydric Soil Interpretation

1. Soil Survey

Is there a published soil survey for this site? yes no
title/date:
map number:
soil type mapped:
hydric soil inclusions:

Are field observations consistent with soil survey? yes no
Remarks:

2. Soil Description

Horizon	Depth	Matrix Color	Mottles Color

Remarks:

3. Other:

Conclusion: Is soil hydric? yes no

Other Indicators of Hydrology: (check all that apply & describe)

- ❑ Site Inundated: _____
- ❑ Depth to free water in observation hole: _____
- ❑ Depth to soil saturation in observation hole: _____
- ❑ Water marks: _____
- ❑ Drift lines: _____
- ❑ Sediment Deposits: _____
- ❑ Drainage patterns in BVW: _____
- ❑ Oxidized rhizospheres: _____
- ❑ Water-stained leaves: _____
- ❑ Recorded Data (streams, lake, or tidal gauge; aerial photo; other): _____ _____ _____
- ❑ Other: _____

Vegetation and Hydrology Conclusion

	Yes	No
Number of wetland indicator plants ≥ # of non-wetland indicator plants	X	____
Wetland hydrology present:		
Hydric soil present	____	_____
Other indicators of hydrology present	____	_____
Sample location is in a BVW	X	_____

Submit this form with the Request for Determination of Applicability or Notice of Intent.

MassDEP Bordering Vegetated Wetland (310 CMR 10.55) Delineation Field Data Form

Applicant:_____ Prepared by: _Jeff Oakes, CLE Engineering, Inc.___ Project location: Nahant Road, Nahant DEP File #:_____

Check all that apply:

- X Vegetation alone presumed adequate to delineate BVW boundary: fill out Section I only
- ❑ Vegetation and other indicators of hydrology usedto delineateBVW boundary: fill out Sections I and II
- ❑ Method other than dominance test used (attach additional information)

Section I.

Vegetation	Observation Plot Number: 1		Transect Number: 1	Date of Delineation: 10/11/17
A. Sample Layer & Plant Species (by common/scientific name)	B. Percent Cover (or basal Area)	C. Percent Dominance	D. Dominant Plant (yes or no)	E. Wetland Indicator Category*
TREES				
Red Oak *Quercus rubra*	20.5	100	Yes	FACU-
SAPLINGS				
Mountain Maple *Acer spicatum*	3.0	100	Yes	FACU-
SHRUBS				
Staghorn sumac *Rhus typhina*	20.5	100	Yes	Not indicated
Ground Cover				
Golden Rod *Solidago spp*	10.5	28	yes	FACU
Tansey *Tanacetum vulgare*	10.5	28	yes	Not indicated
Mountain maple *Acer spicatum*	3.0	8	no	
Virginia creeper *Parthenocissus quinquefolia*	10.5	28	yes	FACU
Aster *Aster spp*	3.0	8	no	

* *Use an asterisk to mark wetland indicator plants: plant species listed in the Wetlands Protection Act (MGL c.131, s.40); plants in the genus Sphagnum; plants listed as FAC, FAC+, FACW-, FACW, FACW+, or OBL; or plants with physiological or morphological adaptations. If any plants are identified as wetland indicator plants due to physiological or morphological adaptations, describe the adaptation next to the asterisk.*

Vegetation conclusion:

Number of dominant wetland indicator plants: 0 Number of dominant non-wetland indicator plants: 6

Is the number of dominant wetland plants equal to or greater than the number of dominant non-wetland plants? **NO**

If vegetation alone is presumed adequate to delineate the BVW boundary, submit this form with the Request for Determination of Applicability or Notice of Intent

Section II. Indicators of Hydrology

Hydric Soil Interpretation

1. Soil Survey

Is there a published soil survey for this site? yes no
title/date:
map number:
soil type mapped:
hydric soil inclusions:

Are field observations consistent with soil survey? yes no
Remarks:

2. Soil Description

Horizon	Depth	Matrix Color	Mottles Color

Remarks:

3. Other:

Conclusion: Is soil hydric? yes no

Other Indicators of Hydrology: (check all that apply & describe)

- ❑ Site Inundated: _____
- ❑ Depth to free water in observation hole: _____
- ❑ Depth to soil saturation in observation hole: _____
- ❑ Water marks: _____
- ❑ Drift lines: _____
- ❑ Sediment Deposits: _____
- ❑ Drainage patterns in BVW: _____
- ❑ Oxidized rhizospheres: _____
- ❑ Water-stained leaves: _____
- ❑ Recorded Data (streams, lake, or tidal gauge; aerial photo; other): _____ _____ _____
- ❑ Other: _____

Vegetation and Hydrology Conclusion

	Yes	No
Number of wetland indicator plants ≥ # of non-wetland indicator plants	___	_x_
Wetland hydrology present:		
Hydric soil present	___	___
Other indicators of hydrology present	___	___
Sample location is in a BVW	___	_x_

Submit this form with the Request for Determination of Applicability or Notice of Intent.

COASTAL BANK AND BEACH DETERMINATION
Northeastern University,
Nahant, Massachusetts

CROSS SECTION ID	TOE OF SLOPE ELEV. (NAVD 88)	TOP OF SLOPE ELEV. (NAVD88)	VERTICAL DIFFERENCE	HORIZONTAL DIFFERENCE	SLOPE (H:V)	ELEV OF TOP OF COASTAL BANK (NAVD88)	MASS DEP POLICY 92-1 FIGURE:	NOTES			
A - A'	10	16.7	6.7	51	7.6	SEE FEMA LINE	3				
B-B'	10	16	6	27	4.5	SEE FEMA LINE	3				
C-C1	6.1	14.4	8.3	42.6	5.1						
C1-C2	14.4	16.5	2.1	43	20.5	14.4	4				
D-D1	5	9.3	4.3	29	6.7						
D1-D2	9.3	17.2	7.9	15	1.9						
D2-D3	17.2	19.2	2	45	22.5						
D3-D4	19.2	54.4	35.2	71	2.0	17.2	2				
E-E'	4.9	29.2	24.3	154	6.3	SEE FEMA LINE	3				
F-F1	12	26	14	21	1.5						
F1-F2	26	27	1	17	17.0	26	2				
G-G1	-4.9	7	11.9	43.6	3.7						
G1-G2	11.9	23.2	11.3	42.4	3.8						
G2-G3	23.2	24.1	0.9	17	18.9	23.2	2				
H--H1	-4.9	42	46.9	148.7	3.2		2				
H1-H2	42	45.1	3.1	21.5	6.9	42					
I-I1	15	39	24	9.8	0.4						
I1-I2	39	45	6	29	4.8	39	2				
J-J1	15	30.5	15.5	19	1.2						
J1-J2	30.5	60.8	30.3	63.4	2.1	60.8	2				
K-K1	-4.9	28	32.9	152	4.6	SEE FEMA LINE	3				
K1-K2	28	45.9	17.9	43.8	2.4						
L-L'	-4.9	15	19.9	36	1.8						
L1-L2	15	26.3	11.3	66.5	5.9	15	2				
M-M1	3.7	11.4	7.7	30	3.9			CONSIDER SEAWALL AS ENGINEERED			
M1-M2	11.4	13.4	2	23	11.5			COASTAL STRUCTURE RATHER THAN			
M2-M3	13.4	25.2	11.8	28.7	2.4	13.4		COASTAL BANK			
N-N'	-4.9	11.58	16.48	104	6.3			COASTAL BEACH			

cleengineering

15 Creek Road | Marion, Massachusetts 02738
t: 508.748.0937 | 800.668.3220 | f: 508.748.1363

October 26, 2017

Denis Seguin, PLS
Vice President – Land Surveying
Nitsch Engineering
2 Center Plaza, Suite 430
Boston, MA 02108

Re: ***Northeastern University, Marine Sciences Campus, Saltwater Intake Pipe Replacement Bathymetric survey and Eelgrass Video Survey,***

CLE Engineering (CLE) was contracted Nitsch Engineering (Nitsch) to collect bathymetric and geophysical data in support of the proposed saltwater intake pipe replacement project. Data was required to establish the existing bathymetric conditions for the purposes of the structural design. In addition a video survey was done in order to establish the existence/nonexistence of any potential eelgrass beds within the work area. A multi-beam survey system was deployed in order to establish bottom conditions of the approximately 400' x 400' survey area. In addition to the bathymetric data, a sub-bottom profiler (SBP) was deployed to gather imagery of sub-bottom features of the work area, allowing for the mapping of buried obstructions within the depth of interest.

Methods

Bathymetric Multi-beam Survey

The bathymetric survey took place on October 18, 2017, and was performed by Michael Campagnone, P.E. (Massachusetts) and Michael Count, CH. Weather conditions were generally calm with limited calm seas and west winds at 5-10 knots. The survey effort consisted of collecting bathymetric data along pre-determined survey transects. The survey crew utilized a 28' vessel with an integrated survey system consisting of; a Reson 7101 single frequency (240 Khz) multi-beam sounder, CODA F-180 Inertial Positioning System/MRU, Odom Digi-Bar Pro SVP, and a Trimble R-7 RTK level GPS. Corrections were taken from a VRS provided by Keynet. The hydrographic surveys utilized methods and accuracies outlined in the Army Corps of Engineers' November 2013, Hydrographic Surveying Manual (EM 1110-2-1003).

Horizontal positioning was taken from a Trimble R-7 RTK level DGPS. Corrections were received from a Virtual Reference Station (VRS) with data provided by Keynet. Corrections were received via internet and transferred to the GPS via NTRIP software. The Hypack survey program converted the geodetic information into NAD-83 State Plane coordinates for the Massachusetts Mainland zone. The applied geoid was Geoid12b.

Water level information was taken from a benchmark provided by Nitsch. The benchmark is a drill hole in the apron of the existing pump house. The point is known as "DH #53". The control point has an NAVD88 orthometric height of 13.92'. The water level at the time of the survey was recorded with RTK tides in Hypack.

The survey transects were run perpendicular to the shoreline to the dock face with a beam coverage that provided 200% coverage at a beam angle of 45°. The exception being passes taken adjacent to banks were angle limits were increased to the bank side by up to 15° using the beam canting feature in the Reson software. Sound velocity profiles were taken in two locations, at the outset and after surveying, to confirm consistency within the water column throughout the survey area. Bar checks were performed to confirm proper transducer draft calibration.

Data was reduced using the Hysweep editor in Hypack. Sensor data was scrutinized, data outliers were removed. Several filters were applied to the data prior to reviewing the sounding data set including; minimum and maximum depths, beam angle, over/under filter, and the median filter. Once the filters were applied the data was viewed as profiles viewing 5' to 10' matrix swaths, outliers indicated in only one pass were removed after reviewing deleted points. During this review areas of cobble and boulders were noted.

Eelgrass Video Survey

The eelgrass survey was performed on October 18, 2017, by Michael Campagnone, P.E. (Massachusetts) and Michael Count, CH. Weather conditions were generally calm with limited calm seas and west winds at 5-10 knots. The survey effort consisted of collecting video imagery at selected stations in order to determine the conditions. The survey crew utilized a 28' vessel with an integrated survey system consisting of; an underwater camera attached to a weight, and a Trimble R-7 RTK level GPS. Corrections were taken from a VRS provided by Keynet. The camera was deployed from the stern of the vessel. At each station the weight was lowered to the bottom and allowed to settle long enough for disturbed sediments to clear, and a quality still image be developed.

Results

Bathymetric Multi-beam Survey

The reduced bathymetric data has been presented on the attached project plans. Cleaned data was reduced to the project datum NAVD88. Data reduction using the matrix program in Hypack produced two data sets, 10' x 10' mcentermost value and 1'x1' minimum value. Soundings shown on the plan are based on the 10' centermost value and contours are based on the 1' minimum value.

From USACE Manual;

In theory, there is no need to reduce the size of the collected multibeam dataset. The entire "raw" database could be used for project or dredging condition assessment, volume computations, etc. However, these large datasets are thinned for a number of reasons, such as: (1) plotting in plan view without sounding overlap, (2) dredge volume computations, (3) channel clearance strike plots, (4) controlling channel depth reports, (5) 3D visualization models, or (6) simply to reduce the data down to a manageable storage size. There are a number of methods for reducing (or thinning) the size of large, edited multibeam datasets. For basic terrain visualization requirements (i.e. non-navigation uses), various thinning routines have been developed that can reduce datasets by 95% or more; typically selecting representative depths based on gradient changes over large areas.

Each bin (or cell) will likely contain multiple depths, depending on the density of the multibeam data and the number of overlapping passes made over the area. It is not uncommon for a 3- x 3-ft cell to have 50 or more depths if multiple passes were made over a suspected shoal area. Thus, an established method is needed to represent the depth within this bin. Presently, common selection options include: (1) a shot depth nearest to the bin center, (2) an average depth (placed at bin center), (3) a median depth, or (4) a minimum depth.

a. Dredge measurement and payment surveys. The average or median depth within a bin is recommended for dredge payment surveys. These representative depths are subsequently used in TIN volume computations.
b. General plan drawings. The shot depth nearest the cell center is recommended to be shown as the representative depth on plan drawings, including those used for plans and specifications or project condition reports. Obviously additional thinning will be required to plot 3- x 3-ft bin depth data on a 1 in = 100-ft plan—only every 8 or 10 bin depths could be displayed at this scale.
c. Minimum depths. Minimum depths may be selected for channel condition reports, shoal or strike detection, or some dredge clearance purposes. <u>Special caution must be exercised in using minimum depths in that the dataset will be significantly biased.</u>
d. Figure 6-26 is an example of the representative depth options that can be selected from binned multibeam data on a navigation project.

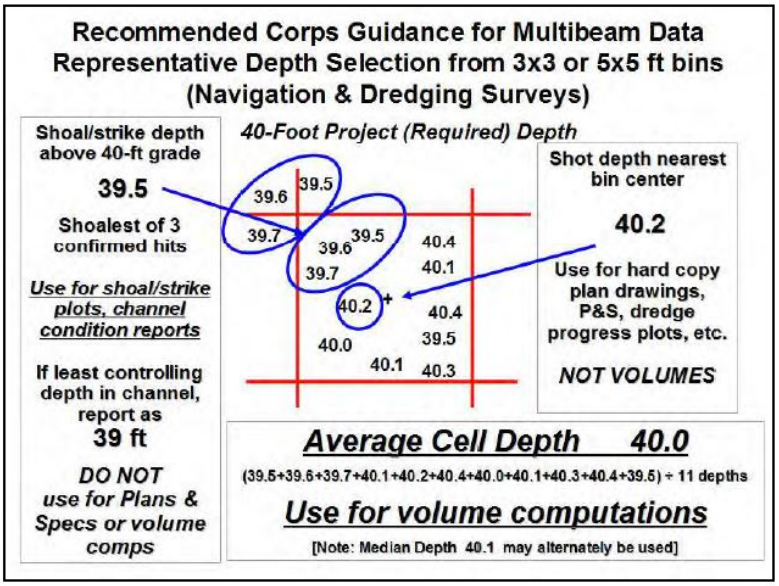


Fig. 1: USACE M-beam Data Reduction

At the heart of the USACE discussion is what the intent of use is for the data set. In the case of this survey the centermost value was used to show the data in plan view as this data set is not biased, the minimum value with a small bin size was selected for the contours in order establish the variability in the work area, capture existing structures, and provide a workable surface for design. It should be noted that the 1'x1' average value data set may also be of value if the intent is to remove the existing rocks for the purpose of installing the new intake pipe.

Eelgrass Video Survey

No evidence of eelgrass was encountered within the work area. Eight Stations were selected and videos taken to confirm the nonexistence of eelgrass beds in the area. Still images from the survey are included on sheet 2 of 2, along with station locations shown in plan view. While no eelgrass bed was encountered, some subaquatic vegetation was encountered in the work area including; Bladder Wrack, Kelp, and Sea Hair.

Fig. 2 Sample Still Images

If you have any questions or need further information, I can be reached in the office at 800-668-3220 or via email at mcampagnone@cleengineering.com.

Sincerely;
CLE Engineering, Inc.

Michael Campagnone, P.E.

Michael Campagnone
Project Manager

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

WPA Form 5 – Order of Conditions

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

MassDEP File Number:

047-0475

A. General Information

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

1. From: Nahant
Conservation Commission

2. This issuance is for (check one): a. ☒ Order of Conditions b. ☐ Amended Order of Conditions

3. To: Applicant:

Samuel
a. First Name

Solomon
b. Last Name

Northeastern University
c. Organization

360 Huntington Ave
d. Mailing Address

Boston
e. City/Town

MA
f. State

02115-5000
g. Zip Code

4. Property Owner (if different from applicant):

a. First Name

b. Last Name

c. Organization

d. Mailing Address

e. City/Town

f. State

g. Zip Code

5. Project Location:

430 Nahant Rd
a. Street Address

Nahant
b. City/Town

1B
c. Assessors Map/Plat Number

1
d. Parcel/Lot Number

Latitude and Longitude, if known:

42.416713
e. Latitude

-70.906807
f. Longitude

6. Property recorded at the Registry of Deeds for (attach additional information if more than one parcel):

Essex
a. County

b. Certificate Number (if registered land)

5344
c. Book

142
d. Page

7. Dates:

June 3, 2009
a. Date Notice of Intent Filed

June 23, 2009
b. Date Public Hearing Closed

June 24, 2009
c. Date of Issuance

8. Final Approved Plans and Other Documents (attach additional plan or document references as needed):

Salt Water Intake Pipe Replacement and Extension
a. Plan Title

Pare Corporation
b. Prepared By

Karl Hammond, PE
c. Signed and Stamped by

May 2009
d. Final Revision Date

1"=20'
e. Scale

f. Additional Plan or Document Title

g. Date

B. Findings

1. Findings pursuant to the Massachusetts Wetlands Protection Act:

   Following the review of the above-referenced Notice of Intent and based on the information provided in this application and presented at the public hearing, this Commission finds that the areas in which work is proposed is significant to the following interests of the Wetlands Protection Act. Check all that apply:

a. ☐ Public Water Supply b. ☐ Land Containing Shellfish c. ☐ Prevention of Pollution

d. ☐ Private Water Supply e. ☐ Fisheries f. ☐ Protection of Wildlife Habitat

g. ☐ Groundwater Supply h. ☐ Storm Damage Prevention i. ☐ Flood Control

2. This Commission hereby finds the project, as proposed, is: (check one of the following boxes)

Approved subject to:

a. ☒ the following conditions which are necessary in accordance with the performance standards set forth in the wetlands regulations. This Commission orders that all work shall be performed in accordance with the Notice of Intent referenced above, the following General Conditions, and any other special conditions attached to this Order. To the extent that the following conditions modify or differ from the plans, specifications, or other proposals submitted with the Notice of Intent, these conditions shall control.

Denied because:

b. ☐ the proposed work cannot be conditioned to meet the performance standards set forth in the wetland regulations. Therefore, work on this project may not go forward unless and until a new Notice of Intent is submitted which provides measures which are adequate to protect these interests, and a final Order of Conditions is issued. **A description of the performance standards which the proposed work cannot meet is attached to this Order.**

c. ☐ the information submitted by the applicant is not sufficient to describe the site, the work, or the effect of the work on the interests identified in the Wetlands Protection Act. Therefore, work on this project may not go forward unless and until a revised Notice of Intent is submitted which provides sufficient information and includes measures which are adequate to protect the Act's interests, and a final Order of Conditions is issued. **A description of the specific information which is lacking and why it is necessary is attached to this Order as per 310 CMR 10.05(6)(c).**

Inland Resource Area Impacts: Check all that apply below. (For Approvals Only)

3. ☐ Buffer Zone Impacts: Shortest distance between limit of project disturbance and wetland boundary (if available) _____ a. linear feet

Resource Area	Proposed Alteration	Permitted Alteration	Proposed Replacement	Permitted Replacement
4. ☐ Bank	a. linear feet	b. linear feet	c. linear feet	d. linear feet
5. ☐ Bordering Vegetated Wetland	a. square feet	b. square feet	c. square feet	d. square feet
6. ☐ Land Under Waterbodies and Waterways	a. square feet	b. square feet	c. square feet	d. square feet
	e. c/y dredged	f. c/y dredged		

B. Findings (cont.)

Resource Area	Proposed Alteration	Permitted Alteration	Proposed Replacement	Permitted Replacement
7. ☐ Bordering Land Subject to Flooding	a. square feet	b. square feet	c. square feet	d. square feet
Cubic Feet Flood Storage	e. cubic feet	f. cubic feet	g. cubic feet	h. cubic feet
8. ☐ Isolated Land Subject to Flooding	a. square feet	b. square feet		
Cubic Feet Flood Storage	c. cubic feet	d. cubic feet	e. cubic feet	f. cubic feet
9. ☐ Riverfront area	a. total sq. feet	b. total sq. feet		
Sq ft within 100 ft	c. square feet	d. square feet	e. square feet	f. square feet
Sq ft between 100-200 ft	g. square feet	h. square feet	i. square feet	j. square feet

Coastal Resource Area Impacts: Check all that apply below. (For Approvals Only)

10. ☐ Designated Port Areas	Indicate size under Land Under the Ocean, below			
11. ☒ Land Under the Ocean	211.80 a. square feet	b. square feet		
	0 c. c/y dredged	d. c/y dredged		
12. ☐ Barrier Beaches	Indicate size under Coastal Beaches and/or Coastal Dunes below			
13. ☐ Coastal Beaches	a. square feet	b. square feet	c. c/y nourishmt.	d. c/y nourishmt.
14. ☐ Coastal Dunes	a. square feet	b. square feet	c. c/y nourishmt.	d. c/y nourishmt.
15. ☐ Coastal Banks	0 a. linear feet	b. linear feet		
16. ☐ Rocky Intertidal Shores	0 a. square feet	b. square feet		
17. ☐ Salt Marshes	a. square feet	b. square feet	c. square feet	d. square feet
18. ☐ Land Under Salt Ponds	a. square feet	b. square feet		
	c. c/y dredged	d. c/y dredged		
19. ☐ Land Containing Shellfish	0 a. square feet	b. square feet	c. square feet	d. square feet
20. ☐ Fish Runs	Indicate size under Coastal Banks, inland Bank, Land Under the Ocean, and/or inland Land Under Waterbodies and Waterways, above			
	a. c/y dredged	b. c/y dredged		
21. ☐ Land Subject to Coastal Storm Flowage	a. square feet	b. square feet		

C. General Conditions Under Massachusetts Wetlands Protection Act

(only applicable to approved projects)

1. Failure to comply with all conditions stated herein, and with all related statutes and other regulatory measures, shall be deemed cause to revoke or modify this Order.

2. The Order does not grant any property rights or any exclusive privileges; it does not authorize any injury to private property or invasion of private rights.

3. This Order does not relieve the permittee or any other person of the necessity of complying with all other applicable federal, state, or local statutes, ordinances, bylaws, or regulations.

4. The work authorized hereunder shall be completed within three years from the date of this Order unless either of the following apply:
   a. the work is a maintenance dredging project as provided for in the Act; or
   b. the time for completion has been extended to a specified date more than three years, but less than five years, from the date of issuance. If this Order is intended to be valid for more than three years, the extension date and the special circumstances warranting the extended time period are set forth as a special condition in this Order.

5. This Order may be extended by the issuing authority for one or more periods of up to three years each upon application to the issuing authority at least 30 days prior to the expiration date of the Order.

6. Any fill used in connection with this project shall be clean fill. Any fill shall contain no trash, refuse, rubbish, or debris, including but not limited to lumber, bricks, plaster, wire, lath, paper, cardboard, pipe, tires, ashes, refrigerators, motor vehicles, or parts of any of the foregoing.

7. This Order is not final until all administrative appeal periods from this Order have elapsed, or if such an appeal has been taken, until all proceedings before the Department have been completed.

8. No work shall be undertaken until the Order has become final and then has been recorded in the Registry of Deeds or the Land Court for the district in which the land is located, within the chain of title of the affected property. In the case of recorded land, the Final Order shall also be noted in the Registry's Grantor Index under the name of the owner of the land upon which the proposed work is to be done. In the case of the registered land, the Final Order shall also be noted on the Land Court Certificate of Title of the owner of the land upon which the proposed work is done. The recording information shall be submitted to this Conservation Commission on the form at the end of this Order, which form must be stamped by the Registry of Deeds, prior to the commencement of work.

9. A sign shall be displayed at the site not less then two square feet or more than three square feet in size bearing the words,

   "Massachusetts Department of Environmental Protection" [or, "MassDEP"]

   "File Number 047-0474 "

C. General Conditions Under Massachusetts Wetlands Protection Act

10. Where the Department of Environmental Protection is requested to issue a Superseding Order, the Conservation Commission shall be a party to all agency proceedings and hearings before MassDEP.

11. Upon completion of the work described herein, the applicant shall submit a Request for Certificate of Compliance (WPA Form 8A) to the Conservation Commission.

12. The work shall conform to the plans and special conditions referenced in this order.

13. Any change to the plans identified in Condition #12 above shall require the applicant to inquire of the Conservation Commission in writing whether the change is significant enough to require the filing of a new Notice of Intent.

14. The Agent or members of the Conservation Commission and the Department of Environmental Protection shall have the right to enter and inspect the area subject to this Order at reasonable hours to evaluate compliance with the conditions stated in this Order, and may require the submittal of any data deemed necessary by the Conservation Commission or Department for that evaluation.

15. This Order of Conditions shall apply to any successor in interest or successor in control of the property subject to this Order and to any contractor or other person performing work conditioned by this Order.

16. Prior to the start of work, and if the project involves work adjacent to a Bordering Vegetated Wetland, the boundary of the wetland in the vicinity of the proposed work area shall be marked by wooden stakes or flagging. Once in place, the wetland boundary markers shall be maintained until a Certificate of Compliance has been issued by the Conservation Commission.

17. All sedimentation barriers shall be maintained in good repair until all disturbed areas have been fully stabilized with vegetation or other means. At no time shall sediments be deposited in a wetland or water body. During construction, the applicant or his/her designee shall inspect the erosion controls on a daily basis and shall remove accumulated sediments as needed. The applicant shall immediately control any erosion problems that occur at the site and shall also immediately notify the Conservation Commission, which reserves the right to require additional erosion and/or damage prevention controls it may deem necessary. Sedimentation barriers shall serve as the limit of work unless another limit of work line has been approved by this Order.

18. **The work associated with this Order is** (1) ☐ **is not** (2) ☒ **subject to the Massachusetts Stormwater Policy Standards. If the work is subject to the Stormwater Policy, the following conditions apply to this work and are incorporated into this Order:**

    a) No work, including site preparation, land disturbance, construction and redevelopment, shall commence unless and until the construction period pollution prevention and erosion and sedimentation control plan required by Stormwater Standard 8 is approved in writing by the issuing authority. Until the site is fully stabilized, construction period erosion, sedimentation and pollution control measures and best management practices (BMPs) shall be implemented in accordance with the construction period pollution prevention and erosion and sedimentation control plan, and if applicable, the Stormwater Pollution Plan required by the National Discharge Elimination System Construction General Permit.

C. General Conditions Under Massachusetts Wetlands Protection Act (cont.)

b) No stormwater runoff may be discharged to the post-construction stormwater BMPs until written approval is received from the issuing authority. To request written approval, the following must be submitted: illicit discharge compliance statement required by Stormwater Standard 10 and as-built plans signed and stamped by a registered professional engineer certifying the site is fully stabilized; all construction period stormwater BMPs and any illicit discharges to the stormwater management system have been removed; and all post-construction stormwater BMPs were installed in accordance with the plans (including all planting plans) approved by the issuing authority, and have been inspected to ensure they are not damaged and will function properly.

c) Prior to requesting a Certificate of Compliance, the responsible party (defined in General Condition 18(e)) shall submit to the issuing authority an Operation and Maintenance (O & M) Compliance Statement for the Stormwater BMPs. This Statement shall identify the responsible party for implementing the Operation and Maintenance Plan and also state that: 1. "Future responsible parties shall be notified in writing of their continuing legal responsibility to operate and maintain the stormwater management BMPs and implement the Pollution Prevention Plan; and 2. The Operation and Maintenance Plan for the stormwater BMPs is complete and will be implemented upon receipt of the Certificate."

d) Post-construction pollution prevention and source control shall be implemented in accordance with the long-term pollution prevention plan section of the approved Stormwater Report and, if applicable, the Stormwater Pollution Prevention Plan required by the National Discharge Elimination System Multi-Sector General Permit.

e) Unless and until another party accepts responsibility, the issuing authority shall presume that the responsible party for maintaining each BMP is the landowner of the property on which the BMP is located. To overcome this presumption, the landowner of the property must submit to the issuing authority a legally binding agreement acceptable to the issuing authority evidencing that another entity has accepted responsibility for maintaining the BMP, and that the proposed responsible party shall be treated as a permittee for purposes of implementing the requirements of Conditions 18(f) through 18(k) with respect to that BMP. Any failure of the proposed responsible party to implement the requirements of Conditions 18(f) through 18(k) with respect to that BMP shall be a violation of the Order of Conditions or Certificate of Compliance. In the case of stormwater BMPs that are serving more than one lot, the legally binding agreement shall also identify the lots that will be serviced by the stormwater BMPs. A plan and easement deed that grants the responsible party access to perform the required operation and maintenance must be submitted along with the legally binding agreement.

f) The responsible party shall operate and maintain all stormwater BMPs in accordance with the design plans, the Operation and Maintenance Plan section of the approved Stormwater Report, and the Massachusetts Stormwater Handbook.

g) The responsible party shall:
1. Maintain an operation and maintenance log for the last three years including inspections, repairs, replacement and disposal (for disposal the log shall indicate the type of material and the disposal location);
2. Make this log available to MassDEP and the Conservation Commission upon request; and
3. Allow members and agents of the MassDEP and the Conservation Commission to enter and inspect the premises to evaluate and ensure that the responsible party complies with the Operation and Maintenance requirements for each BMP set forth in the Operations and Maintenance Plan approved by the issuing authority.

h) All sediments or other contaminants removed from stormwater BMPs shall be disposed of in accordance with all applicable federal, state, and local laws and regulations.

i) Illicit discharges to the stormwater management system as defined in 310 CMR 10.04 are prohibited.

C. General Conditions Under Massachusetts Wetlands Protection Act (cont.)

j) The stormwater management system approved in the Final Order of Conditions shall not be changed without the prior written approval of the issuing authority. Areas designated as qualifying pervious areas for purpose of the Low Impact Site Design Credit shall not be altered without the prior written approval of the issuing authority.

k) Access for maintenance of stormwater BMPs shall not be obstructed or blocked. Any fencing constructed around stormwater BMPs shall include access gates. Fence(s) shall be at least six inches above grade to allow for wildlife passage.

Special Conditions (if you need more space for additional conditions, please attach a text document):

D. Findings Under Municipal Wetlands Bylaw or Ordinance

1. Is a municipal wetlands bylaw or ordinance applicable? ☐ Yes ☒ No
2. The _____ hereby finds (check one that applies):
   Conservation Commission
   a. ☐ that the proposed work cannot be conditioned to meet the standards set forth in a municipal ordinance or bylaw specifically:

      1. Municipal Ordinance or Bylaw _____ 2. Citation _____

      Therefore, work on this project may not go forward unless and until a revised Notice of Intent is submitted which provides measures which are adequate to meet these standards, and a final Order of Conditions is issued.

   b. ☐ that the following additional conditions are necessary to comply with a municipal ordinance or bylaw:

      1. Municipal Ordinance or Bylaw _____ 2. Citation _____
3. The Commission orders that all work shall be performed in accordance with the following conditions and with the Notice of Intent referenced above. To the extent that the following conditions modify or differ from the plans, specifications, or other proposals submitted with the Notice of Intent, the conditions shall control.
   The special conditions relating to municipal ordinance or bylaw are as follows (if you need more space for additional conditions, attach a text document):

E. Issuance

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

WPA Form 5 – Order of Conditions

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

MassDEP File Number:

This Order is valid for three years, unless otherwise specified as a special condition pursuant to General Conditions #4, from the date of issuance.
Please indicate the number of members who will sign this form:
This Order must be signed by a majority of the Conservation Commission.

1. Date of Issuance
6
2. Number of Signers

The Order must be mailed by certified mail (return receipt requested) or hand delivered to the applicant. A copy also must be mailed or hand delivered at the same time to the appropriate Department of Environmental Protection Regional Office, if not filing electronically, and the property owner, if different from applicant.

Signatures:

Notary Acknowledgement

Commonwealth of Massachusetts County of

On this 26th (Day) of June (Month) 2009 (Year)

Before me, the undersigned Notary Public, personally appeared Consert. Comm. (Name of Document Signer)

proved to me through satisfactory evidence of identification, which was/were

Know Personally
Description of evidence of identification

to be the person whose name is signed on the preceding or attached document, and acknowledged to me that he/she signed it voluntarily for its stated purpose.

As member of Nahant (City/Town) Conservation Commission

OFFICIAL SEAL
KATHLEEN COSTIN
NOTARY PUBLIC
COMMONWEALTH OF MASSACHUSETTS
My Comm. Expires Apr. 26, 2013

Signature of Notary Public

Kathleen Costin
Printed Name of Notary Public

April 26 2013
My Commission Expires (Date)

Place notary seal and/or any stamp above

This Order is issued to the applicant as follows:

☐ by hand delivery on

Date

☐ by certified mail, return receipt requested, on

Date

F. Appeals

The applicant, the owner, any person aggrieved by this Order, any owner of land abutting the land subject to this Order, or any ten residents of the city or town in which such land is located, are hereby notified of their right to request the appropriate MassDEP Regional Office to issue a Superseding Order of Conditions. The request must be made by certified mail or hand delivery to the Department, with the appropriate filing fee and a completed Request of Departmental Action Fee Transmittal Form, as provided in 310 CMR 10.03(7) within ten business days from the date of issuance of this Order. A copy of the request shall at the same time be sent by certified mail or hand delivery to the Conservation Commission and to the applicant, if he/she is not the appellant. Any appellants seeking to appeal the Department's Superseding Order associated with this appeal will be required to demonstrate prior participation in the review of this project. Previous participation in the permit proceeding means the submission of written information to the Conservation Commission prior to the close of the public hearing, requesting a Superseding Order or Determination, or providing written information to the Department prior to issuance of a Superseding Order or Determination.

The request shall state clearly and concisely the objections to the Order which is being appealed and how the Order does not contribute to the protection of the interests identified in the Massachusetts Wetlands Protection Act (M.G.L. c. 131, § 40), and is inconsistent with the wetlands regulations (310 CMR 10.00). To the extent that the Order is based on a municipal ordinance or bylaw, and not on the Massachusetts Wetlands Protection Act or regulations, the Department has no appellate jurisdiction.

Section G, Recording Information is available on the following page.

G. Recording Information

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

WPA Form 5 – Order of Conditions

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

MassDEP File Number:

047-0475

This Order of Conditions must be recorded in the Registry of Deeds or the Land Court for the district in which the land is located, within the chain of title of the affected property. In the case of recorded land, the Final Order shall also be noted in the Registry's Grantor Index under the name of the owner of the land subject to the Order. In the case of registered land, this Order shall also be noted on the Land Court Certificate of Title of the owner of the land subject to the Order of Conditions. The recording information on this page shall be submitted to the Conservation Commission listed below.

Nahant
Conservation Commission

Detach on dotted line, have stamped by the Registry of Deeds and submit to the Conservation Commission.

To:

Conservation Commission

Please be advised that the Order of Conditions for the Project at:

Project Location | MassDEP File Number

Has been recorded at the Registry of Deeds of:

County | Book | Page

for:

Property Owner

and has been noted in the chain of title of the affected property in:

Book | Page

In accordance with the Order of Conditions issued on:

Date

If recorded land, the instrument number identifying this transaction is:

Instrument Number

If registered land, the document number identifying this transaction is:

Document Number

Signature of Applicant

2

JJ6

2013110700087 Bk:32940 Pg:339
11/07/2013 09:42 COMPLI Pg 1/2

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

WPA Form 8B – Certificate of Compliance

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

DEP File Number: 047-0475
Provided by DEP

A. Project Information

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.

1. This Certificate of Compliance is issued to:
   Northeastern University
   Name
   360 Huntington Avenue
   Mailing Address
   Boston — MA — 02115-5000
   City/Town — State — Zip Code
2. This Certificate of Compliance is issued for work regulated by a final Order of Conditions issued to:
   Northeastern University
   Name
   November 10, 2009 — 047-0475
   Dated — DEP File Number
3. The project site is located at:
   430 Nahant Road — Nahant
   Street Address — City/Town
   13 — 1
   Assessors Map/Plat Number — Parcel/Lot Number

   the final Order of Condition was recorded at the Registry of Deeds for:

   Property Owner (if different)
   ESSEX — 29187 — 423
   County — Book — Page

   Certificate
4. A site inspection was made in the presence of the applicant, or the applicant's agent, on:
   10-12-13
   Date

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

WPA Form 8B – Certificate of Compliance

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

DEP File Number: 047-0475
Provided by DEP

B. Certification

Check all that apply:

☒ **Complete Certification**: It is hereby certified that the work regulated by the above-referenced Order of Conditions has been satisfactorily completed.

☐ **Partial Certification:** It is hereby certified that only the following portions of work regulated by the above-referenced Order of Conditions have been satisfactorily completed. The project areas or work subject to this partial certification that have been completed and are released from this Order are:

☐ Invalid Order of Conditions: It is hereby certified that the work regulated by the above-referenced Order of Conditions never commenced. The Order of Conditions has lapsed and is therefore no longer valid. No future work subject to regulation under the Wetlands Protection Act may commence without filing a new Notice of Intent and receiving a new Order of Conditions.

☐ **Ongoing Conditions**: The following conditions of the Order shall continue: (Include any conditions contained in the Final Order, such as maintenance or monitoring, that should continue for a longer period).

Condition Numbers:

C. Authorization

Issued by: Nahant
Conservation Commission

10/29/13
Date of Issuance

This Certificate must be signed by a majority of the Conservation Commission and a copy sent to the applicant and appropriate DEP Regional Office (See http://www.mass.gov/dep/about/region/findyour.htm).

Signatures:

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands

WPA Form 8B – Certificate of Compliance

Massachusetts Wetlands Protection Act M.G.L. c. 131, §40

DEP File Number:
047-0475
Provided by DEP

D. Recording Confirmation

The applicant is responsible for ensuring that this Certificate of Compliance is recorded in the Registry of Deeds or the Land Court for the district in which the land is located.

Detach on dotted line and submit to the Conservation Commission.

To:

_____
Conservation Commission

Please be advised that the Certificate of Compliance for the project at:

_____
Project Location DEP File Number

Has been recorded at the Registry of Deeds of:

_____
County

for:

_____
Property Owner

and has been noted in the chain of title of the affected property on:

_____
Date Book Page

If recorded land, the instrument number which identifies this transaction is:

_____

If registered land, the document number which identifies this transaction is:

_____
Document Number

_____
Signature of Applicant

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENERGY & ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
ONE WINTER STREET, BOSTON, MA 02108 617-292-5500

08195.00

DEVAL L. PATRICK
Governor

TIMOTHY P. MURRAY
Lieutenant Governor

IAN A. BOWLES
Secretary

LAURIE BURT
Commissioner

RECEIVED
BBL (RH)
JAN 11 2010
Pare Corporation

Northeastern University
c/o Pare Corporation
8 Blackstone Valley Place
Lincoln, RI 02865
Attn: Briscoe B. Lang, PWS

JAN X 6 2010

RE: ISSUANCE OF CHAPTER 91 WATERWAYS LICENSE
Waterways License Application No. W09-2680, License No. 12627
Nahant Harbor, Nahant, Essex County

Dear Licensee,

The Department of Environmental Protection hereby issues the above-referenced Waterways license, enclosed, authorizing you to perform certain activities pursuant to M.G.L. c. 91, the Public Waterfront Act and its regulations 310 CMR 9.00. Any change in use or alteration of any structure or fill not authorized by this license shall render this license void.

This License is not final until all administrative appeal periods from this License have elapsed, or if such an appeal has been taken, until all proceedings before the Department have been completed. The appeal period is for twenty-one (21) days. No work shall be undertaken until the License has become final and has been recorded in the Registry of Deeds or the Land Court for the district in which the land is located, within the chain of title of the affected property

RECORDING OF THE LICENSE

This License must be recorded at the County Registry of Deeds or, if registered land, with the Land Registration Office within sixty (60) days from the date of license issuance. In the case of recorded land, the License shall also be noted in the Registry's Grantor Index under the name of the owner of the land upon which the project is located. In the case of the registered land, the License shall also be noted on the Land Court Certificate of Title of the owner of the land upon which the project is located. **Failure to record this license within sixty (60) days of the date of issuance will render this license void pursuant to 310 CMR 9.18.**

A Waterways License Recordation Notice Form has been enclosed for your use in notifying the Department of the recording information for this License. **Failure to notify the Department of the recording of this license is a violation of 310 CMR 9.00 and is subject to enforcement action by the Department.**

REQUEST CERTIFICATE OF COMPLIANCE

Pursuant to 310 CMR 9.19, once the proposed project is completed you must file a Request for a Certificate of Compliance form, BRP WW05, within sixty (60) days of completion but in no event

later than five (5) years from the License's issuance date. The license for any project for which such a request is not filed and certificate issued may be revoked pursuant to 310 CMR 9.26.

APPEAL RIGHTS AND TIME LIMITS

The following persons shall have the right to an adjudicatory hearing concerning this decision by the Department to grant or deny a license or permit, in accordance with 310 CMR 9.17(1): (a) an applicant who has demonstrated property rights in the lands in question, or which is a public agency; (b) any person aggrieved by the decision of the Department to grant a license or permit who has submitted written comments within the public comment period; (c) ten (10) residents of the Commonwealth who, pursuant to M.G.L. c. 30A, § 10A, have submitted comments within the public comment period with at least 5 of the 10 residents residing in the municipality(s) in which the license or permitted activity is located. The appeal shall clearly and specifically state the facts and grounds for the appeal and the relief sought, and each appealing resident shall file an affidavit stating the intent to be part of the group and to be represented by its authorized representative; (d) the municipal official in the affected municipality who has submitted written comments within the public comment period; and (e) CZM, for any project identified in 310 CMR 9.13(2) (a) for CZM participation or, in an Ocean Sanctuary, if it has filed a notice of participation within the public comment period.

A person requesting an adjudicatory hearing must submit a "Notice of Claim" to the Department, with a copy of the MassDEP Transmittal Form and including the detail specified below, within twenty-one (21) days of the date of issuance of this decision. The MassDEP Fee Transmittal Form is available at the following website: http://www.mass.gov/dep/service/adr/adjherfm.doc. The Notice of Claim must be made in writing and sent by certified mail or hand delivery to:

Case Administrator
MassDEP
One Winter Street, 2nd Floor
Boston, MA 02108

A copy of the complete Notice of Claim must be sent at the same time by certified mail or hand delivery to: (1) the applicant, (2) the municipal official of the city or town where the project is located, and (3) the issuing office of the MassDEP, which in this case is located at:

MassDEP Waterways Regulation Program
One Winter Street, 5th Floor
Boston, MA 02108

The MassDEP Fee Transmittal Form and a valid check payable to the Commonwealth of Massachusetts in the amount of one hundred dollars ($100) must be mailed to:

Mass. Department of Environmental Protection
Commonwealth Master Lockbox
P.O. Box 4062
Boston, Massachusetts 02211

CONTENTS OF APPEAL REQUEST

Pursuant to 310 CMR 9.17(3), any Notice of Claim requesting an adjudicatory hearing must include the following information:

(a) the MassDEP Waterways Application File Number;
(b) the complete name, address, fax number and telephone number of the applicant;
(c) the address of the project;
(d) the complete name, address, fax number, and telephone number of the party filing the request and, if represented by counsel, the name, address, fax number, and phone number of the attorney;

(e) if claiming to be a person aggrieved, the specific facts that demonstrate that the party satisfies the definition of "aggrieved person" found in 310 CMR 9.02;

(f) a clear statement that a formal adjudicatory hearing is being requested;

(g) a clear statement of the facts which are the grounds for the proceedings, the specific objections to the MassDEP's written decision, and the relief sought through the adjudicatory hearing, including specifically the changes desired in the final written decision; and

(h) a statement that a copy of the request has been sent to: the applicant and the municipal official of the city or town where the project is located.

DISMISSAL OF REQUEST

The request for appeal will be dismissed if the filing fee is not paid, unless the appellant is exempt or is granted a waiver. The filing fee is not required if the appellant is a city or town (or municipal agency), county, or district of the Commonwealth of Massachusetts, or a municipal housing authority. The Department may waive the adjudicatory hearing filing fee pursuant to 310 CMR 4.06(2) for a person who shows that paying the fee will create an undue financial hardship. A person seeking a waiver must file an affidavit setting forth the facts believed to support the claim of undue financial hardship together with the hearing request as provided above.

Please feel free to contact David B. Slagle of the Waterways Regulation Program, (617) 654-6640, if you have any questions pertaining to the recording of your Waterways license or Certificate of Compliance.

Sincerely,

Ben Lynch
Program Chief
Waterways Regulation Program

cc: Nahant, Board of Selectmen
Nahant, Conservation Commission
Nahant, Planning Board
Nahant, Harbormaster

Ecc: DEP/NE Wetlands File #
EOEEA, MEPA Unit File #

Enclosure(s) Waterways License # **12627**
Notification of Waterways License Recordation form

Michael Girvan
Waterways Regulation Program
Department of Environmental Protection
1 Winter Street, 5th Floor
Boston, Massachusetts 02108

RE: NOTIFICATION OF RECORDING THE WATERWAYS LICENSE
Waterways License No. 12627
Nahant Harbor, Nahant, Essex County

Dear Mr. Girvan:

This is to notify you that the above referenced Waterways license was recorded with the appropriate Registry of Deeds/ Land Court for this project location and to provide your office with the following recordation information.

Date of Recordation: _____
County Registry of Deeds/ Land Court: _____
Book number_____, and page number(s) _____.

We will apply for a Certificate of Compliance with your office when the authorized work or change in use is completed.

Sincerely,

_____, Chapter 91 Waterways Licensee

License is void if not recorded within sixty (60) days of issuance.

The Commonwealth of Massachusetts

No. 12627

Whereas, Northeastern University

of -- Boston --, in the County of -- Suffolk -- and Commonwealth aforesaid, has applied to the Department of Environmental Protection for license to -- replace, extend and maintain salt water intake pipes to be held in place by concrete anchor blocks -----

and has submitted plans of the same; and whereas due notice of said application has been given, as required by law, to the -- Board of Selectmen -- of the -- Town of Nahant; ---------

NOW, said Department, having heard all parties desiring to be heard, and having fully considered said application, hereby, subject to the approval of the Governor, authorizes and licenses the said

-- Northeastern University --, subject to the provisions of the ninety-first chapter of the General Laws, and of all laws which are or may be in force applicable thereto, to -- replace, extend and maintain salt water intake pipes to be held in place by concrete anchor blocks --

in and over the waters of -- Boston Harbor -- located at the Marine Science Center, 430 Nahant Road -- in the -- Town -- of -- Nahant -- and in accordance with the locations shown and details indicated on the accompanying DEP License Plan No. 12627, (4 sheets).

PRINTED ON RECYCLED PAPER

The structures hereby authorized shall be limited to the following uses: to provide for the conveyance of salt water for use within the Marine Science Center's Edwards Laboratory.

SPECIAL CONDITIONS

This license will expire thirty (30) years from the date of issuance.

In accordance with any license condition, easement, or other public right of lateral passage that exists in the area of the subject property lying below the high water mark, the Licensee shall allow the public in the exercise of such rights to pass freely over/around all structures within such area.

In partial compensation for the private use of structures on land within Commonwealth tidelands, which interferes with the rights of the public to use such lands, the Licensee shall allow the public to pass on foot, for any purpose and from dawn to dusk, along the upland of the subject property within five (5) feet of the high water mark. This condition shall not be construed to prevent the Licensee from taking reasonable measures to discourage unlawful activity by users of the area intended for public passage, including but not limited to trespassing on adjacent private areas and deposit of refuse of any kind or nature in the water or on the shore. Further, the exercise by the public of free on-foot passage in accordance with this condition shall be considered a permitted use to which the limited liability provisions of M.G.L. c.21, s17c shall apply.

All work authorized herein shall be completed within five (5) years of the date of license issuance. Said construction period may be extended by the Department for one or more one year periods without public notice, provided that the Applicant submits to the Department thirty (30) days prior to the end of the construction period, a written request to extend the period and provides adequate justification for said extension.

Within 60 days of completion of the licensed project, the Licensee shall request in writing that the Department issue a Certificate of Completion in accordance with 310 CMR 9.19. The request shall be accompanied by a certification by a registered professional engineer licensed in the Commonwealth that the project was completed in accordance with the License.

By written request of the licensee for an amendment, the Department may grant a renewal for a term not to exceed that authorized in the original license.

Please see page 3 for additional conditions to this license. ----------

Duplicate of said plan, number 12627 on file in the office of said Department, and original of said plan accompanies this License, and is to be referred to as a part hereof.

STANDARD WATERWAYS LICENSE CONDITIONS

1. Acceptance of this Waterways License shall constitute an agreement by the Licensee to conform to all terms and conditions stated herein.

2. This License is granted upon the express condition that any and all other applicable authorizations necessitated due to the provisions hereof shall be secured by the Licensee prior to the commencement of any activity or use authorized pursuant to this License.

3. Any change in use or any substantial structural alteration of any structure or fill authorized herein shall require the issuance by the Department of a new Waterways License in accordance with the provisions and procedures established in Chapter 91 of the Massachusetts General Laws. Any unauthorized substantial change in use or unauthorized substantial structural alteration of any structure or fill authorized herein shall render this Waterways License void.

4. This Waterways License shall be revocable by the Department for noncompliance with the terms and conditions set forth herein. This license may be revoked after the Department has given written notice of the alleged noncompliance to the Licensee and those persons who have filed a written request for such notice with the Department and afforded them a reasonable opportunity to correct said noncompliance. Failure to correct said noncompliance after the issuance of a written notice by the Department shall render this Waterways License void and the Commonwealth may proceed to remove or cause removal of any structure or fill authorized herein at the expense of the Licensee, its successors and assigns as an unauthorized and unlawful structure and/or fill.

5. The structures and/or fill authorized herein shall be maintained in good repair and in accordance with the terms and conditions stated herein and the details indicated on the accompanying license plans.

6. Nothing in this Waterways License shall be construed as authorizing encroachment in, on or over property not owned or controlled by the Licensee, except with the written consent of the owner or owners thereof.

7. This Waterways License is granted subject to all applicable Federal, State, County, and Municipal laws, ordinances and regulations including but not limited to a valid final Order of Conditions issued pursuant to the Wetlands Protection Act, G.L. Chapter 131, s.40.

8. This Waterways License is granted upon the express condition that the use of the structures and/or fill authorized hereby shall be in strict conformance with all applicable requirements and authorizations of the DEP.

9. This License authorizes structure(s) and/or fill on:

X Private Tidelands. In accordance with the public easement that exists by law on private tidelands, the licensee shall allow the public to use and to pass freely upon the area of the subject property lying between the high and low water marks, for the purposes of fishing, fowling, navigation, and the natural derivatives thereof.

X Commonwealth Tidelands. The Licensee shall not restrict the public's right to use and to pass freely, for any lawful purpose, upon lands lying seaward of the low water mark. Said lands are held in trust by the Commonwealth for the benefit of the public.

__ a Great Pond of the Commonwealth. The Licensee shall not restrict the public's right to use and to pass freely upon lands lying seaward of the high water mark for any lawful purpose.

__ Navigable River or Stream. The Licensee shall not restrict the public's right to use and to pass freely, for any lawful purpose, in the waterway.

No restriction on the exercise of these public rights shall be imposed unless otherwise expressly provided in this license.

10. Unless otherwise expressly provided by this license, the licensee shall not limit the hours of availability of any areas of the subject property designated for public passage, nor place any gates, fences, or other structures on such areas in a manner that would impede or discourage the free flow of pedestrian movement thereon.

The amount of tidewater displaced by the work hereby authorized has been ascertained by said Department, and compensation thereof has been made by the said -- Northeastern University -- by paying into the treasury of the Commonwealth -- two dollars and zero cents ($2.00)-- for each cubic yard so displaced, being the amount hereby assessed by said Department. (0.0 cu. yds. = $0.00)

Nothing in this License shall be so construed as to impair the legal rights of any person. This License shall be void unless the same and the accompanying plan are recorded within 60 days from the date hereof, in the Registry of Deeds for the County of -- Essex -------

IN WITNESS WHEREAS, said Department of Environmental Protection have hereunto set their hands this 6th day of January in the year two thousand and ten.

Commissioner _____ Department of Environmental Protection

Program Chief _____

THE COMMONWEALTH OF MASSACHUSETTS

This license is approved in consideration of the payment into the treasury of the Commonwealth by the said -- Northeastern University

-- the further sum of -- zero dollars and zero cents ($0.00)

the amount determined by the Governor as a just and equitable charge for rights and privileges hereby granted in the land of the Commonwealth.

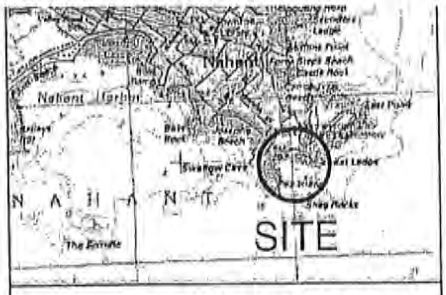
BOSTON,

Approved by the Governor.

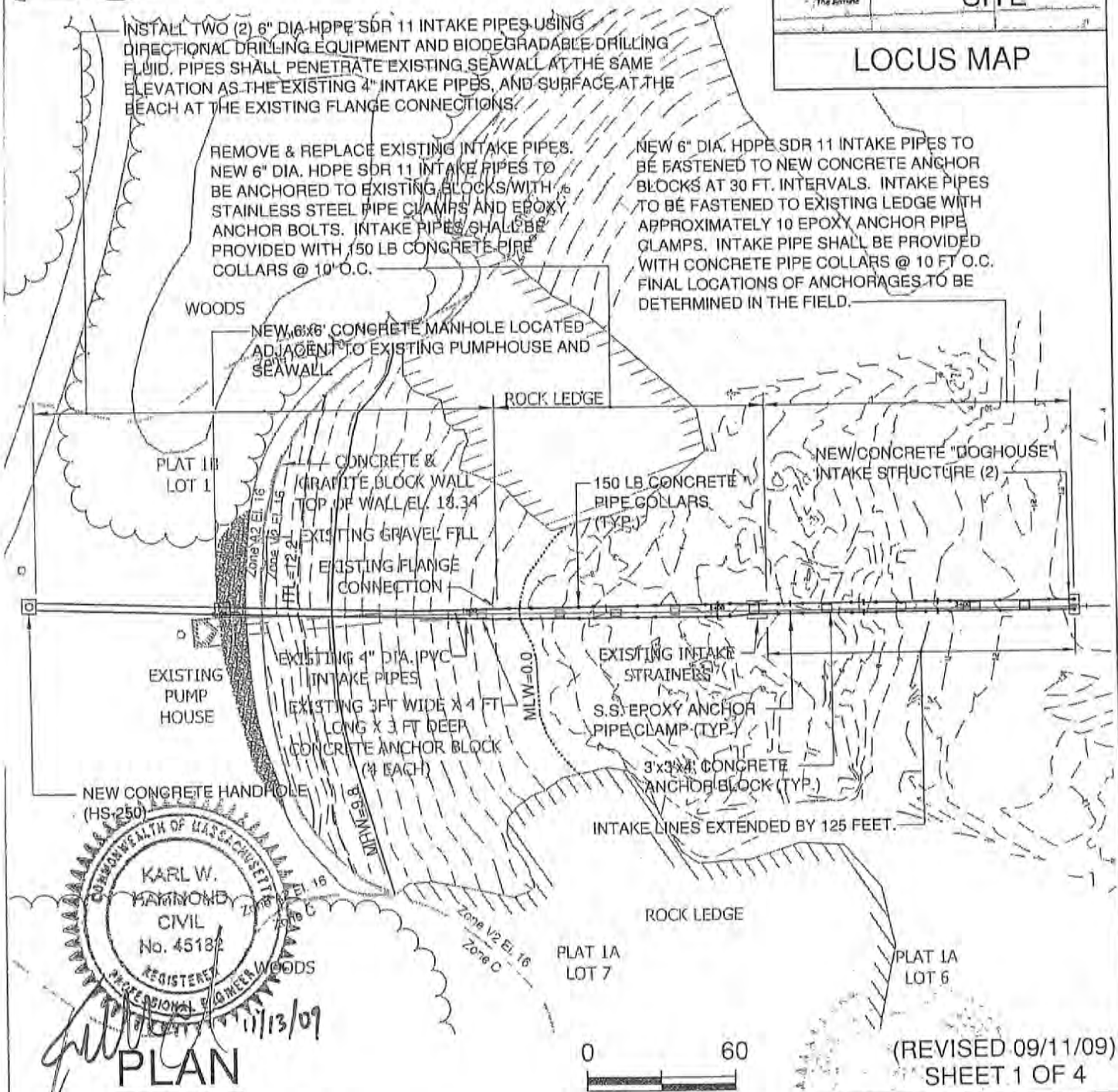
Governor

2. TOPOGRAPHIC SURVEY PERFORMED BY PARE CORPORATION ON SEPTEMBER 2, 2008.

3. BATHYMETRIC SURVEY PERFORMED BY INNERTEK INC. ON SEPTEMBER 5, 2008.



LOCUS MAP



COMMONWEALTH OF MASSACHUSETTS
KARL W. RAYMOND
CIVIL
No. 45182
REGISTERED PROFESSIONAL ENGINEER

11/13/09

PLAN

SCALE: 1"=60'

(REVISED 09/11/09)
SHEET 1 OF 4

PLAN ACCOMPANYING PETITION OF:
NORTHEASTERN UNIVERSITY
MARINE SCIENCE CENTER
TO LICENSE SALT WATER INTAKE PIPE
REPLACEMENT AND EXTENSION.
NAHANT HARBOR,
NAHANT, MASSACHUSETTS

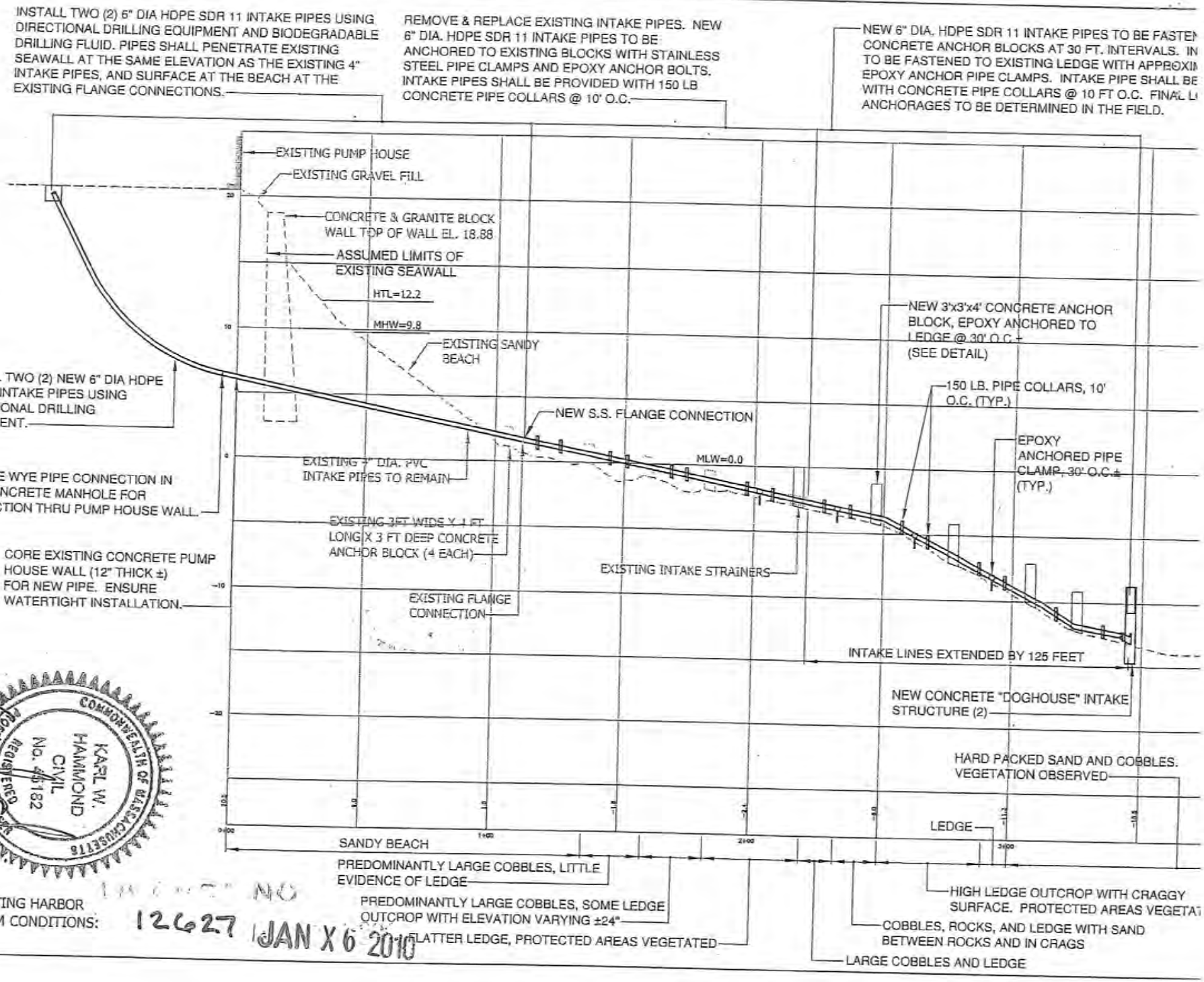
September 2009

LICENSE PLAN NO. 12627

JAN X 6 2010

PROFILE PLAN

SCALE: HORIZ. 1"=50'
VERT. 1"=8'

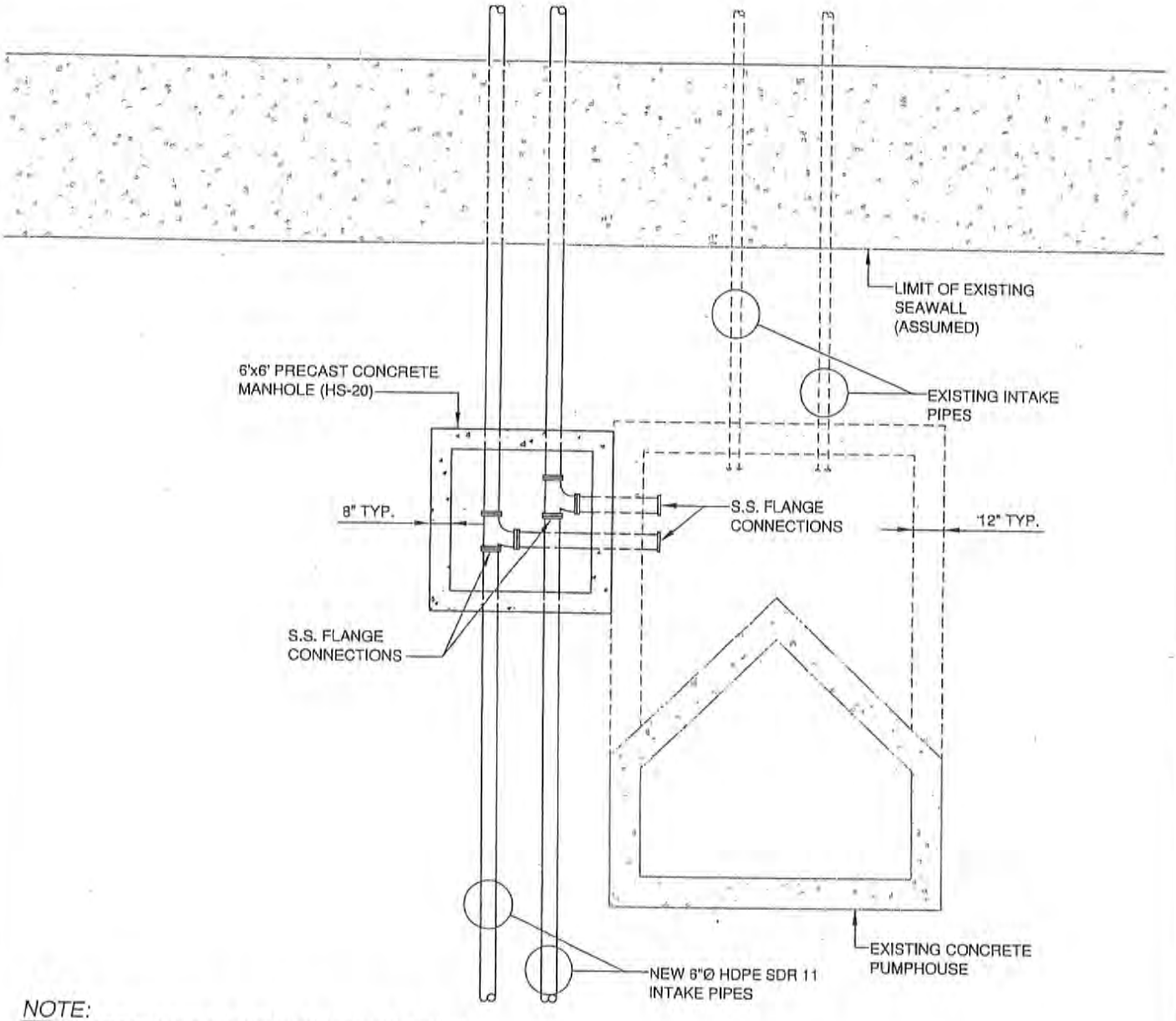


COMMONWEALTH OF MASSACHUSETTS
KARL W. HAMMOND
CIVIL
No. 45182
REGISTERED PROFESSIONAL ENGINEER

11/13/09

(REVISED 09/11/09)
SHEET 2 OF 4

INCORRECT NO
12627 JAN X 6 2010



NOTE:

1. INVERT ELEVATIONS OF NEW INTAKE PIPE TO MATCH INVERT ELEVATIONS OF EXISTING INTAKE PIPES.

PUMPHOUSE PIPE PENETRATION
PLAN VIEW
SCALE: 3/16" = 1'-0"

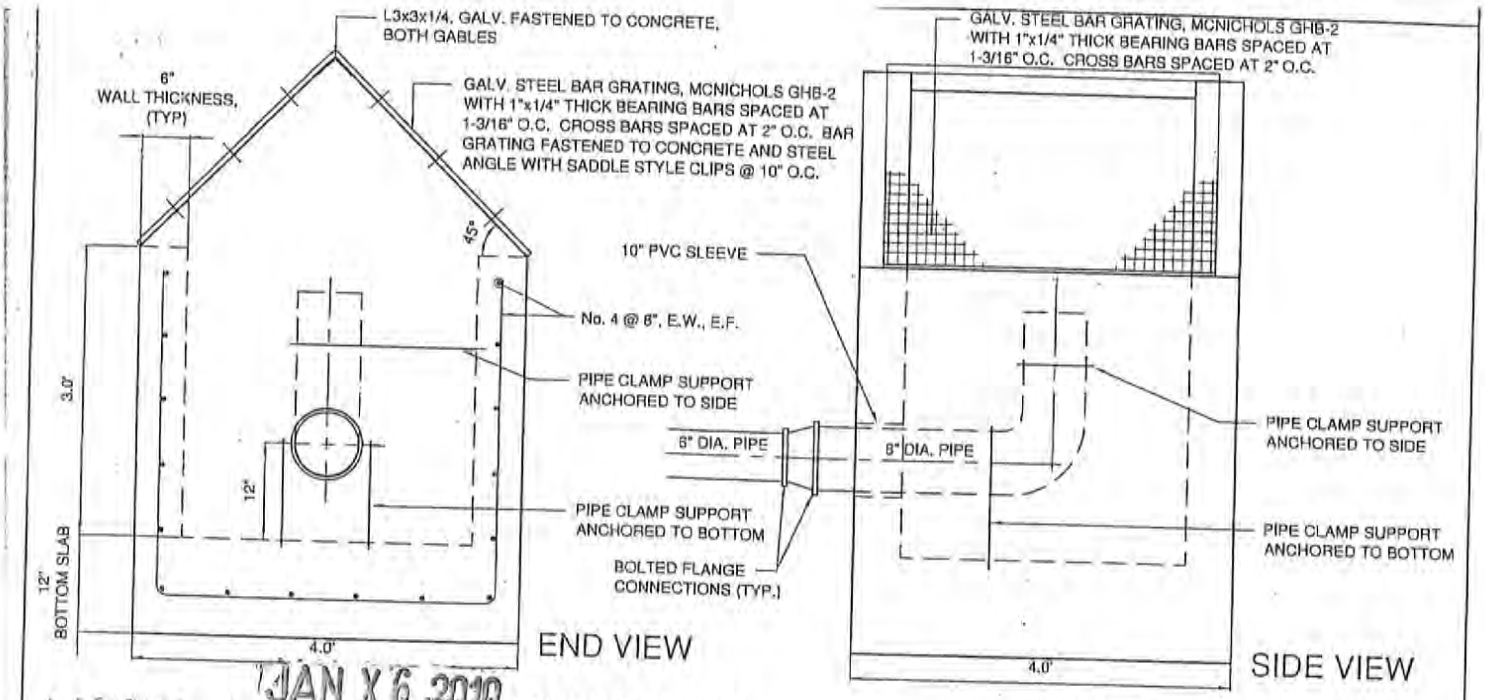
LICENSE PLAN NO. 12627
Approved by Department of Environmental Protection
Date: JAN X 6 2010

COMMONWEALTH OF MASSACHUSETTS
KARL W. HAMMOND
CIVIL
No. 45182
REGISTERED PROFESSIONAL ENGINEER
11/13/09

DETAILS

SCALE: AS NOTED

(REVISED 09/11/09)
SHEET 4 OF 4

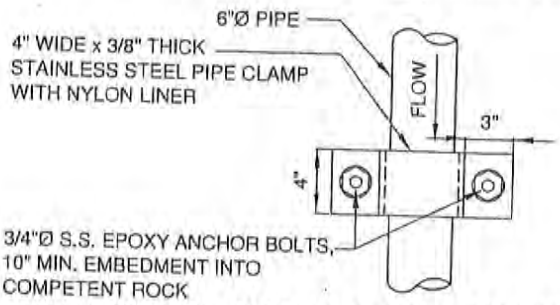


JAN X 6 2010

12.627

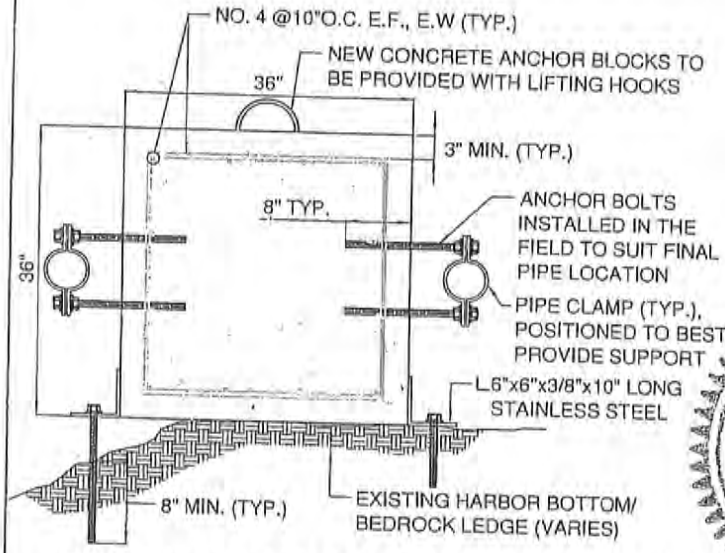
DOGHOUSE DETAILS

SCALE: 1" = 1'-0"



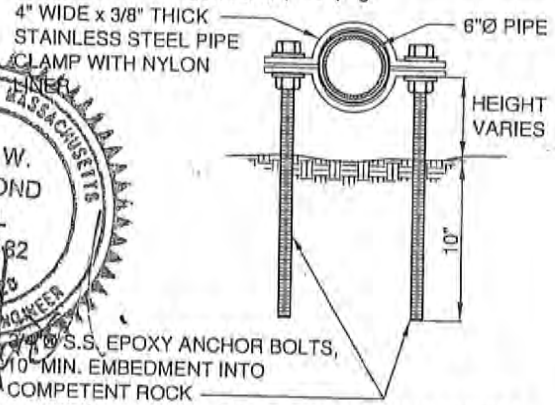
TYPICAL PIPE CLAMP PLAN VIEW

SCALE: 1" = 1'-0"



CONCRETE ANCHOR BLOCK SECTION VIEW

SCALE: 1" = 1'-0"

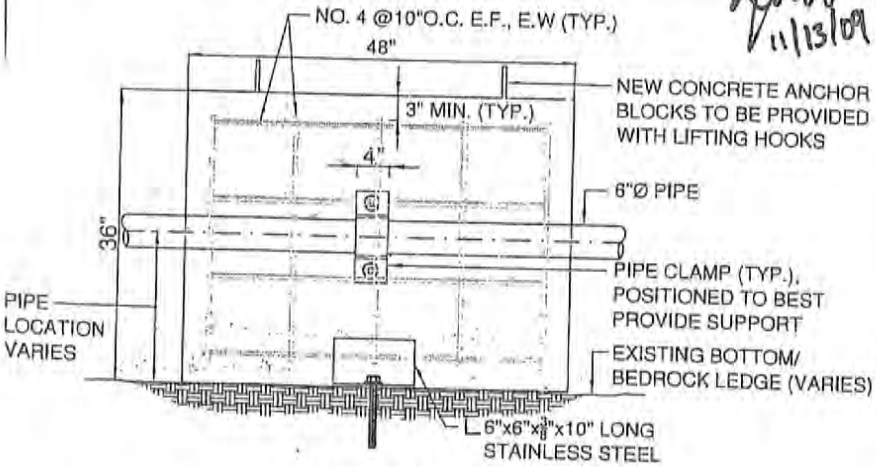


TYPICAL PIPE CLAMP SECTION

SCALE: 1" = 1'-0"

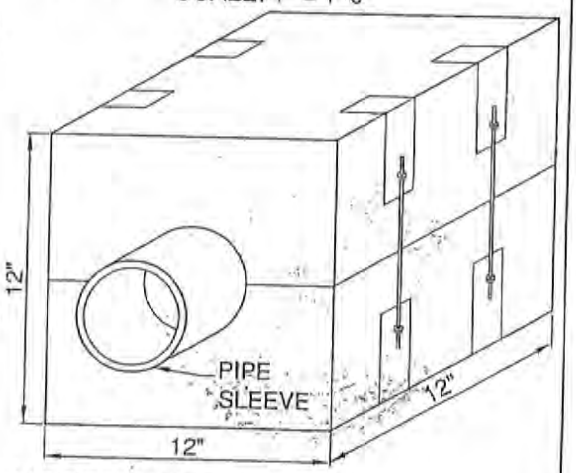
COMMONWEALTH OF MASSACHUSETTS
KARL W. HAMMOND
CIVIL
No. 45162
REGISTERED PROFESSIONAL ENGINEER

11/13/09



CONCRETE ANCHOR BLOCK ELEVATION VIEW

SCALE: 1" = 1'-0"



150 LB CONCRETE PIPE COLLAR

SCALE: 1 1/2" = 1'-0"

DETAILS

SCALE: AS NOTED

Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

One Winter Street Boston, MA 02108 • 617-292-5500

Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Matthew A. Beaton
Secretary

Martin Suuberg
Commissioner

RECEIVED
APR 16 2015
Pare Corporation

Northeastern University
c/o Pare Corporation
10 Lincoln Road, Suite 103
Foxborough, MA 02035
Attn: Briscoe Lang

Re: Certificate of Compliance, DEP License No. 12627
Nahant Bay, Nahant, Essex County

Dear Mr. Lang:

Enclosed is the Certificate of Compliance for the above referenced Waterways License pursuant to Waterways Licensing Regulations 310 CMR 9.19. This Certificate could be attached to the License documents for future reference and a copy of the Certificate will be placed in the License file on record with the Department.

Should you have any questions comments on this matter, please call David B. Slagle of my office at (617) 654-6520.

Sincerely,

Ben Lynch
Program Chief
Waterways Regulation Program

Cc: Nahant Conservation Commission
WRP file

This information is available in alternate format. Call Michelle Waters-Ekanem, Diversity Director, at 617-292-5751. TTY# MassRelay Service 1-800-439-2370
MassDEP Website: www.mass.gov/dep

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Commonwealth of Massachusetts
Executive Office of Energy & Environmental Affairs

Department of Environmental Protection

One Winter Street Boston, MA 02108 • 617-292-5500

Charles D. Baker
Governor

Karyn E. Polito
Lieutenant Governor

Matthew A. Beaton
Secretary

Martin Suuberg
Commissioner

CERTIFICATE OF COMPLIANCE PURSUANT TO MGL CHAPTER 91 WATERWAYS LICENSING REGULATIONS 310 CMR 9.19

This Certificate of Compliance is issued pursuant to Waterways Regulations 310 CMR 9.19 to:

Northeastern University Marine Science Center
430 Nahant Road
Nahant, MA 01908

Waterways License No. 12627, issued on April 27, 2010 and the accompanying license plans authorized the Licensee, Northeastern University to construct and maintain a salt water intake structure. The site is located in within the waters of Nahant Bay in the Town of Nahant.

The License was duly recorded at the Registry of Deeds in Essex County on May 7, 2010.

In accordance with the foregoing and the affidavit of Karl W. Hammond, P.E. of Pare Corporation, 10 Lincoln Road, Suite 103; Foxborough, MA 02035, signed September 29, 2014, submitted pursuant to 310 CMR 9.19, the undersigned certifies to the best of his knowledge that the work authorized in said License has been completed in substantial accordance with the terms and conditions of Chapter 91 Waterways License No. 12627.

The Licensee shall continue to maintain in good repair all authorized structures and uses in accordance with the terms and conditions stated in Waterways License No. 12627 for the full term of the license.

IN WITNESS WHEREAS, said Department of Environmental Protection have hereunto set their hands this 11th day of APRIL in the year two thousand and fifteen.

Program Chief _____

This information is available in alternate format. Call Michelle Waters-Ekanem, Diversity Director, at 617-292-5751. TTY# MassRelay Service 1-800-439-2370
MassDEP Website: www.mass.gov/dep

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DEPARTMENT OF THE ARMY
NEW ENGLAND DISTRICT, CORPS OF ENGINEERS
696 VIRGINIA ROAD
CONCORD, MASSACHUSETTS 01742-2751

REPLY TO:
ATTENTION OF:

October 28, 2009

Regulatory Division
CENAE-R-PEA
Permit Number: NAE-2009-1693

Northeastern University
Attn: Samuel Solomon, Director of Finance and Treasurer
360 Huntington Avenue
Boston, Massachusetts 02115

Dear Mr. Solomon:

We have reviewed your application for Northeastern University to replace and extend to deeper water the existing paired seawater intake pipes at the Northeastern University's Marine Science Center in Nahant. The work will replace about 105 feet of 4-inch piping with 6-inch piping, extend the intake about 130 feet seaward with 6-inch diameter piping, and install a concrete intake structure. The new piping will be anchored to blocks with stainless steel pipe clamps along its length. The project site is located in Nahant Bay, 430 Nahant Road, Nahant Massachusetts. The work is shown on the attached plans entitled "PROPOSED SALT WATER INTAKE PIPE REPLACEMENT AND EXTENSION NAHANT HARBOR NAHANT, MASSACHUSETTS", on 5 sheets, and dated "09/11/09".

Based on the information you have provided, we have determined that the proposed activity will have only minimal individual or cumulative environmental impacts on waters of the United States, including wetlands. Therefore, this work is authorized as a Category 2 activity under the attached Federal permit known as the Massachusetts Programmatic General Permit (PGP). This work must be performed in accordance with the terms and conditions of the PGP.

The Corps of Engineers has consulted with the National Marine Fisheries Service (NMFS) regarding the effects of your project on Essential Fish Habitat (EFH) as designated under the Magnuson-Stevens Fishery Conservation and Management Act. The NMFS did not provide EFH conservation recommendations.

You are responsible for complying with all of the PGP's requirements. Please review the attached PGP carefully, in particular the PGP conditions beginning on Page 9, to familiarize yourself with its contents. You should ensure that whoever does the work fully understands the requirements and that a copy of the permit document and this authorization letter are at the project site throughout the time the work is underway.

Your project is located within, or may affect resources within the coastal zone. The Massachusetts Office of Coastal Zone Management (CZM) has already determined that no further Federal Consistency Review is required.

This authorization expires on January 20, 2010, unless the PGP is modified, suspended, or revoked. You must commence or have under contract to commence the work authorized herein by January 20, 2010 and complete the work by January 20, 2011. For work within Corps jurisdiction that is not completed by January 20, 2011, you will need to reapply to the Corps to continue work within our jurisdiction. We recommend you contact us *before* this permit expires to discuss permit reissuance.

If you change the plans or construction methods for work within our jurisdiction, please contact us immediately to discuss modification of this authorization. This office must approve any changes before you undertake them.

This authorization requires you to complete and return the enclosed Work Start Notification Form to this office at least two weeks before the anticipated starting date. You must also complete and return the enclosed Compliance Certification Form within one month following the completion of the authorized work and any required mitigation.

This authorization presumes that the work as described above and as shown on your plans noted above is in waters of the U.S. Should you desire to appeal our jurisdiction, please submit a request for an approved jurisdictional determination in writing to this office.

This permit does not obviate the need to obtain other Federal, state, or local authorizations required by law, as listed on Page 1 of the PGP. Performing work not specifically authorized by this determination or failing to comply with all the terms and conditions of the PGP may subject you to the enforcement provisions of our regulations.

We continually strive to improve our customer service. In order for us to better serve you, we would appreciate your completing our Customer Service Survey located at http://per2.nwp.usace.army.mil/survey.html

Please contact John Sargent, of my staff at 978-318-8026 if you have any questions.

Sincerely,

Karen Kirk Adams
Chief, Permits & Enforcement Branch
Regulatory Division

Attachments

Copies Furnished:

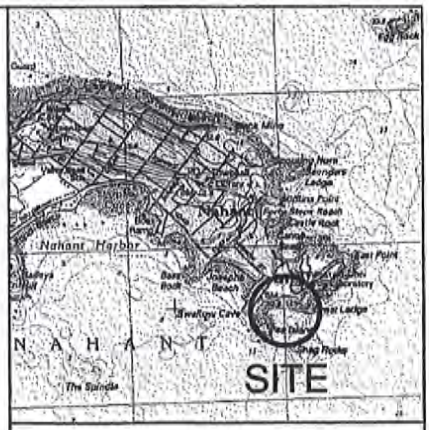
Ed Reiner, U.S. EPA, Region 1, Boston, Massachusetts, reiner.ed@epa.gov
Christopher Boelke, National Marine Fisheries Service, Gloucester, Massachusetts, christopher.boelke@noaa.gov
Rachel Freed, DEP NERO, Wetland and Waterways, Wilmington, Massachusetts, rachel.freed@state.ma.us (DEP File No. 047-0475)
Robert Boeri, Coastal Zone Management, Boston, Massachusetts Robert.Boeri@state.ma.us
Briscoe Lang, Pare Corporation, 8 Blackstone Valley Place, Lincoln, Rhode Island 02865

NOTES:

1. VERTICAL ELEVATIONS REFERENCED TO BENCHMARK SET ON TOP OF THE EXISTING SEAWALL. VERTICAL DATUM REFERENCED TO MLW = 0.0 , MHW = +9.8 , HTL = +12.2.

2. TOPOGRAPHIC SURVEY PERFORMED BY PARE CORPORATION ON SEPTEMBER 2, 2008.

3. BATHYMETRIC SURVEY PERFORMED BY INNERTEK INC. ON SEPTEMBER 5, 2008.



LOCUS MAP

PLAN

SCALE: 1"=60'

0 60

PROPOSED SALT WATER INTAKE PIPE
REPLACEMENT AND EXTENSION
NAHANT HARBOR
NAHANT, MASSACHUSETTS
SEPTEMBER 2009

(REVISED 09/11/09)
SHEET 1 OF 5

08195.00\DWG\Army Corp\01 TITLE

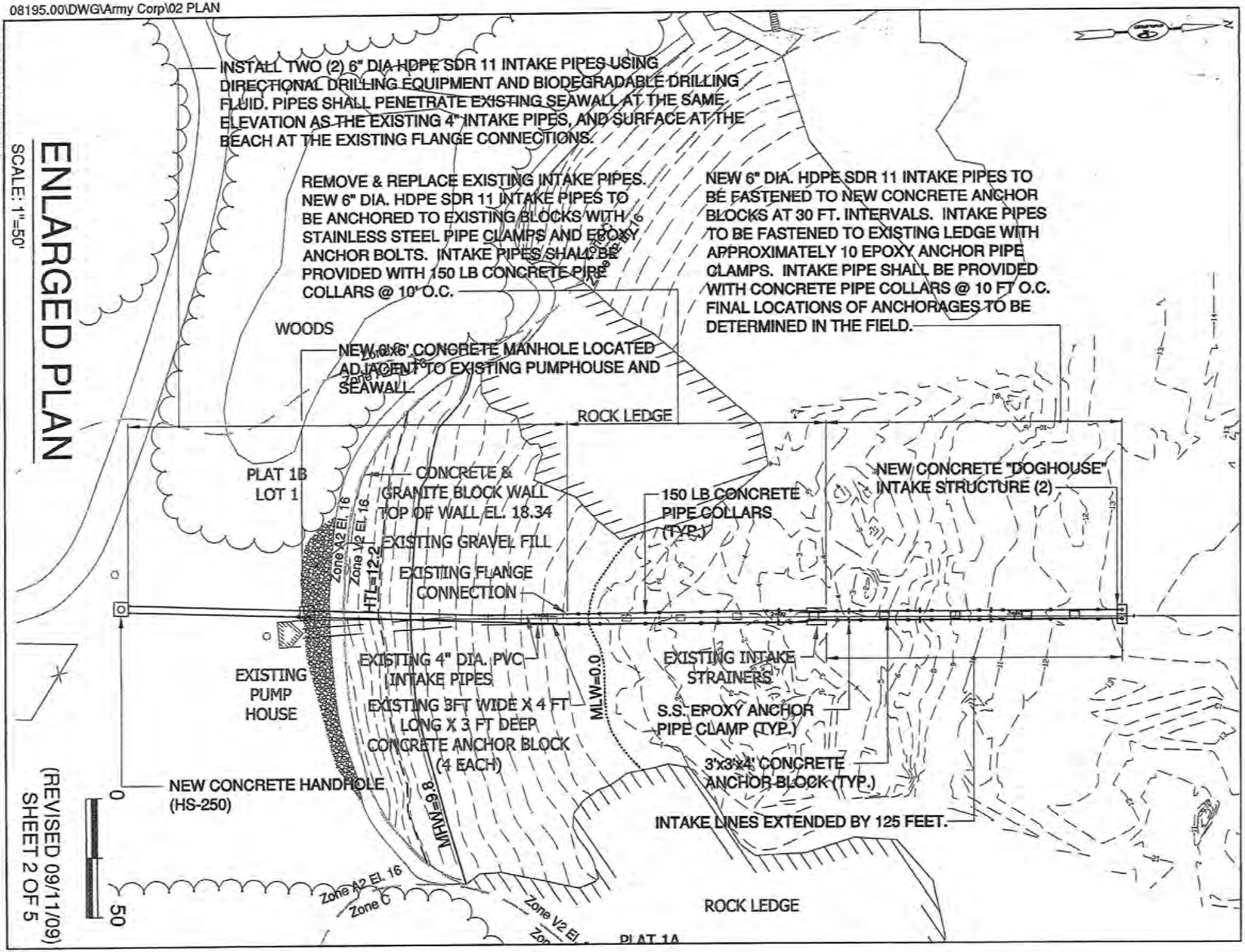
PARE CORPORATION

08195.00\DWG\Army Corp\02 PLAN

PARE CORPORATION

ENLARGED PLAN

SCALE: 1"=50'



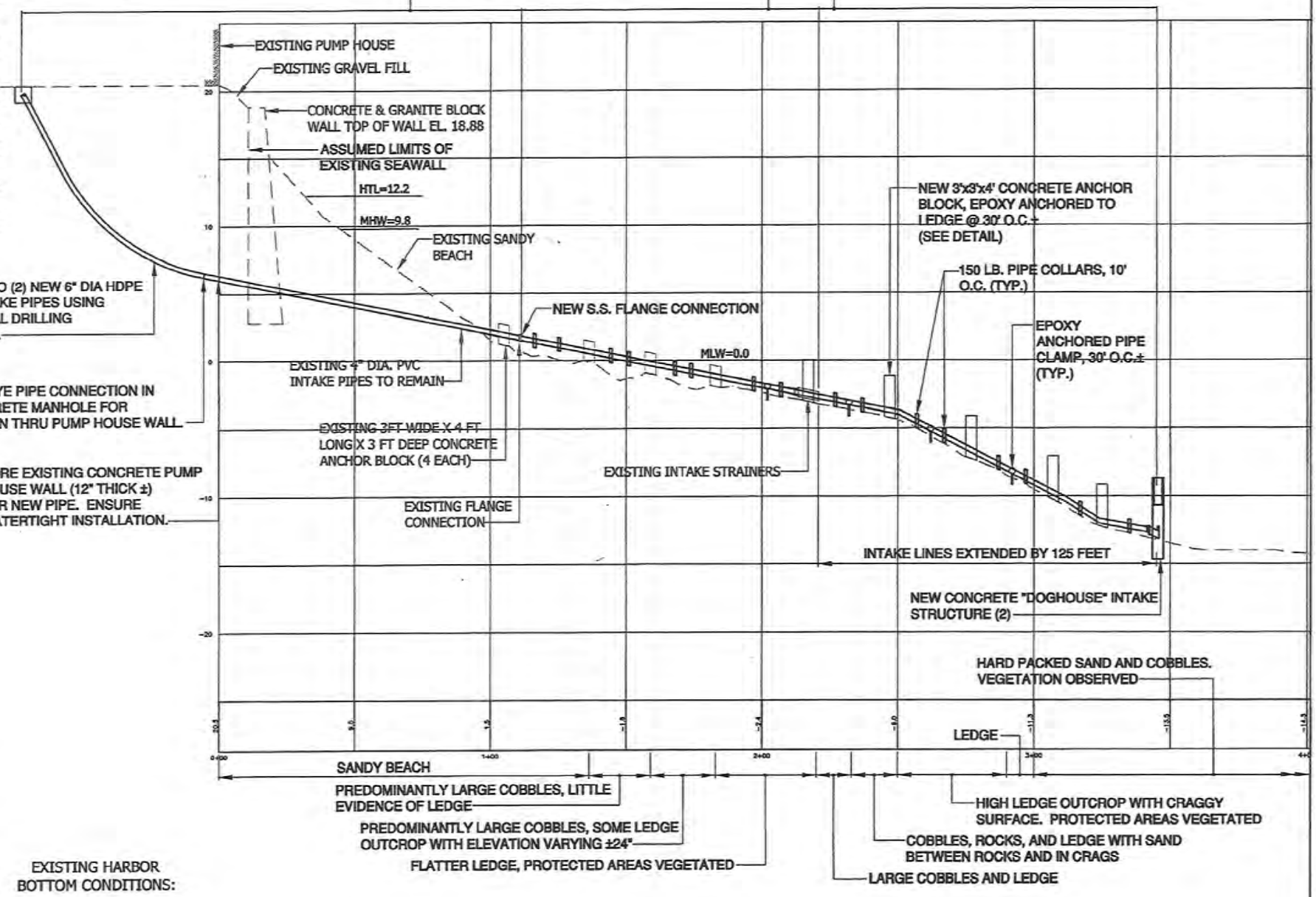
(REVISED 09/11/09)
SHEET 2 OF 5

08195.00\DWG\Army Corp\03 PROFILE

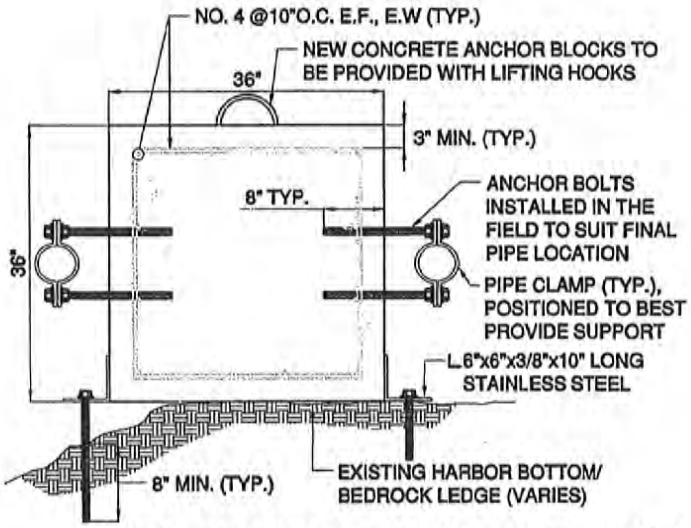
PARE CORPORATION

PROFILE PLAN

SCALE: HORIZ. 1"=50'
VERT. 1"=8'

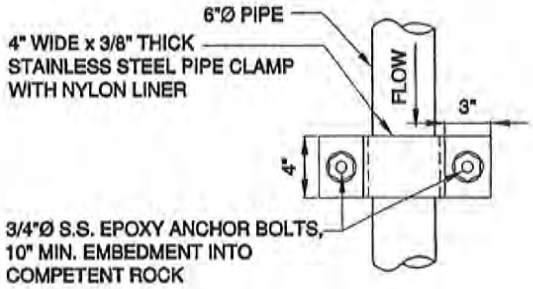


(REVISED 09/11/09)
SHEET 3 OF 5



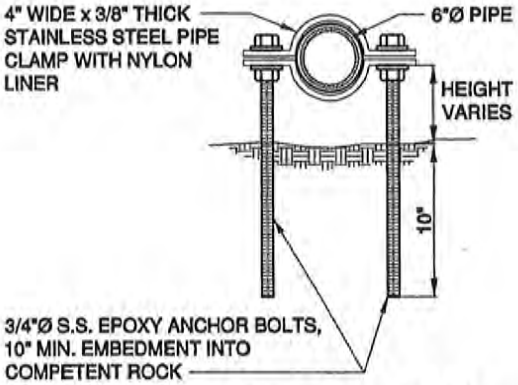
CONCRETE ANCHOR BLOCK SECTION VIEW

SCALE: 1" = 1'-0"



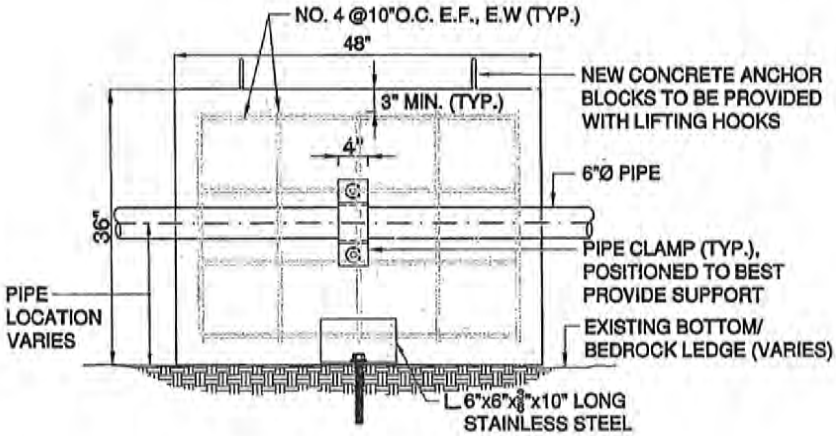
TYPICAL PIPE CLAMP PLAN VIEW

SCALE: 1" = 1'-0"



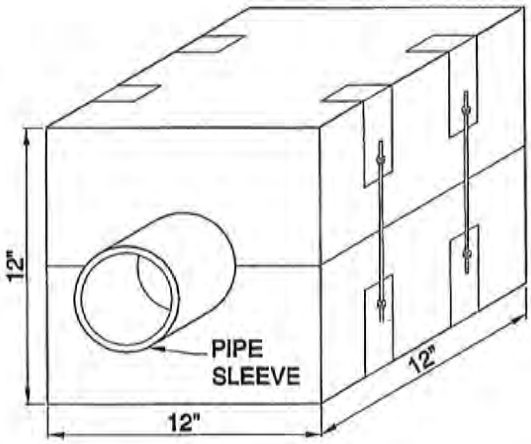
TYPICAL PIPE CLAMP SECTION

SCALE: 1" = 1'-0"



CONCRETE ANCHOR BLOCK ELEVATION VIEW

SCALE: 1" = 1'-0"



150 LB CONCRETE PIPE COLLAR

SCALE: 1 1/2" = 1'-0"

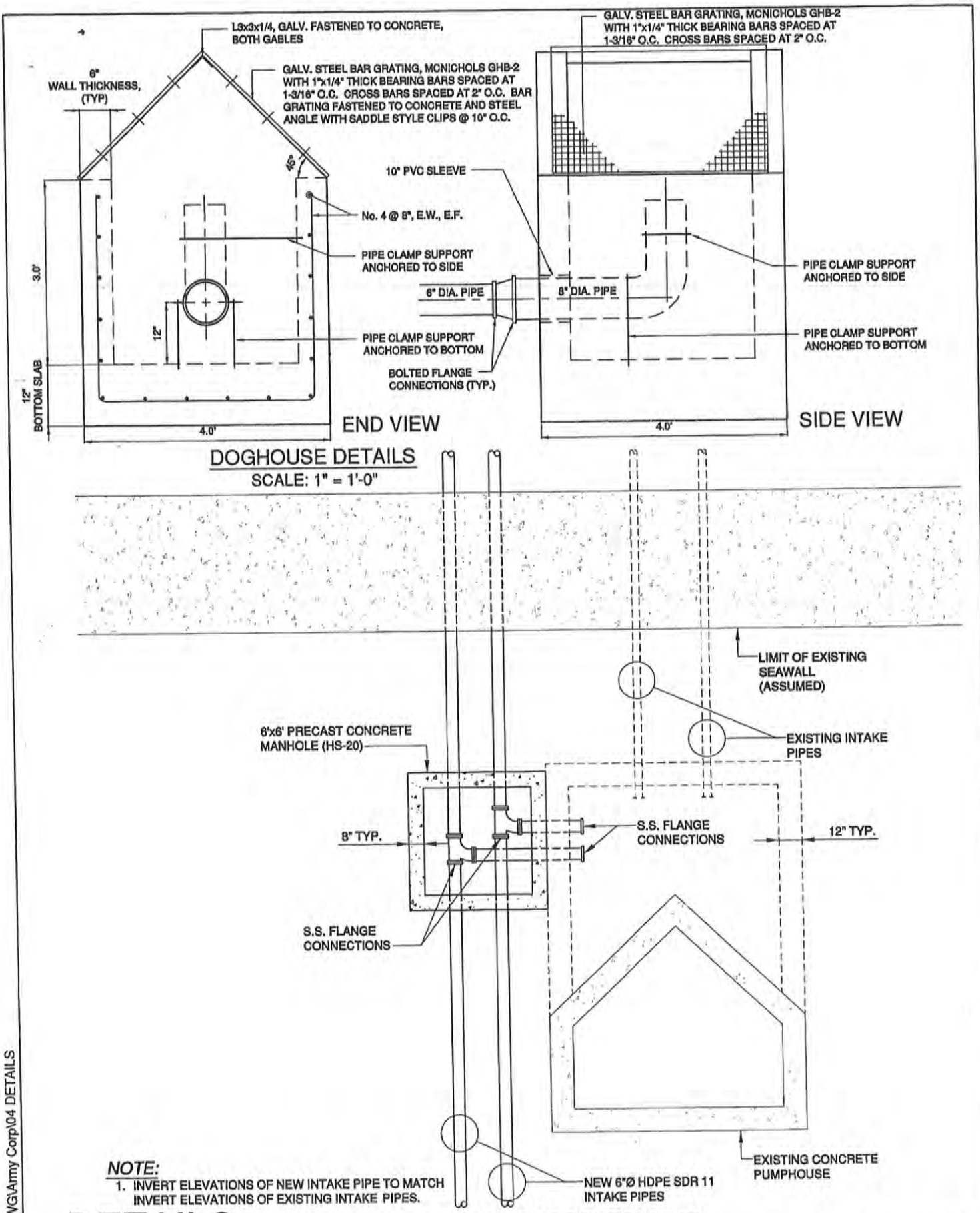
DETAILS

SCALE: AS NOTED

(REVISED 09/11/09)
SHEET 4 OF 5

08195.00\DWG\Army Corp\04 DETAILS

PARE CORPORATION



NOTE:

1. INVERT ELEVATIONS OF NEW INTAKE PIPE TO MATCH INVERT ELEVATIONS OF EXISTING INTAKE PIPES.

DETAILS

SCALE: AS NOTED

PUMPHOUSE PIPE PENETRATION
PLAN VIEW
SCALE: 3/16" = 1'-0"

(REVISED 09/11/09)
SHEET 5 OF 5

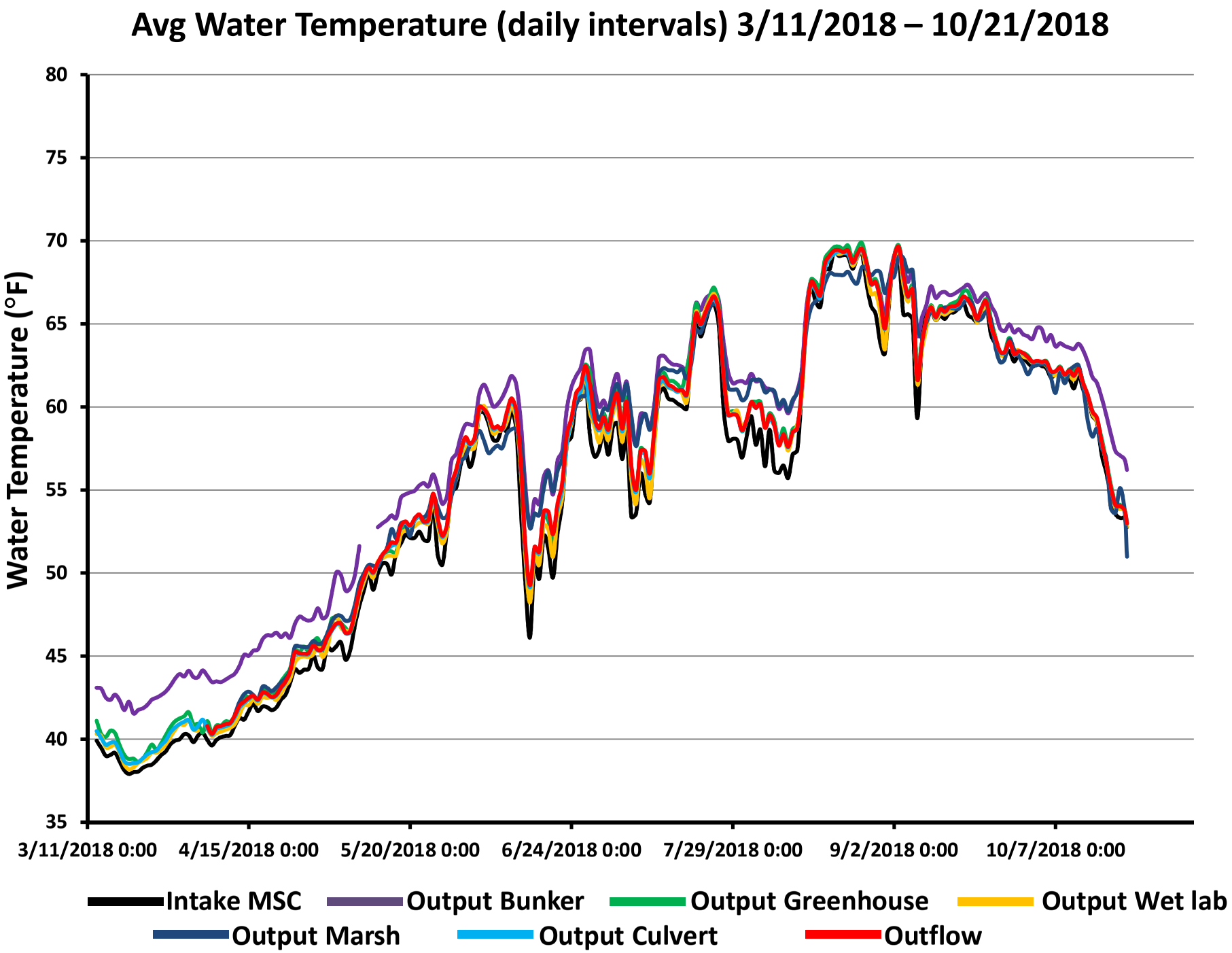
08195.00\DWG\Army Corp\04 DETAILS

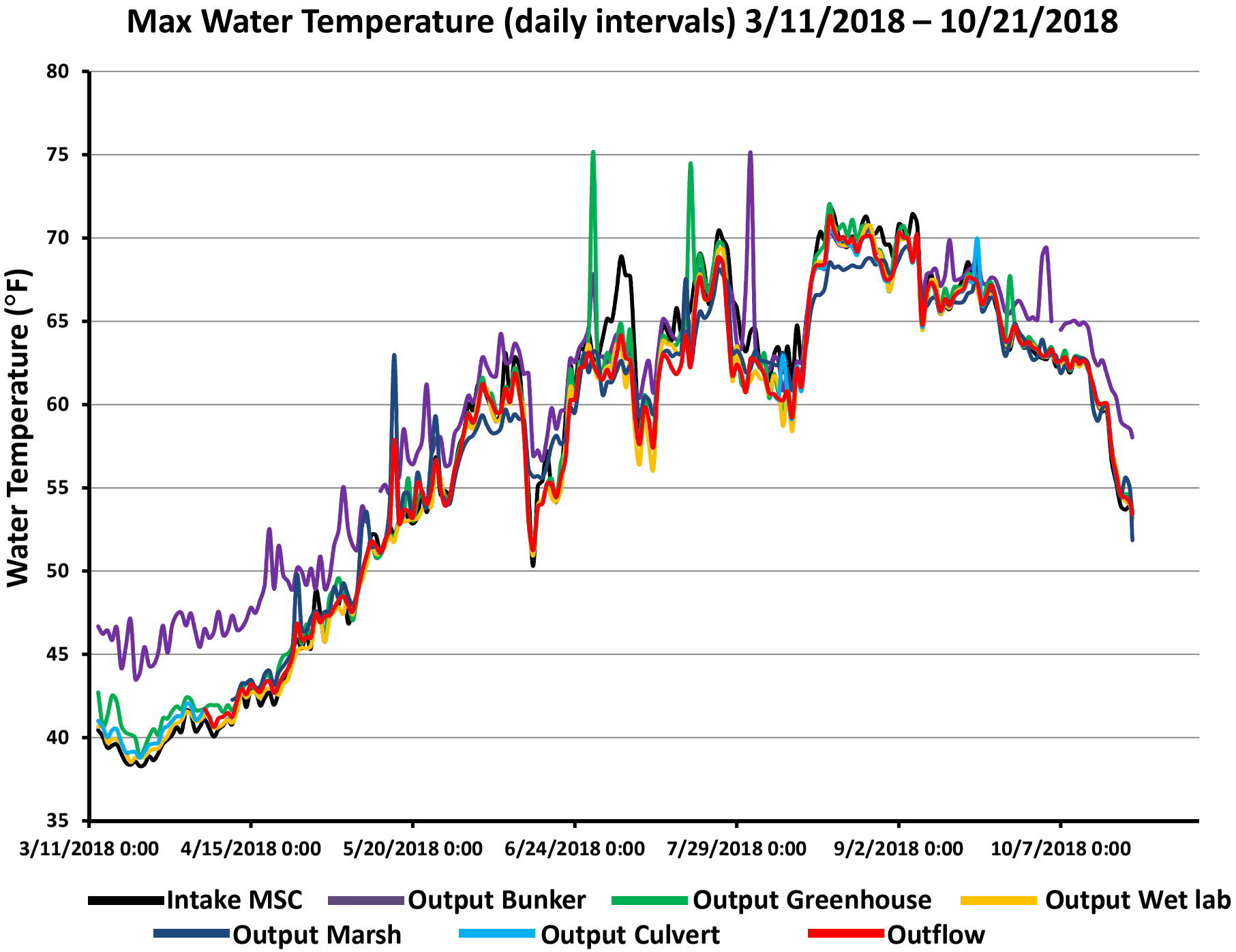
PARE CORPORATION

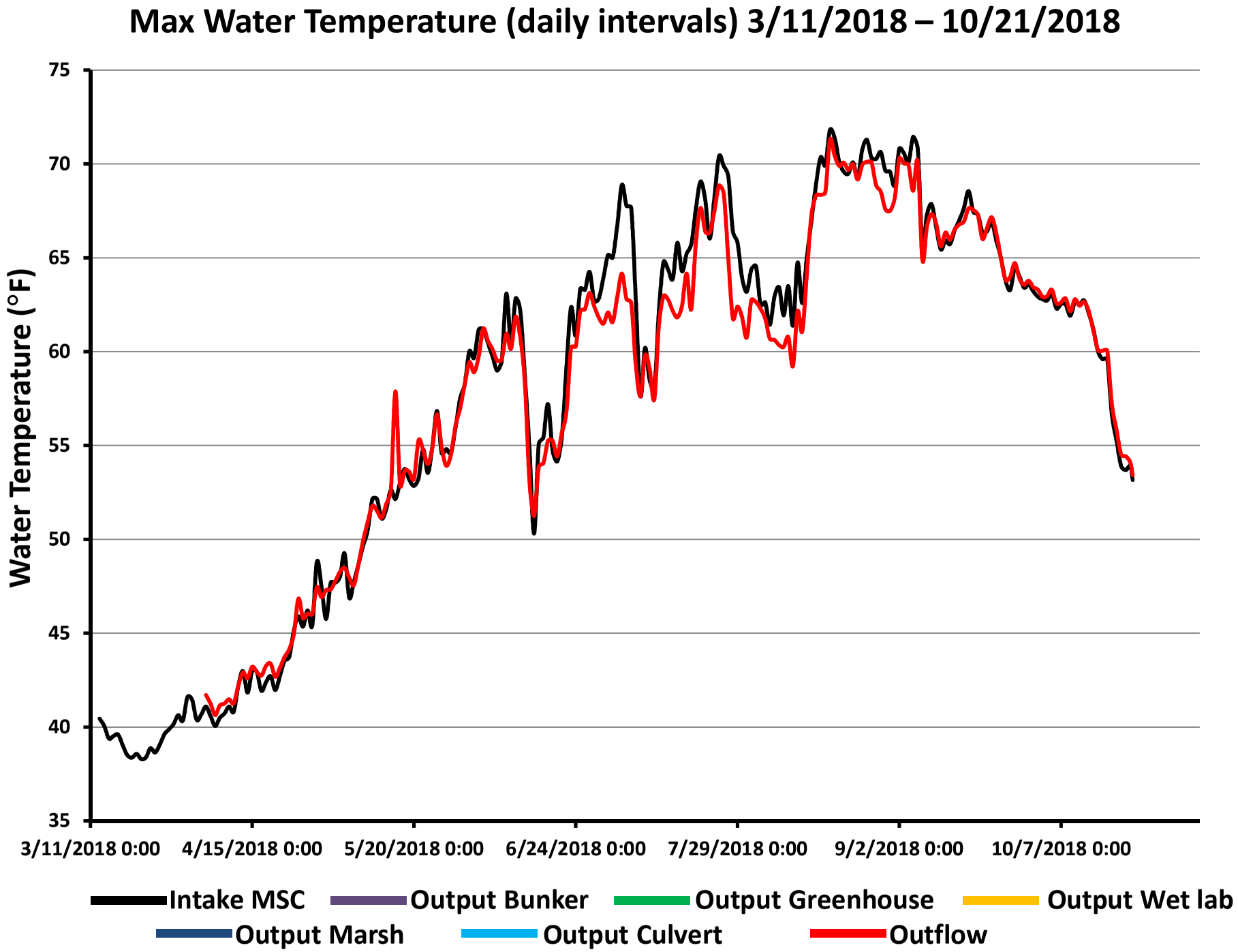
Proposed Seawater Intake Upgrade

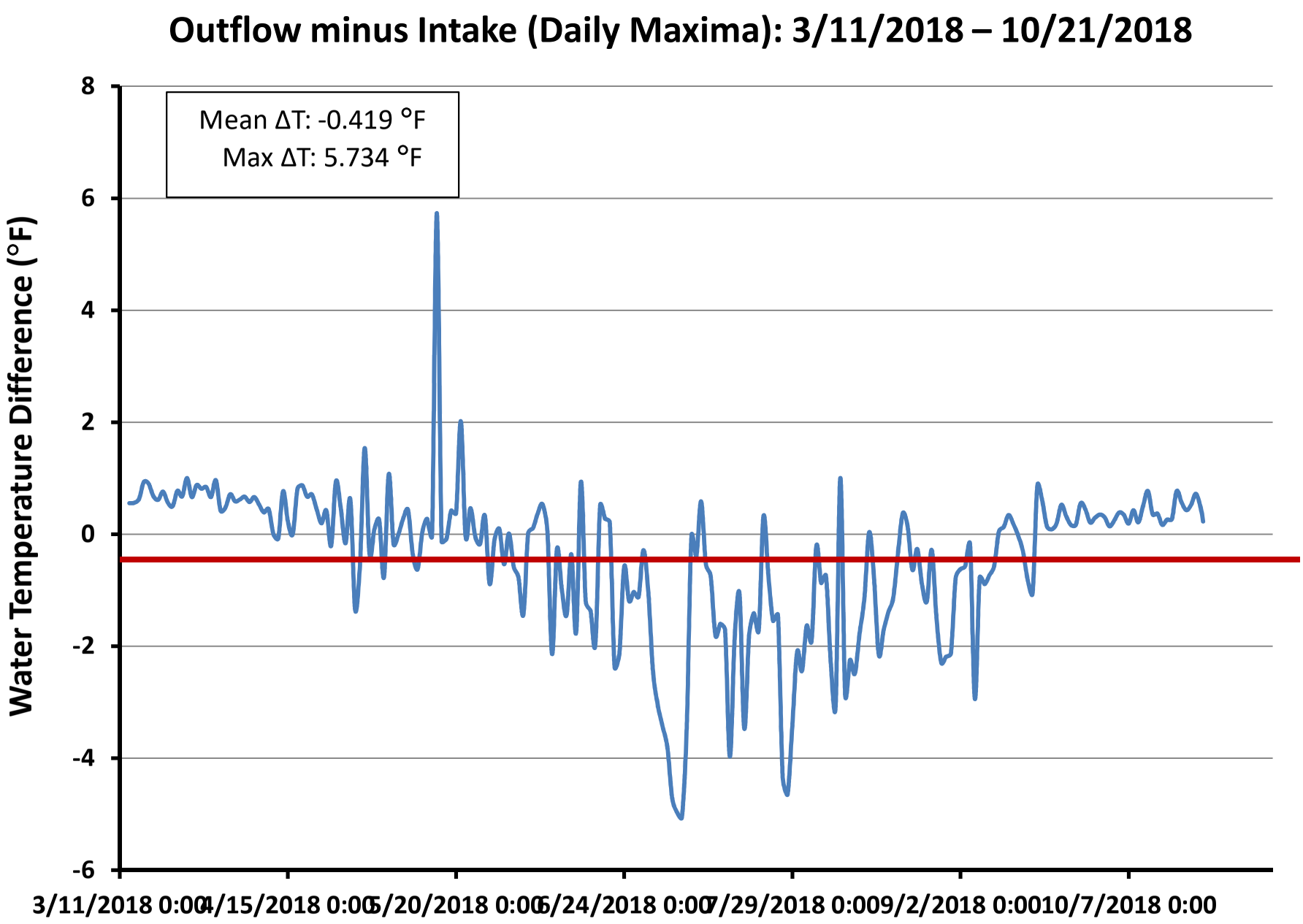
Data Tracking Update

Fall 2018

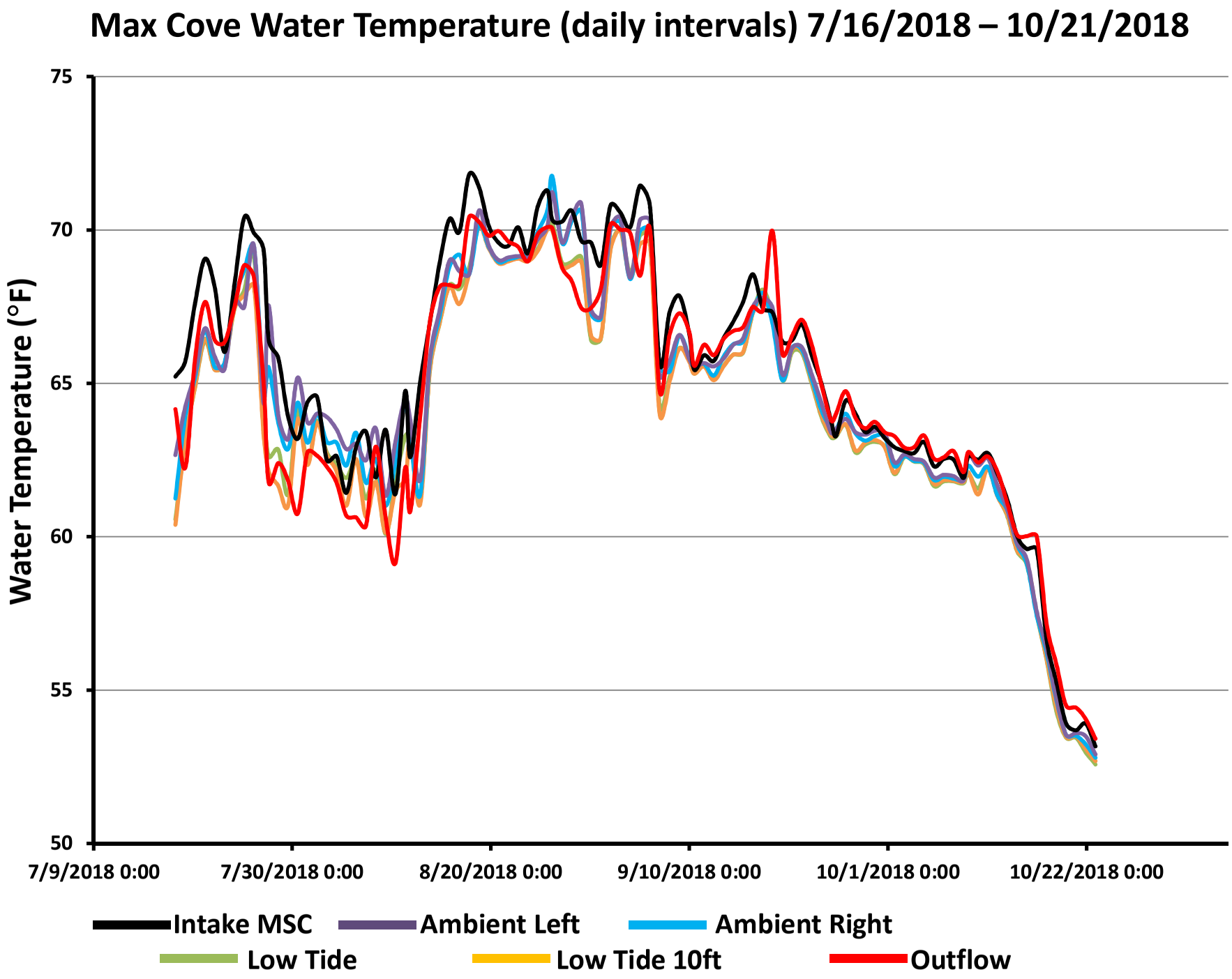

Avg Water Temperature (daily intervals) 3/11/2018 – 10/21/2018
Water Temperature (°F)
80
75
70
65
60
55
50
45
40
35
3/11/2018 0:00
4/15/2018 0:00
5/20/2018 0:00
6/24/2018 0:00
7/29/2018 0:00
9/2/2018 0:00
10/7/2018 0:00
Intake MSC
Output Bunker
Output Greenhouse
Output Wet lab
Output Marsh
Output Culvert
Outflow

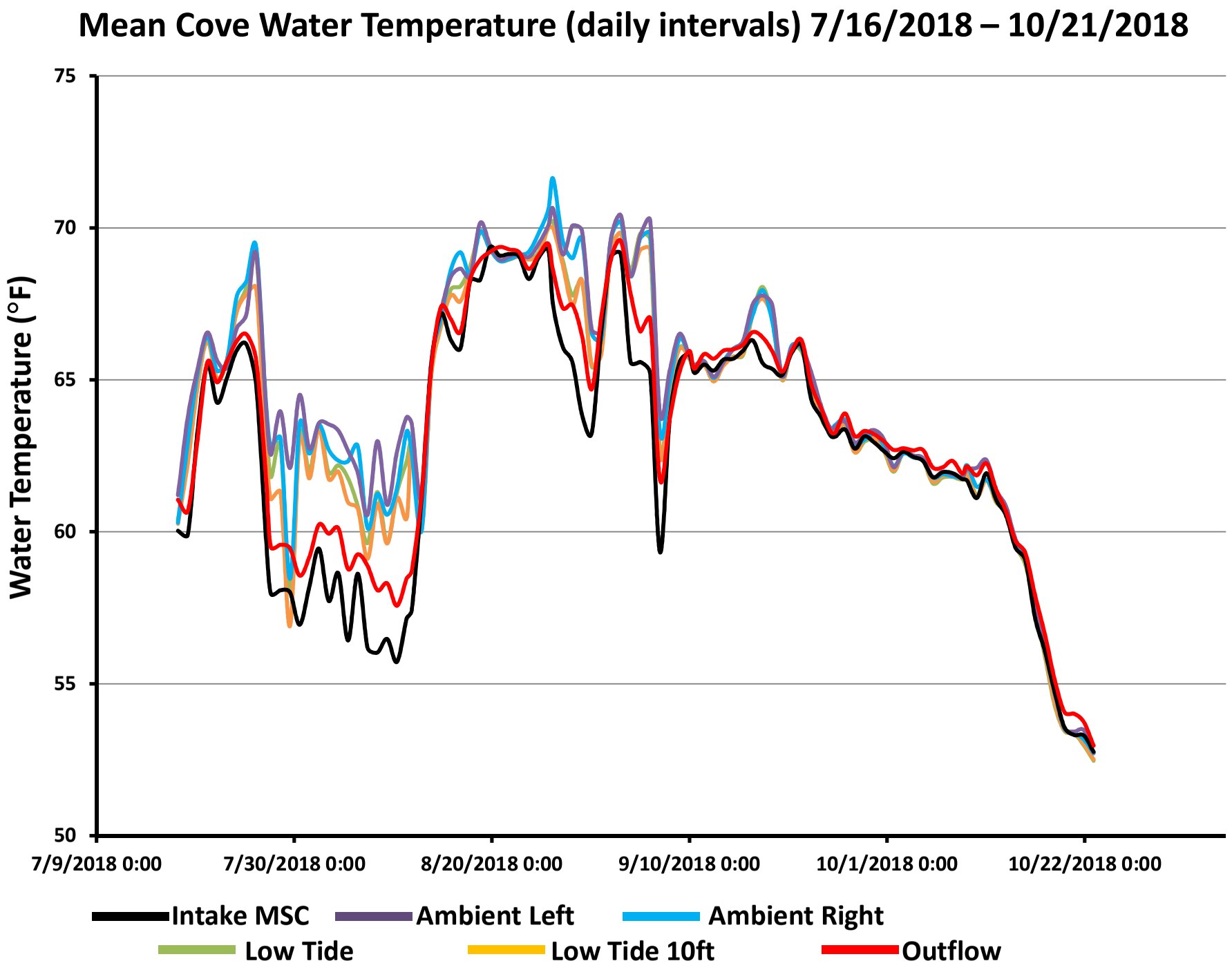

Max Water Temperature (daily intervals) 3/11/2018 – 10/21/2018
Water Temperature (°F)
80
75
70
65
60
55
50
45
40
35
3/11/2018 0:00
4/15/2018 0:00
5/20/2018 0:00
6/24/2018 0:00
7/29/2018 0:00
9/2/2018 0:00
10/7/2018 0:00
Intake MSC
Output Bunker
Output Greenhouse
Output Wet lab
Output Marsh
Output Culvert
Outflow

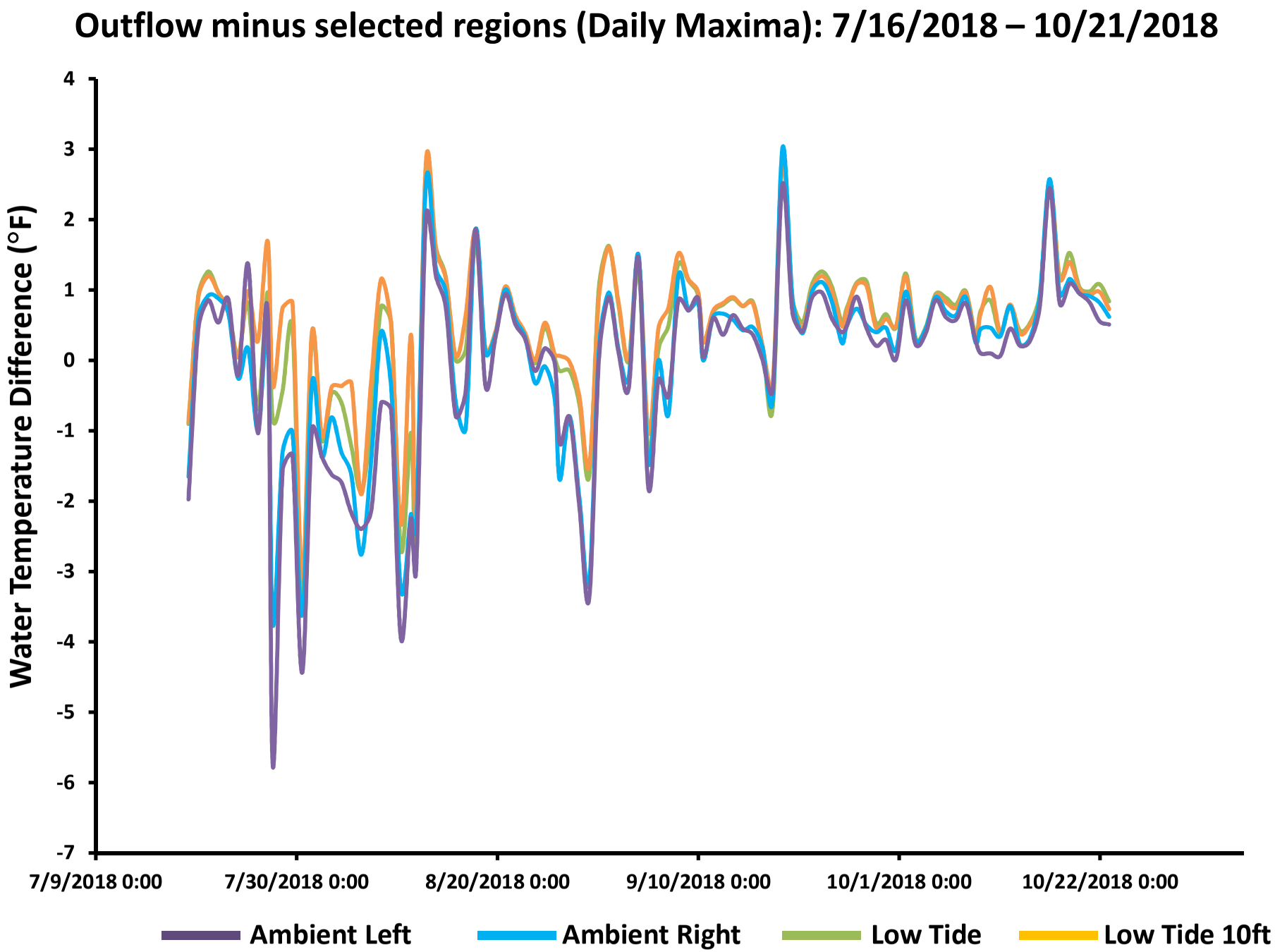

Max Water Temperature (daily intervals) 3/11/2018 – 10/21/2018
Water Temperature (°F)
75
70
65
60
55
50
45
40
35
3/11/2018 0:00
4/15/2018 0:00
5/20/2018 0:00
6/24/2018 0:00
7/29/2018 0:00
9/2/2018 0:00
10/7/2018 0:00
Intake MSC
Output Bunker
Output Greenhouse
Output Wet lab
Output Marsh
Output Culvert
Outflow


Outflow minus Intake (Daily Maxima): 3/11/2018 – 10/21/2018
Mean ΔT: -0.419 °F
Max ΔT: 5.734 °F
Water Temperature Difference (°F)
8
6
4
2
0
-2
-4
-6
3/11/2018 0:00
4/15/2018 0:00
5/20/2018 0:00
6/24/2018 0:00
7/29/2018 0:00
9/2/2018 0:00
10/7/2018 0:00

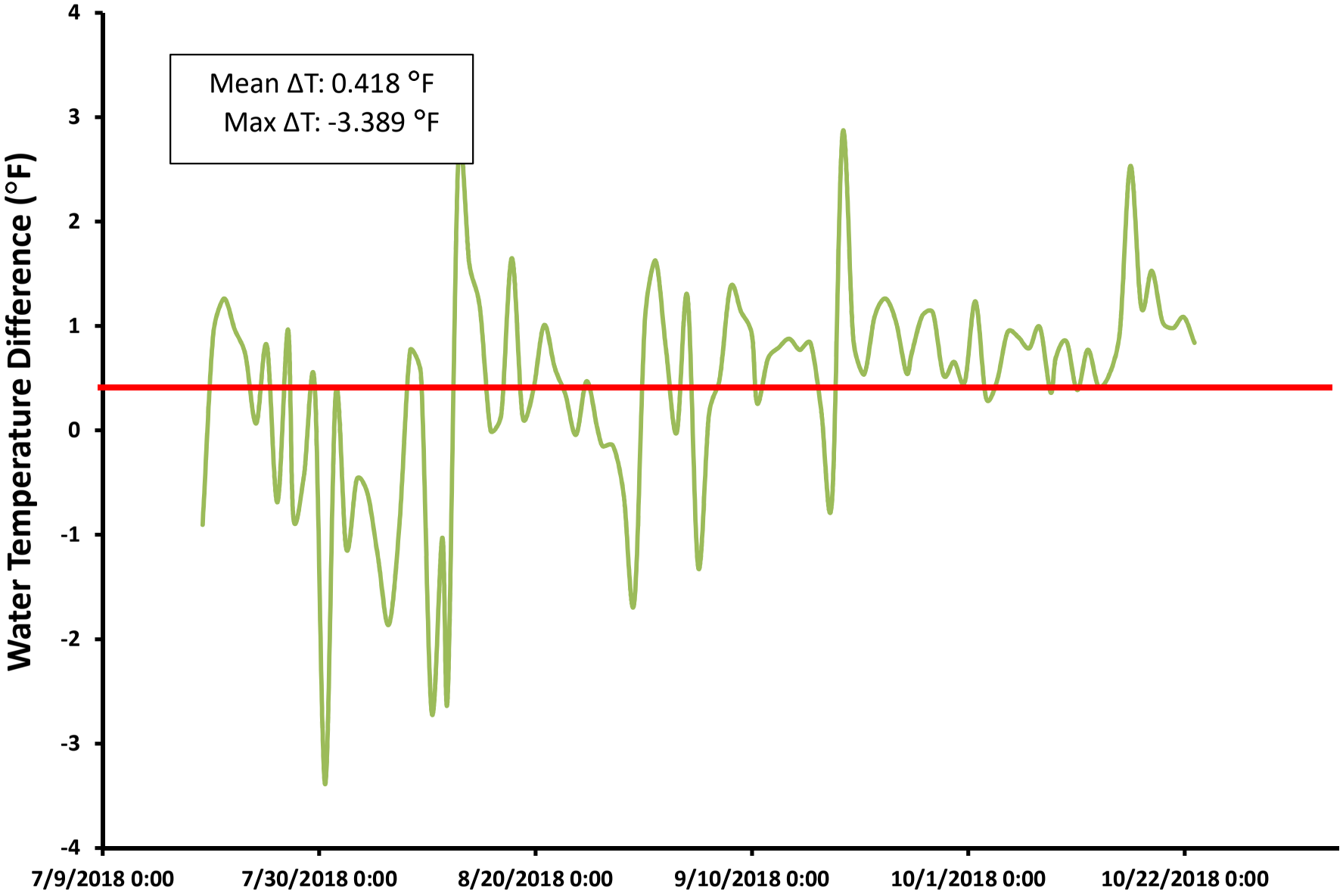
Swallow Cove
Battery 206
Great Egg
Existing Outfall
Ambient Left
Low Tide
Low Tide 10ft
Ambient Right
Existing Intake
Locations of additional temperature probes requested by the EPA
219.0661
649.7078
750.1069
Pea Island
Shag Rocks
Google


Max Cove Water Temperature (daily intervals) 7/16/2018 – 10/21/2018
Water Temperature (°F)
75
70
65
60
55
50
7/9/2018 0:00
7/30/2018 0:00
8/20/2018 0:00
9/10/2018 0:00
10/1/2018 0:00
10/22/2018 0:00
Intake MSC
Ambient Left
Ambient Right
Low Tide
Low Tide 10ft
Outflow

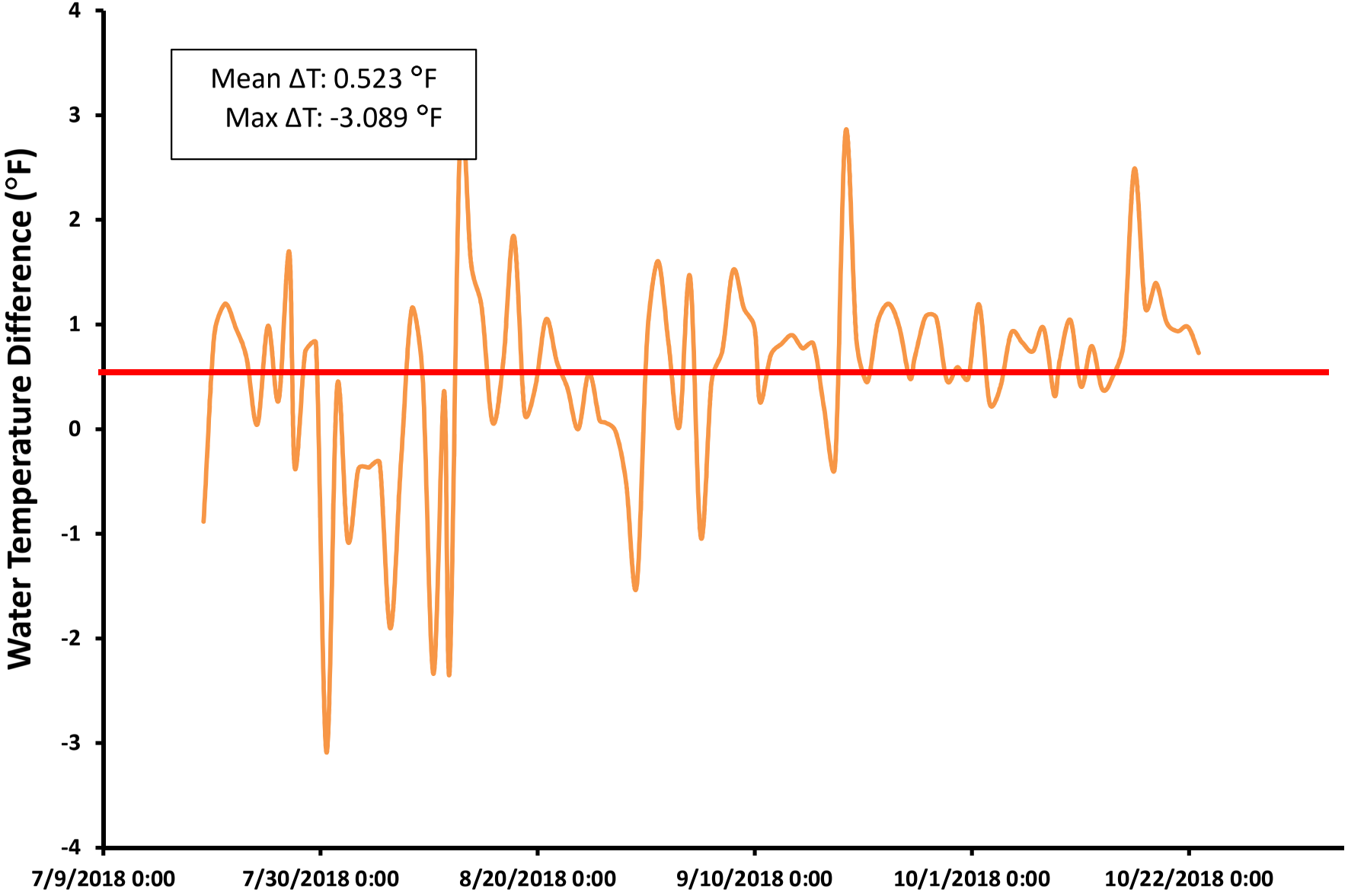

Mean Cove Water Temperature (daily intervals) 7/16/2018 – 10/21/2018
Water Temperature (°F)
75
70
65
60
55
50
7/9/2018 0:00
7/30/2018 0:00
8/20/2018 0:00
9/10/2018 0:00
10/1/2018 0:00
10/22/2018 0:00
Intake MSC
Ambient Left
Ambient Right
Low Tide
Low Tide 10ft
Outflow


Outflow minus selected regions (Daily Maxima): 7/16/2018 – 10/21/2018
Water Temperature Difference (°F)
4
3
2
1
0
-1
-2
-3
-4
-5
-6
-7
7/9/2018 0:00
7/30/2018 0:00
8/20/2018 0:00
9/10/2018 0:00
10/1/2018 0:00
10/22/2018 0:00
Ambient Left
Ambient Right
Low Tide
Low Tide 10ft

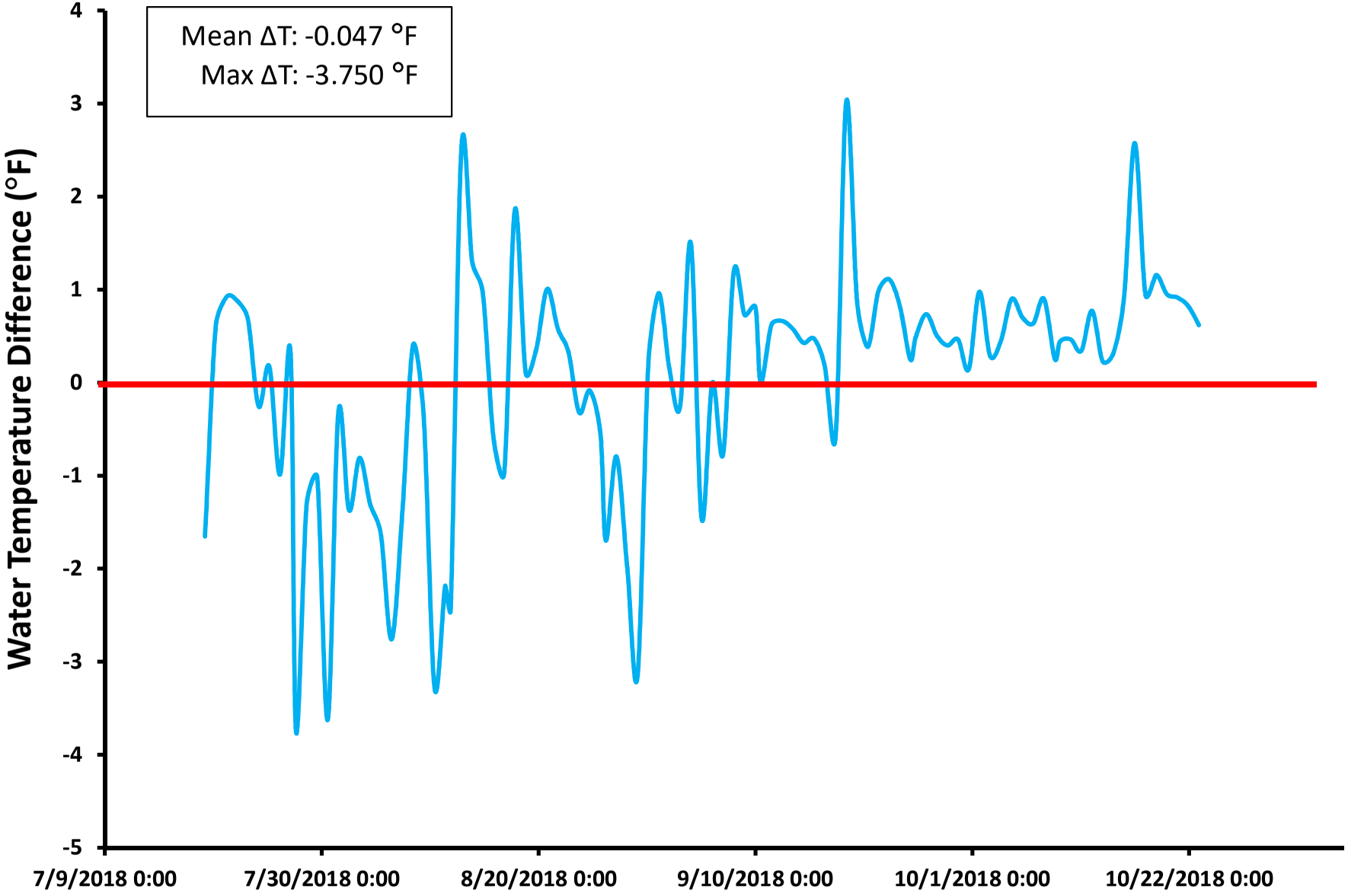
Outflow minus Low Tide "Region" (Daily Maxima): 7/16/2018 – 10/21/2018



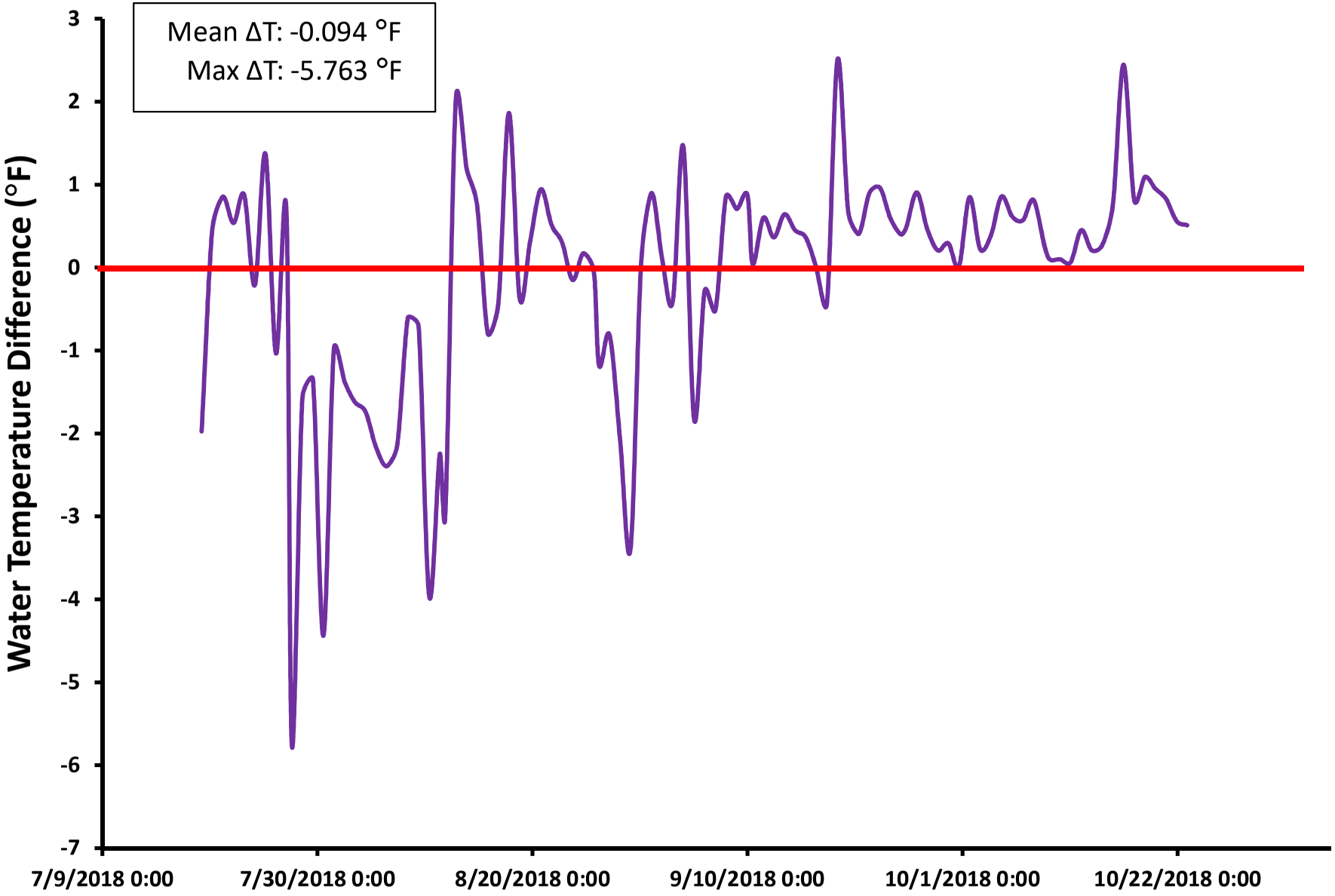
Outflow minus Low Tide 10ft "Region" (Daily Maxima): 7/16/2018 – 10/21/2018



Outflow minus Ambient Right "Region" (Daily Maxima): 7/16/2018 – 10/21/2018



Outflow minus Ambient Left "Region" (Daily Maxima): 7/16/2018 – 10/21/2018

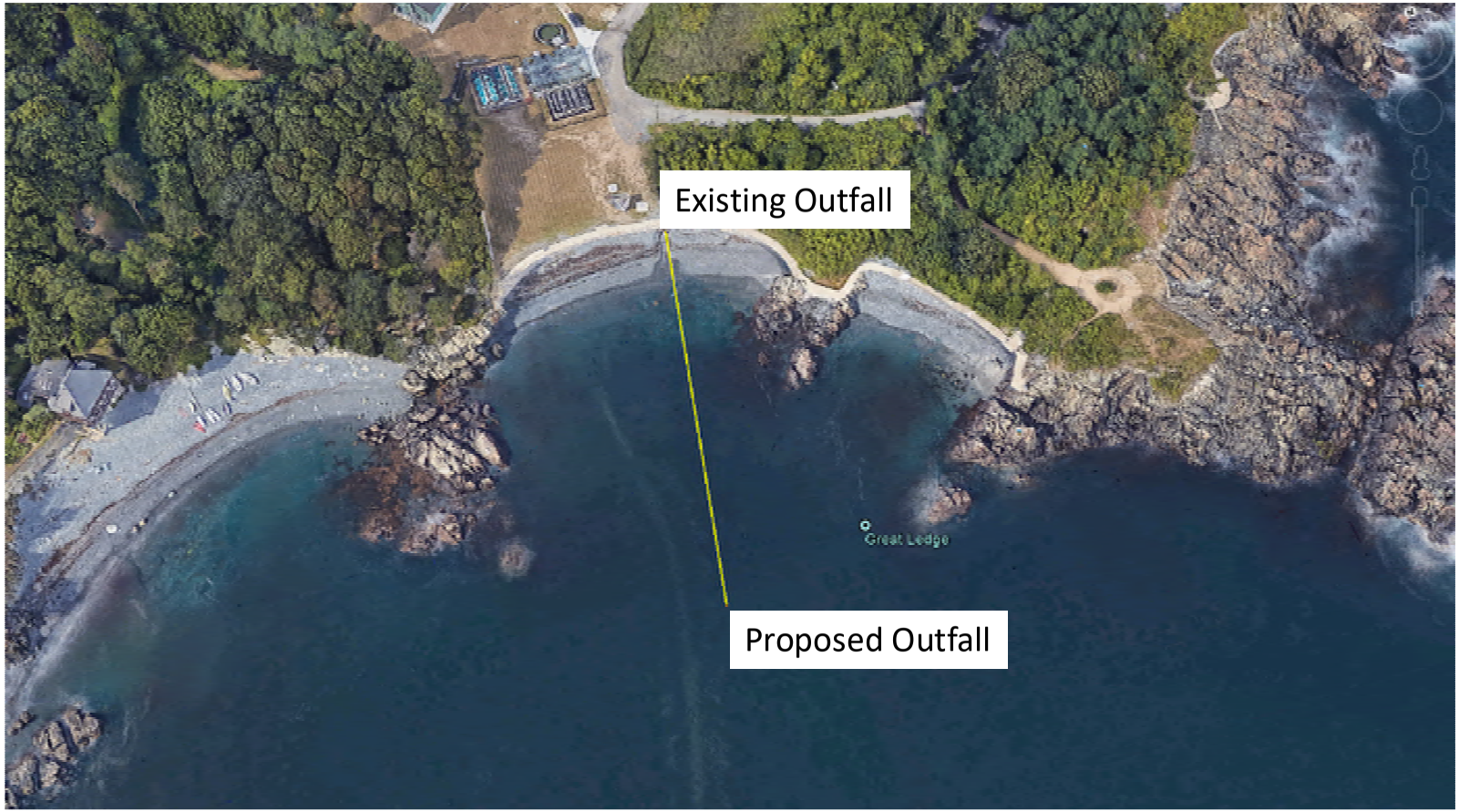


Proposed Seawater Intake Upgrade

Data Tracking Update

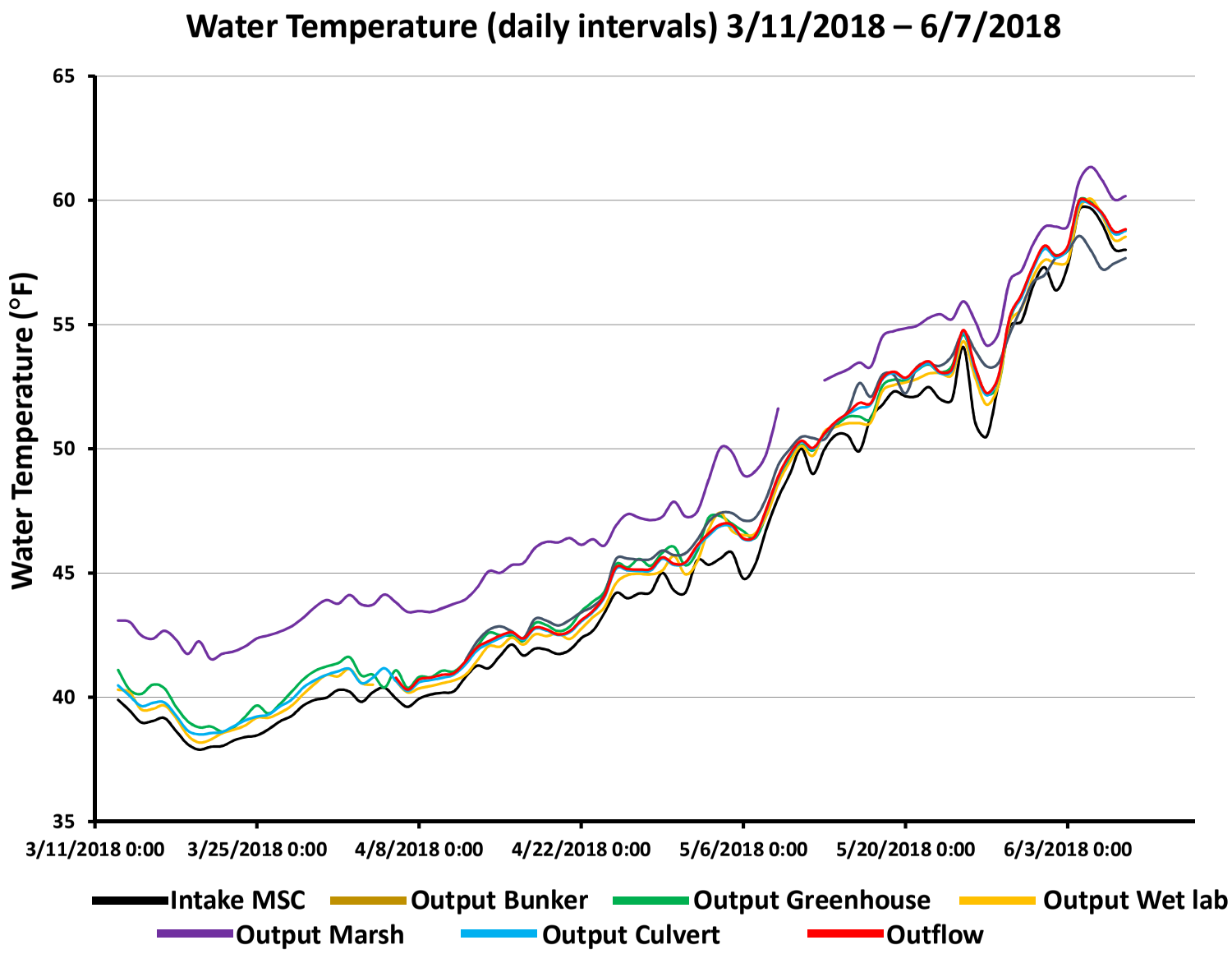
Summer 2018

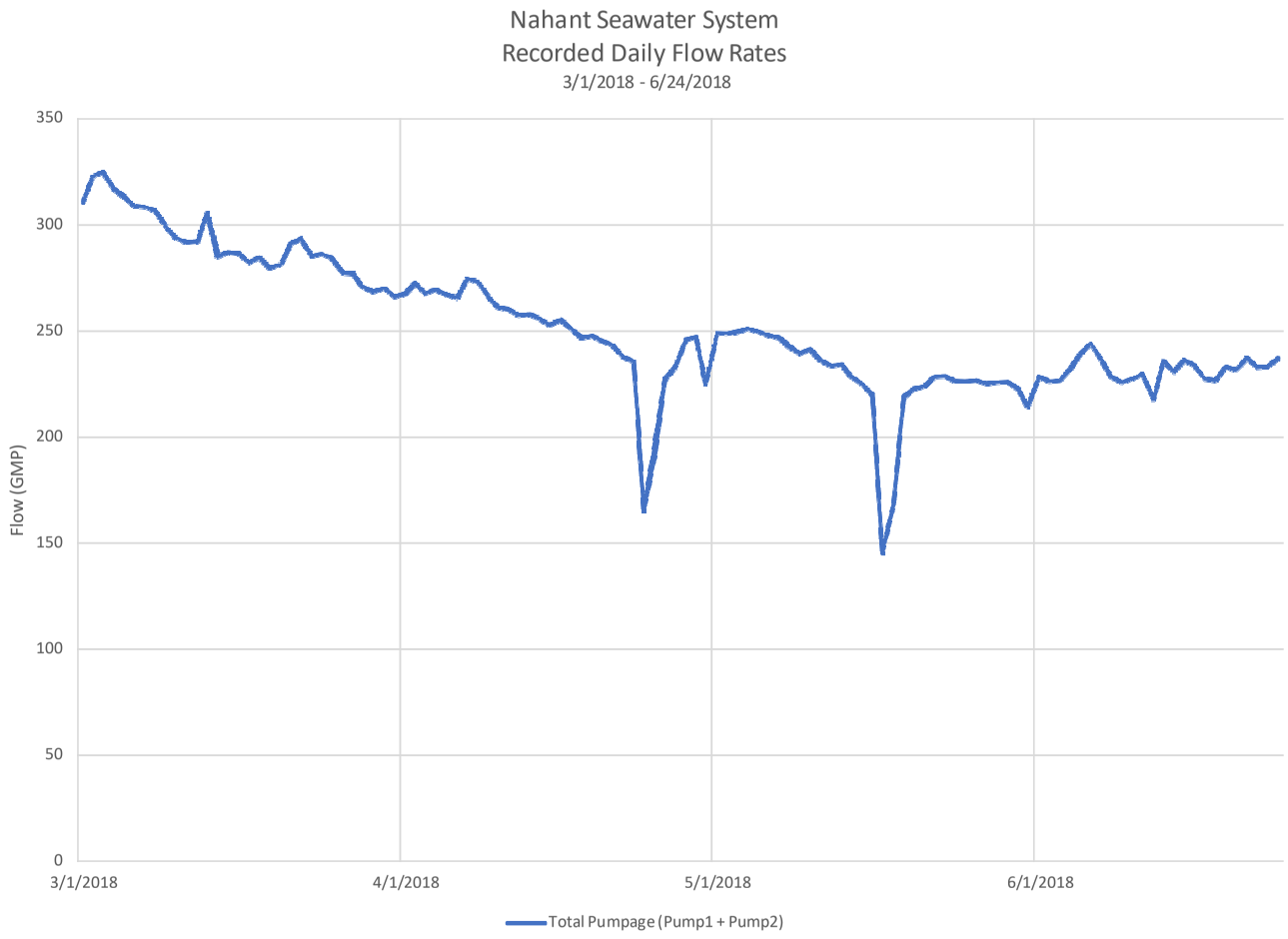
Outfall Location



Existing Conditions Data Collection

- Ambient Temperature taken at inlet of submerged intake pipe
- Flow Rate calculated from pump monitoring data
- Outflow temperature derived from 6 monitoring locations
- Data collected from March 1, 2018 to present Date
- Data collection to continue moving forward


Water Temperature (daily intervals) 3/11/2018 – 6/7/2018
Water Temperature (°F)
65
60
55
50
45
40
35
3/11/2018 0:00
3/25/2018 0:00
4/8/2018 0:00
4/22/2018 0:00
5/6/2018 0:00
5/20/2018 0:00
6/3/2018 0:00
Intake MSC
Output Bunker
Output Greenhouse
Output Wet lab
Output Marsh
Output Culvert
Outflow


Nahant Seawater System
Recorded Daily Flow Rates
3/1/2018 - 6/24/2018
Flow (GMP)
350
300
250
200
150
100
50
0
3/1/2018
4/1/2018
5/1/2018
6/1/2018
Total Pumpage (Pump1 + Pump2)

Existing Conditions Data Analysis

- Recorded 3/1/18 to 6/24/18
  - Average flow rate = 248 GPM (mean) 252 (median)
  - Average temp delta = 0.367 deg F

- Using these parameters, the CORMIX modeling program was unable to produce results based on the negligible effects within the Near Field Region.

Delta T Modeling Exercises

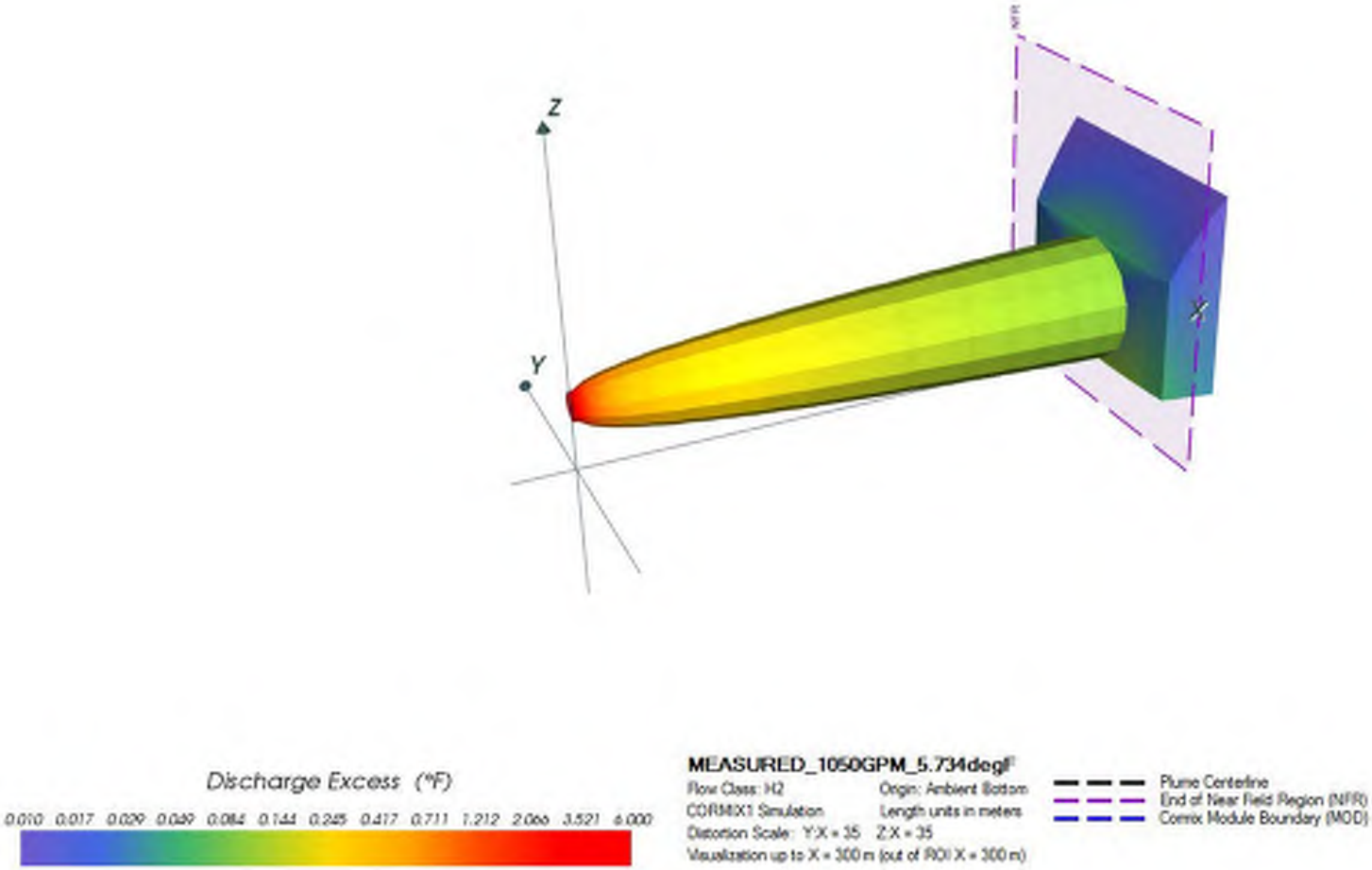
Theoretical Worst Case Scenario

Using max recorded flow rate and max delta T (not simultaneous)

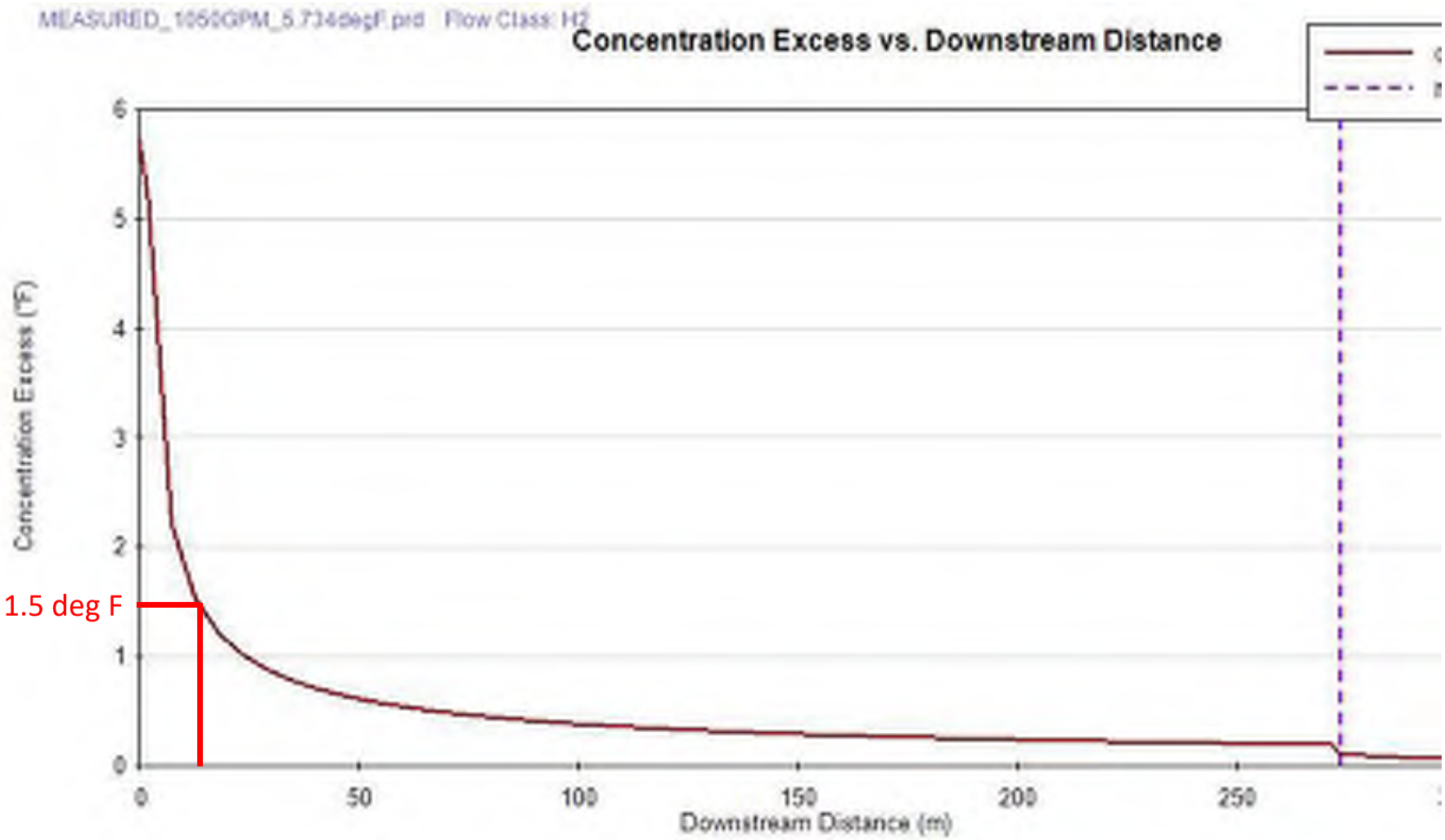
- Recorded:
  - Max hourly temp delta = 5.734 deg F (Recorded 5/1/18)
  - Max instant flow rate = 450 GPM (Recorded 3/15/18)

  Using these parameters, the CORMIX modeling program was also unable to produce results based on the negligible effects within the Near Field Region.

- Assumed for Modeling:
  - Flow rate = 1050 GPM (2.3x recorded instantaneous max flow rate)
    - This is the smallest allowable flow rate to produce the required 3.76 fps minimum CORMIX flow velocity
  - Single 16” ID outfall at proposed location
    - NOT at the seawall
  - Historical Average Ambient Temp
    - 43.4 deg F



The data recorded during our 10 month study could not register any measurable temperature plumes in the DEP / Industry Standard software (CORMIX). For the purposes of modeling, the maximum recorded flow rate of 450 GPM needed to be multiplied by a minimum of 2.3 times, to 1050 GMP in order to register on the model. Similarly, the temperature differential (delta T) was increased from the calculated average of 0.367 degrees F to the maximum instantiations recorded delta T of 5.734 degrees F in order to produce any measureable results in the model. It is also important to note, that the max flow of 450 GPM, and the max delta T were mutually exclusive data points, and never occurred simultaneously.



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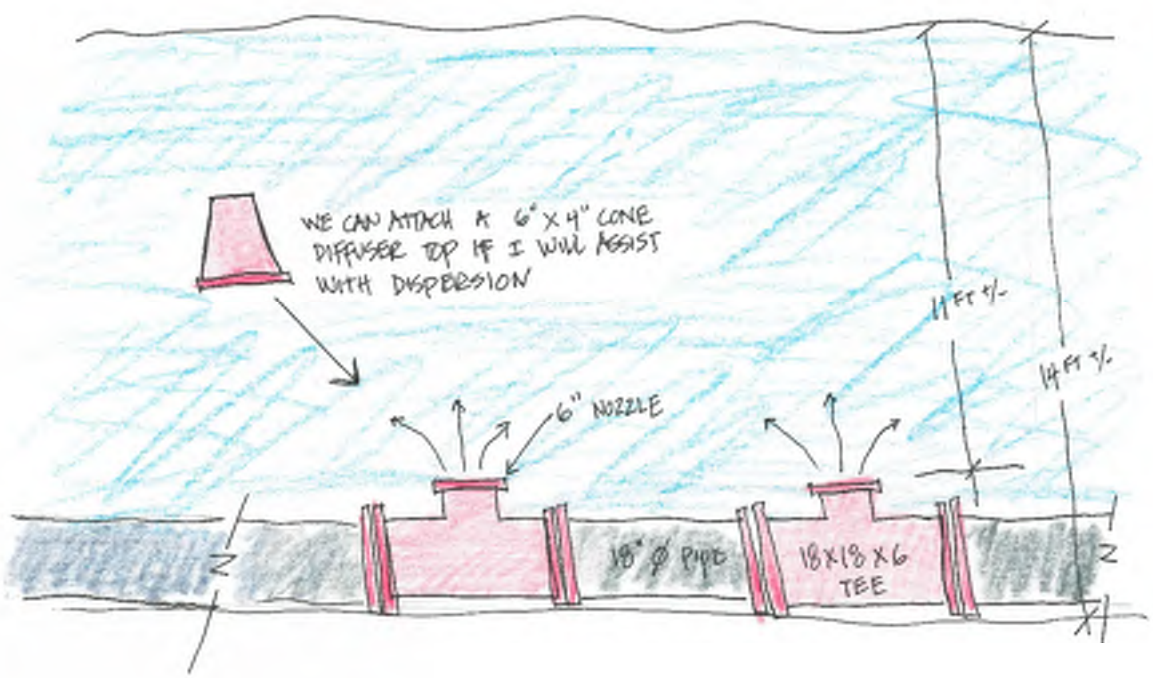
Proposed Configuration

- Submerged 3-port conical diffuser configuration
- Models run for 600, 1200, 1800 and 2400 GPM flow rates
- Proposed Delta T parameters determined by consulting seawater engineer based on current research load and input from researchers regarding future demand.

Summary of Results:

- Negligible effects illustrated in every configuration (< 0.1 deg F Delta T at diffuser nozzle)
- In comparison to EPA water quality standards for this area (max 1.5 deg F.)

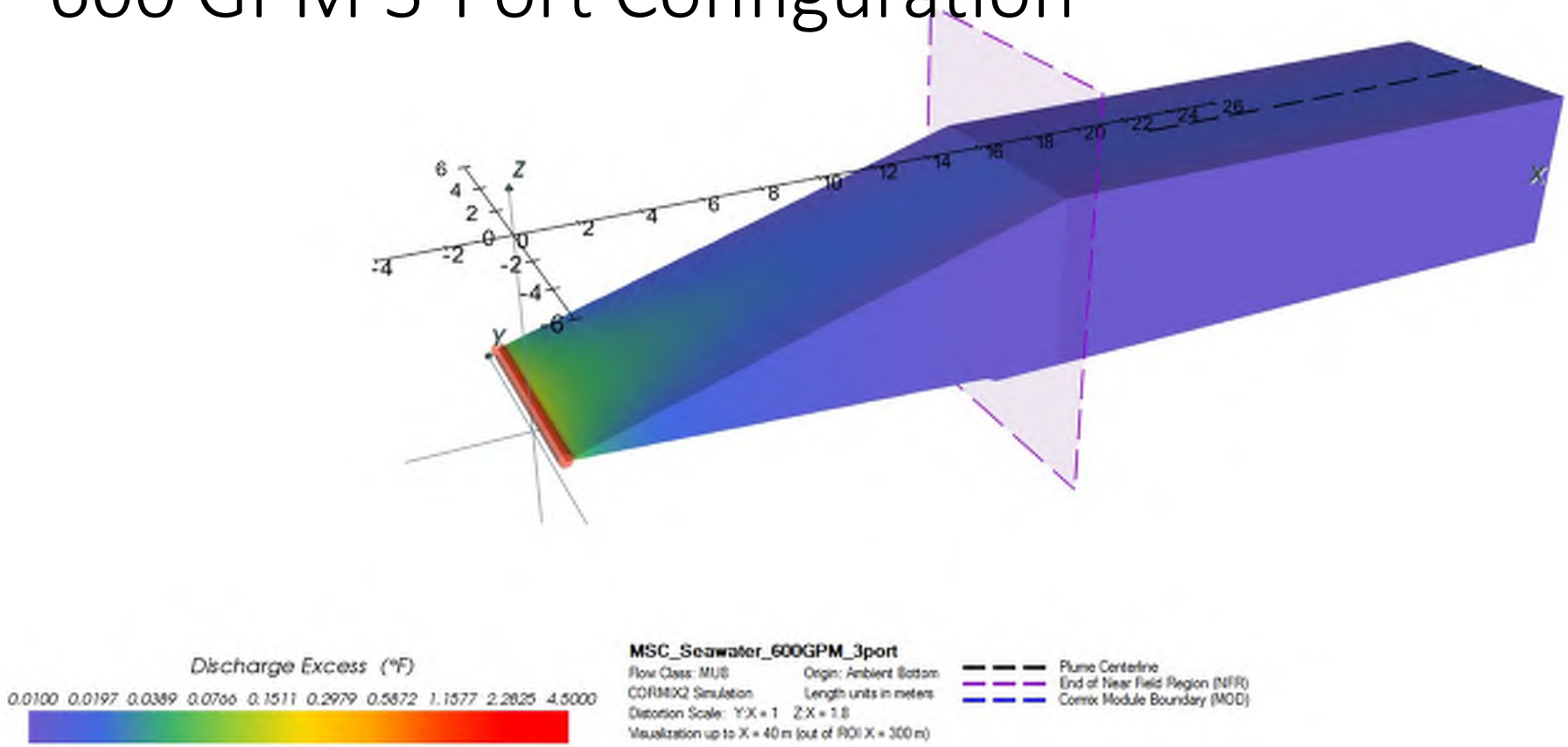
Outfall Concept



Future Proposed – Worst Case Scenario @ 600, 1200, 1800 and 2400GPM Projections

Month	Ambient Temp (F) °F	Total Flow Rate gpm	Delta From Ambient °F
January	41.4	600	4.0
February	38.8	600	4.5
March	38.8	600	4.5
April	43.2	600	3.6
May	48	600	2.7
June	58.1	600	0.7
July	65.8	600	-0.9
August	67.5	600	-1.2
September	63.9	600	-0.5
October	57.9	600	0.7
November	51.3	600	2.0
December	46.2	600	3.0

600 GPM 3-Port Configuration



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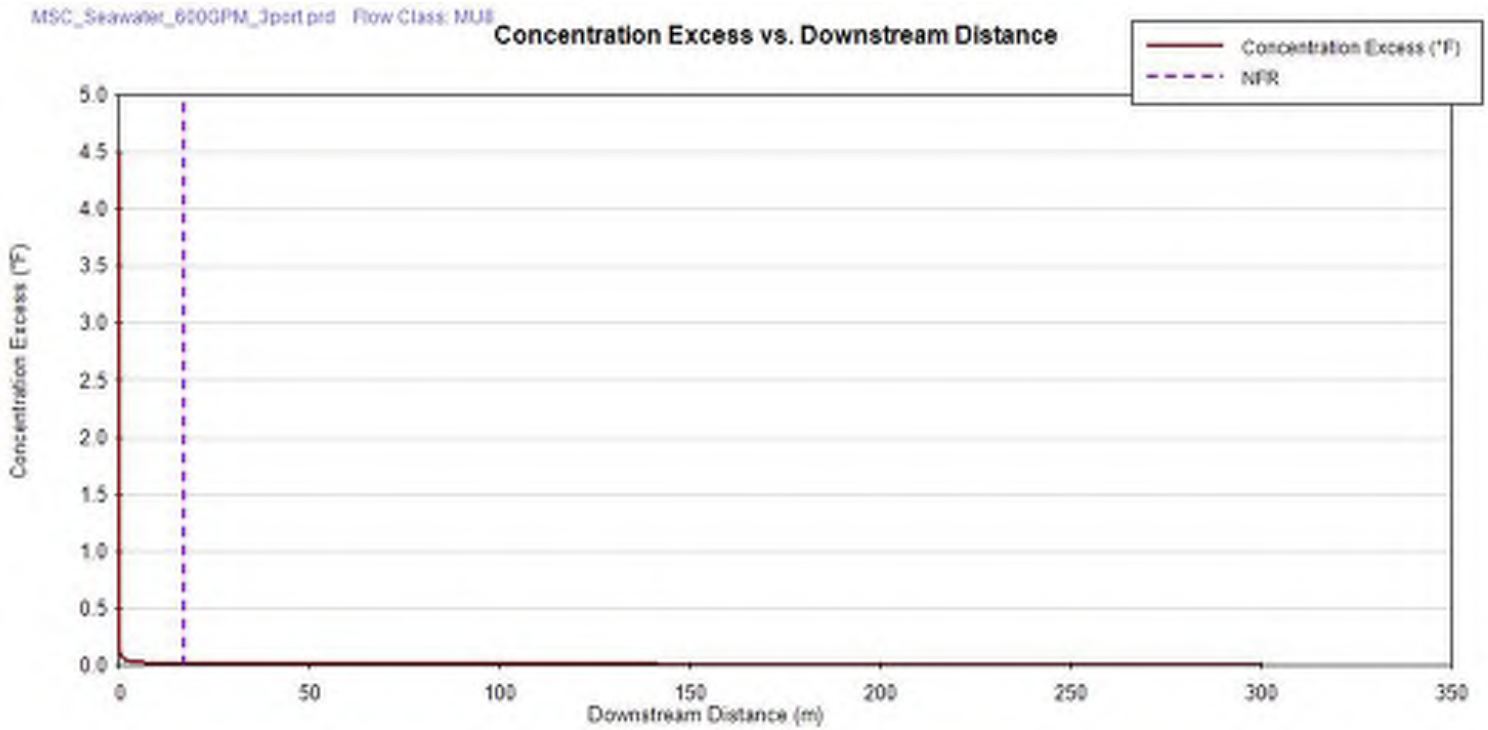
600 GPM 3-Port Configuration



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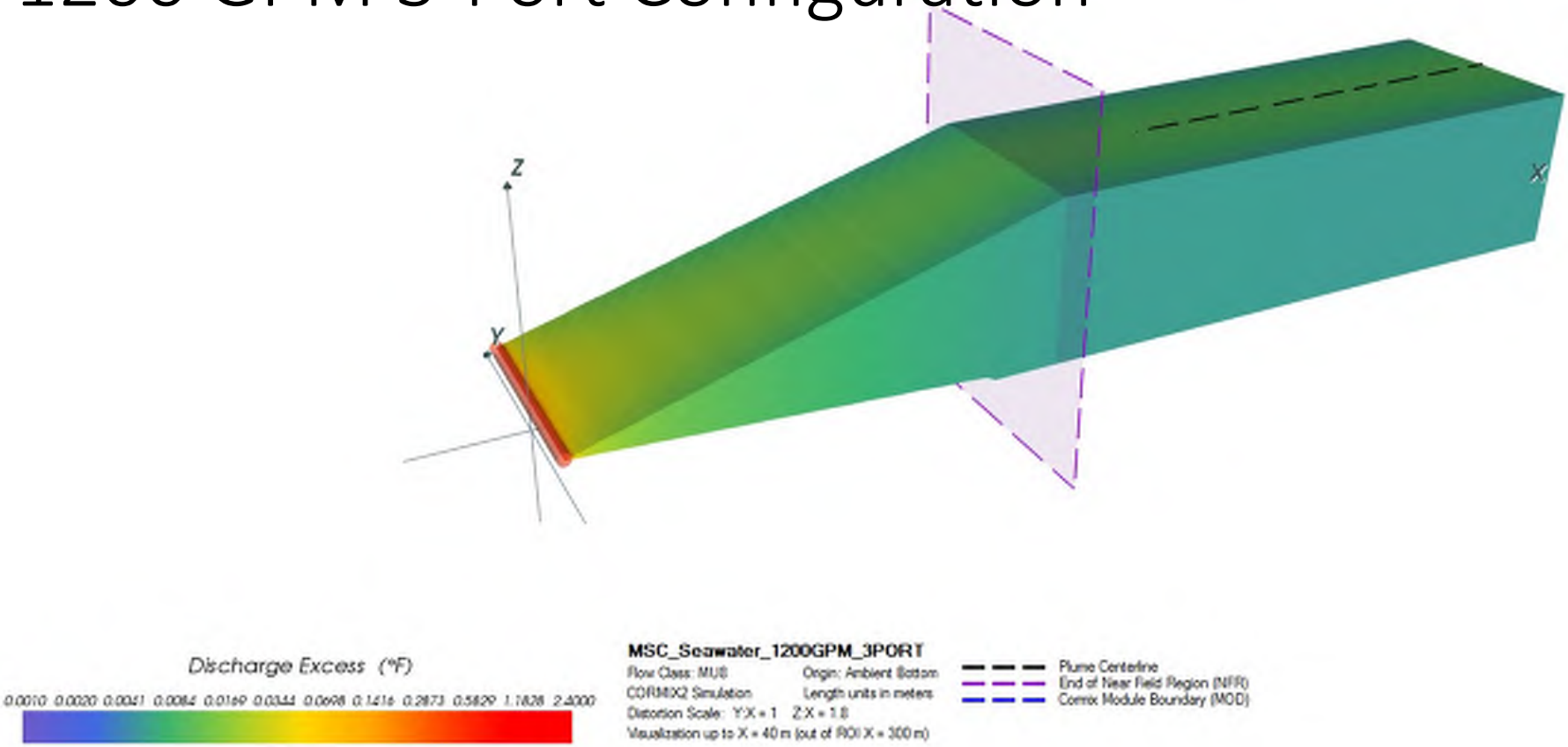
Modeled Scenario

Month	Ambient Temp (F) °F	Total Flow Rate gpm	Delta From Ambient °F
January	41.4	1,200	2.0
February	38.8	1,200	2.3
March	38.8	1,200	2.3
April	43.2	1,200	1.8
May	48	1,200	1.3
June	58.1	1,200	0.3
July	65.8	1,200	-0.4
August	67.5	1,200	-0.6
September	63.9	1,200	-0.3
October	57.9	1,200	0.4
November	51.3	1,200	1.0
December	46.2	1,200	1.5

1200 GPM 3-Port Configuration



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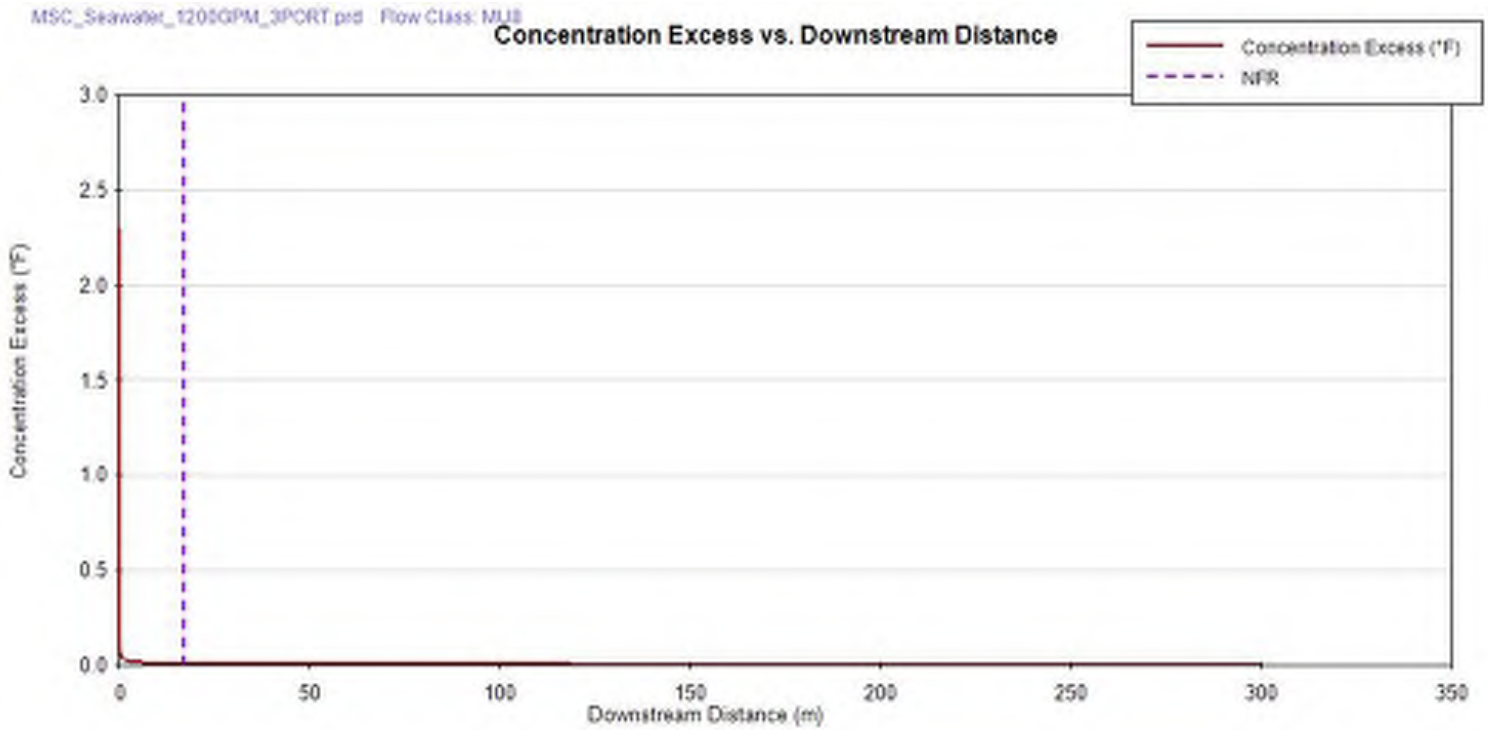
1200 GPM 3-Port Configuration



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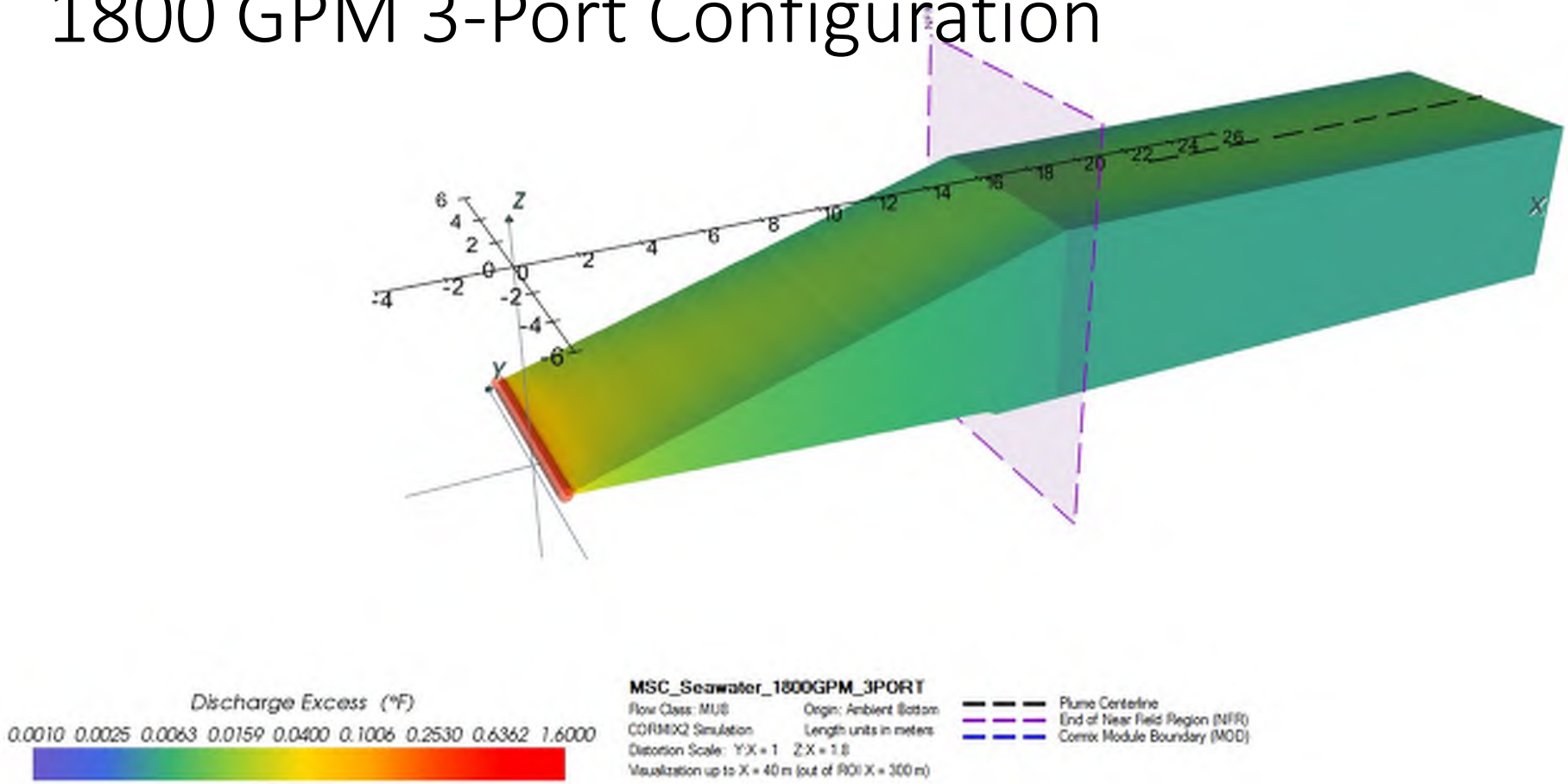
Modeled Scenario

Month	Ambient Temp (F) °F	Total Flow Rate gpm	Delta From Ambient °F
January	41.4	1,800	1.3
February	38.8	1,800	1.5
March	38.8	1,800	1.5
April	43.2	1,800	1.2
May	48	1,800	0.9
June	58.1	1,800	0.2
July	65.8	1,800	-0.3
August	67.5	1,800	-0.4
September	63.9	1,800	-0.2
October	57.9	1,800	0.2
November	51.3	1,800	0.7
December	46.2	1,800	1.0

1800 GPM 3-Port Configuration



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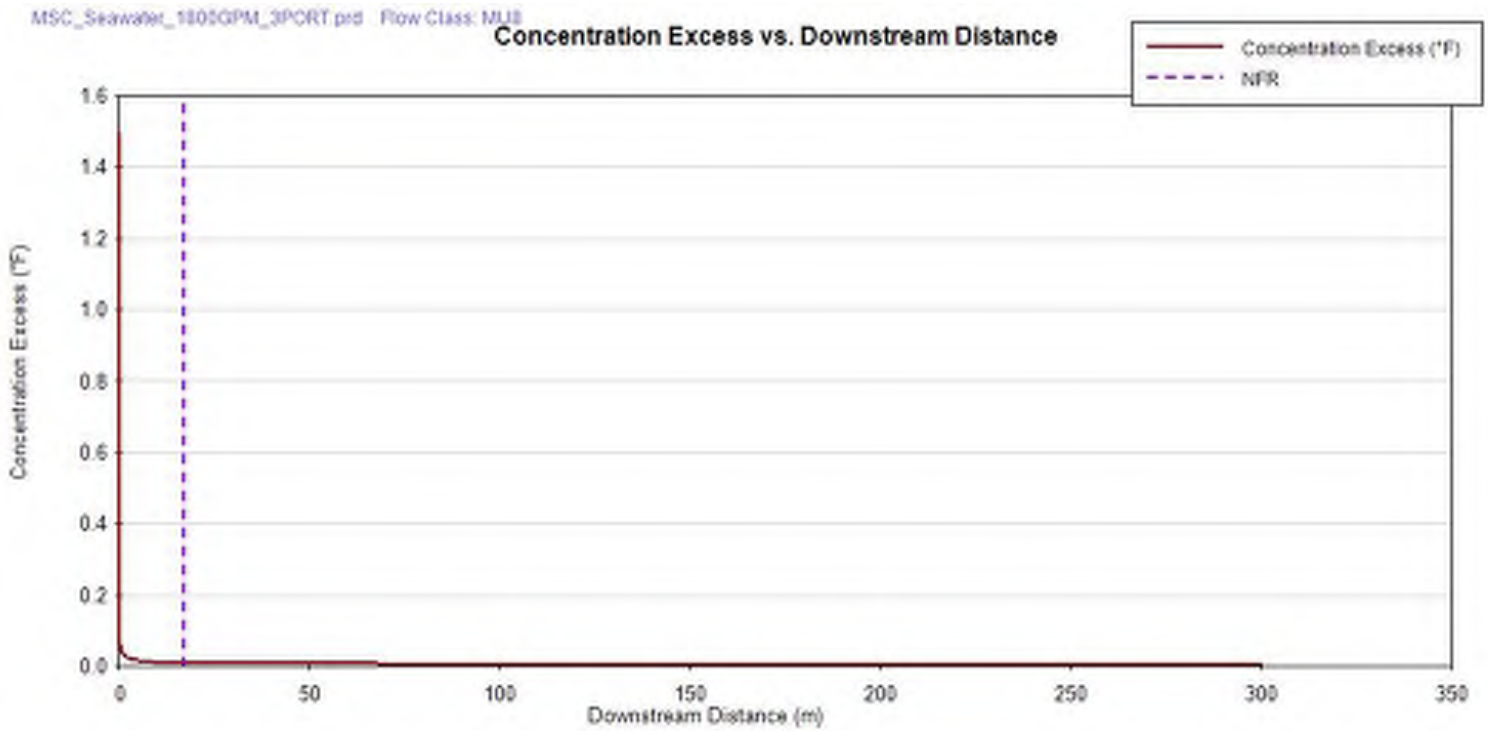
1800 GPM 3-Port Configuration



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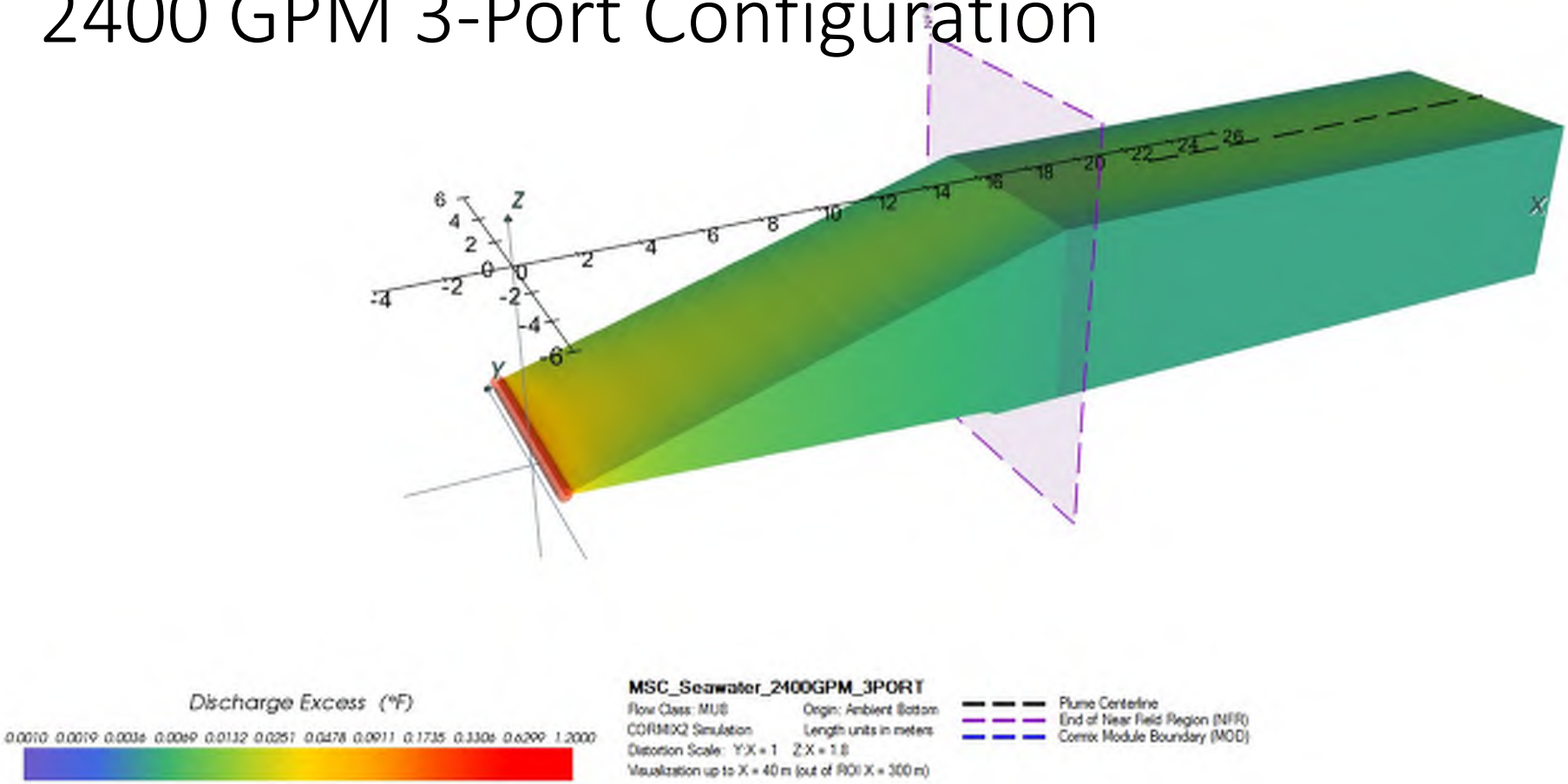
Modeled Scenario

Month	Ambient Temp (F) °F	Total Flow Rate gpm	Delta From Ambient °F
January	41.4	2,400	1.0
February	38.8	2,400	1.1
March	38.8	2,400	1.1
April	43.2	2,400	0.9
May	48	2,400	0.7
June	58.1	2,400	0.2
July	65.8	2,400	-0.2
August	67.5	2,400	-0.3
September	63.9	2,400	-0.1
October	57.9	2,400	0.2
November	51.3	2,400	0.5
December	46.2	2,400	0.8

2400 GPM 3-Port Configuration



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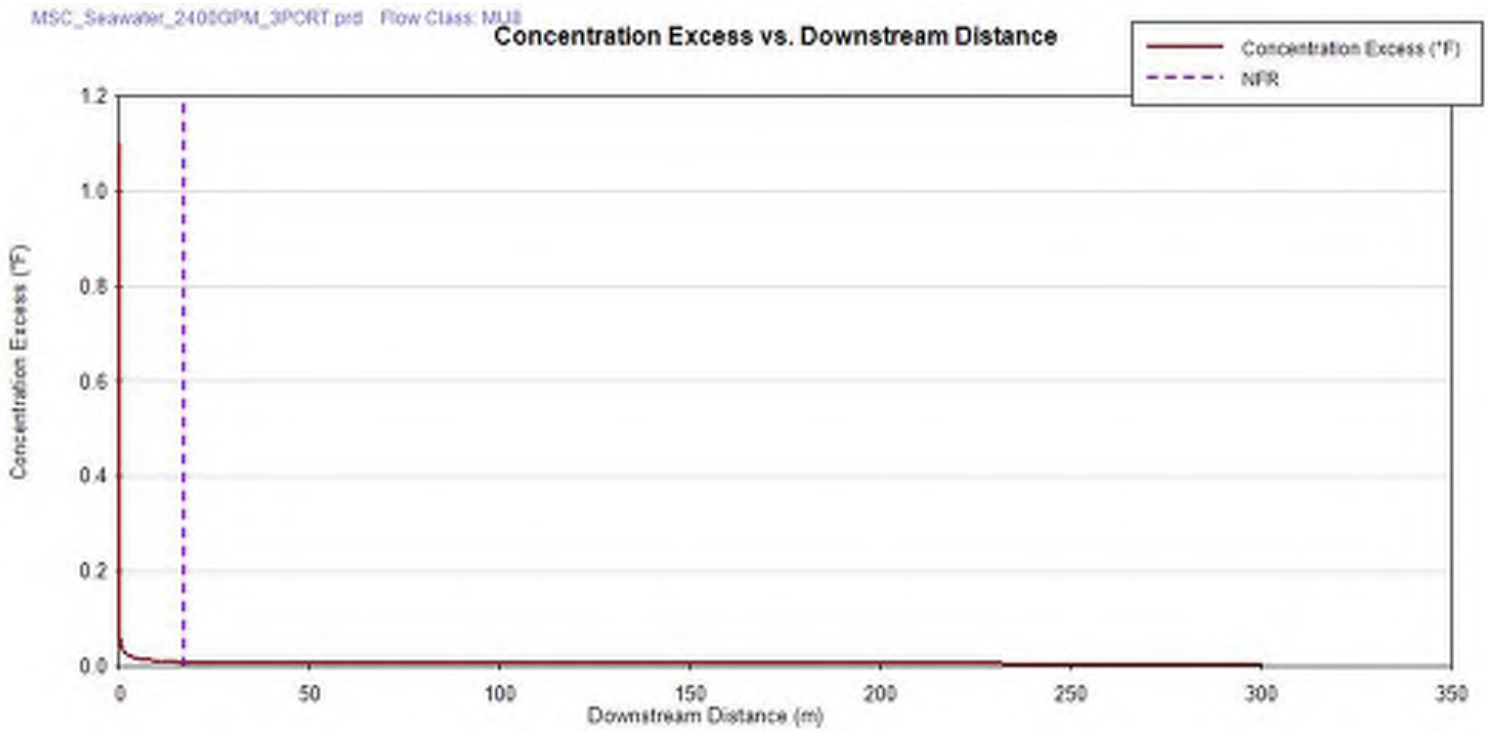
2400 GPM 3-Port Configuration



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Nitsch Engineering

Preliminary Traffic Impact Study
Existing Conditions

Northeastern University Marine Science Center

Nahant, MA

December 5, 2018

Prepared for:

Northeastern University
360 Huntington Avenue
Boston, MA 02115

Submitted by:

Nitsch Engineering
2 Center Plaza, Suite 430
Boston, MA 02108

Nitsch Engineering Project #12125.2

Building better communities with you.

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1 INTRODUCTION

Nitsch Engineering has been retained by Northeastern University in partnership with the Town of Nahant to prepare a Traffic Impact Study for the proposed expansion of the Marine Science Center located at 430 Nahant Road in the Town of Nahant ("the Town"). Figure 1 shows a Locus Map and Figure 2 shows the Study Area.

For the first phase of this project, we have prepared this Preliminary Traffic Impact Study to report the existing conditions of the study area. In preparing this study, we performed a site visit to assess the existing study area roadway and intersections, and we collected traffic volume data and reviewed crash data at three locations. In addition to the study area surrounding the existing Marine Science Center, we also included the areas surrounding the intersections of Nahant Road at Wilson Road (south of causeway) and Nahant Road at Pleasant Street (Town Hall intersection), as shown in Figures 3 and 4, respectively.

We will use the existing conditions presented in this report as the basis of our traffic assessment for the Final Traffic Impact Study.

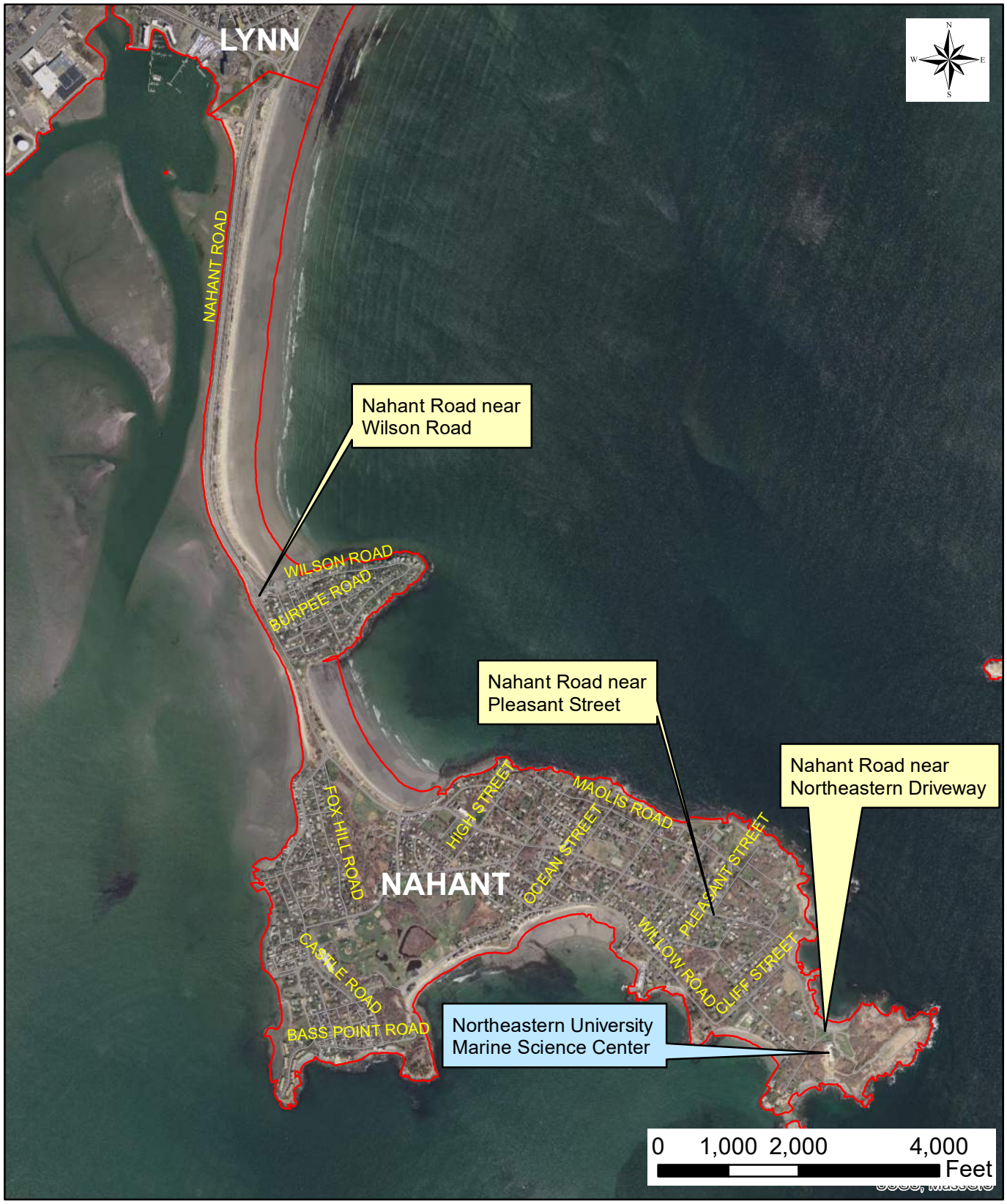

Figure 1: Locus Map

Northeastern University Marine Science Center
Nahant, MA

Data Source: MassGIS
Nitsch Project #12125.2

Nitsch Engineering

Figure 2: Study Area - Nahant Road near Northeastern Driveway
Northeastern University Marine Science Center
Nahant, MA

Data Source: MassGIS
Nitsch Project #12125.2

Nitsch Engineering

Figure 3: Study Area - Nahant Road near Wilson Road
Northeastern University Marine Science Center
Nahant, MA

Data Source: Google Earth
Nitsch Project #12125.2

Nitsch Engineering

Figure 4: Study Area - Nahant Road near Pleasant Street
Northeastern University Marine Science Center
Nahant, MA

Data Source: MassGIS
Nitsch Project #12125.2

Nitsch Engineering

2 EXISTING CONDITIONS

Nitsch Engineering performed a site visit on Wednesday, November 28, 2018 during cloudy conditions. We used the field observations from the site visit to assess the existing study area roadways and intersections.

2.1 Roadways

Nahant Road

Nahant Road is functionally classified by MassDOT as an urban minor arterial that runs in a general north-south direction through the northern part of the Town of Nahant and in a general east-west direction in the southern part of the Town. Nahant Road is present from its northern terminus at the Nahant Rotary with Lynnway and Lynn Shore Drive in the City of Lynn to its southern terminus at East Point. The roadway has a posted speed limit of 45 miles per hour (mph) and is maintained by the Department of Conservation and Recreation (DCR) between its northern terminus and the intersection with Wilson Road, and the remainder of the roadway has a posted speed limit of 25 mph and is maintained by the Town of Nahant. Land use is primarily residential and recreational with some commercial and municipal use.

2.2 Intersections

Nahant Road at Wilson Road

Nahant Road and Wilson Road intersect to form a three-way “T”-type unsignalized intersection with Nahant Road approaching from the north and south and Wilson Road approaching from the east. Nahant Road operates freely with no control and Wilson Road operates under “STOP” control.

Approaching the intersection from the north, Nahant Road contains two general purpose lanes in each direction separated by median island with guardrail. An angled parking lane is present on the east side of the roadway, separated from the traveled way by barrier and fence. Sidewalk is present adjacent to the traveled way on the west side of the roadway and adjacent to the parking lane on the east side of the roadway. No bicycle facilities are present. The land use is entirely recreational with a beach on the east side of the roadway and ocean on the west side of the roadway.

On the north side of the intersection, Nahant Road is 43.5 feet wide and permits two-way travel separated by a 3-foot wide concrete median island with a 1-foot wide shoulder. Due south towards the intersection, the roadway contains a 9-foot wide exclusive left-turn lane, an 11-foot wide through lane, and a 2.5-foot wide right shoulder. Due north away from the intersection, the roadway contains a 10.5-foot wide receiving lane and a 5.5-foot wide shoulder.

Approaching the intersection from the south, Nahant Road contains one general purpose lane in each direction separated by a double yellow center line (DCYL). Guardrail is present on the west side of the roadway and sidewalk is present on the east side of the roadway. No bicycle facilities are present. The land use is residential on the east side of the roadway and recreational with a beach on the west side of the roadway.

On the south side of the intersection, Nahant Road is 47 feet wide and permits two-way travel separated by a 5-foot wide landscaped median island with a 1-foot shoulder. Due north towards the intersection, the roadway contains a 12-foot wide general-purpose lane and 10-foot wide shoulder. Due south away from the intersection, the roadway contains a 15.5-foot wide receiving lane and a 3.5-foot wide shoulder.

On the east side of the intersection, Wilson Road is 30 feet wide and permits two-way travel separated by a DYCL. Due west towards the intersection, the roadway contains a 14-foot wide general-purpose lane. Due east away from the intersection, the roadway contains a 16-foot wide receiving lane.

Crosswalks are present across Nahant Road on the north side of the intersection and across Wilson Road to provide connectivity along the sidewalks on the west side of Nahant Road to the north and the east side of Nahant Road to the south. Wilson Road also contains sidewalk along its north side. Pedestrian ramps are present at all crosswalk termini.

Land use at the intersection is primarily commercial with a Dunkin' Donuts and Tides Restaurant and Pub on the northeast corner and Equitable Bank on the southeast corner.

Bus stops are present on both sides of the Nahant Road just south of the intersection. The Massachusetts Bay Transit Authority (MBTA) provides bus service to Nahant via Route 439 – Bass Point, Nahant – Central Square, Lynn or Wonderland. Route 439 contains several bus stops in the project area along Nahant Road and other roadways, including the stops just south of the intersection of Nahant Road at Wilson Road.

Nahant Road at Pleasant Street

Nahant Road and Pleasant Street intersect to form a three-way "T"-type unsignalized intersection with Nahant Road approaching from the east and west and Pleasant Street approaching from the north. Nahant Road operates freely with no control and Pleasant Street operates under "STOP" control.

Approaching the intersection from the west and east, Nahant Road contains one general purpose lane in each direction separated by a DYCL. Sidewalk is present on both sides of Nahant Road. The roadway contains no bicycle facilities. The land use is primarily residential and municipal.

On the west side of the intersection, Nahant Road is 34 feet wide and permits two-way travel separated by a DYCL. The roadway contains a 15-foot wide general-purpose lane in each direction and 2-foot shoulders on both sides. 30-minute parking is permitted on the north side of the roadway, though the shoulders do not provide sufficient width as a parking lane.

On the east side of the intersection, Nahant Road is 32 feet wide and permits two-way travel separated by a DYCL. The roadway contains a 14-foot wide general-purpose lane in each direction and 2-foot shoulders on both sides.

On the north side of the intersection, Pleasant Street is 20.5 feet wide and permits two-way travel, though no centerline is present. 30-minute parking is permitted on the east side of the roadway, though the width of the roadway is not sufficient to accommodate a parking lane and simultaneous two-way travel.

No crosswalks are present at the intersection. Two midblock crossings are present west of the intersection across Nahant Road to provide access to Nahant Town Hall and the United States Post Office (USPS) on the north side of the roadway. Pedestrian ramps are present at the corners of the intersection and at the crosswalk at Nahant Town Hall; however, the ramps do not contain detectable warning panels and may not be compliant with current Americans with Disabilities Act (ADA) and Massachusetts Architectural Access Board (MAAB) standards. No pedestrian ramps are present at the crosswalk at the Post Office.

Land use at the intersection is residential on the south side of the intersection and contains Nahant Town Hall, USPS, and commercial use on the northwest corner and Nahant Public Library on the northeast corner.

Nahant Road at Northeastern University Marine Science Center Driveway

Public access for Nahant Road terminates at a gated driveway for the Northeastern University Marine Science Center ("Northeastern Driveway"), where Nahant Road continues onto the Northeastern University property. The gated entrance contains 24-hour-a-day security. However, public access is maintained via the Public Right-of-Way to Lodge Park.

Approaching the Nahant Road terminus from the west, Nahant Road contains one general purpose lane in each direction separated by a DYCL, which continues to the south as Swallow Cave Road. No sidewalk or bicycle facilities are present. Resident permit parking is present on the east side of Swallow Cave Road. The land use is primarily residential on the south and west sides of the roadway and recreational with a beach on the north side of the roadway.

To access Northeastern Driveway from the west, vehicles must take a left to continue on Nahant Road. There is approximately 250 feet of public roadway west of the gated entrance. The roadway is approximately 16-feet wide and permits two-way travel, though no centerline is present. Pavement markings indicating "No Parking – Fire Lane" are present on the north side of the roadway. On the south side of the roadway, a public park and a perpendicular parking area containing nine spaces is present for resident permit parking only. No sidewalks or crosswalks are present.

3 EXISTING TRAFFIC CONDITIONS

3.1 Traffic Count Data

Nitsch Engineering retained Precision Data Industries, LLC (PDI) of Framingham, Massachusetts to collect traffic data within the study area.

Automatic Traffic Count (ATR) Data

PDI collected 48-hour continuous Automatic Traffic Recorder (ATR) counts at three locations in the study area from Wednesday, November 7, 2018 to Thursday, November 8, 2018. The ATR data included vehicle volume and classification. We averaged the traffic counts between the two daily 24-hour periods; Table 1 summarizes the results and the counts are shown graphically in Figure 5. The ATR data is included in Appendix A.

Table 1 – Automatic Traffic Recorder (ATR) Summary

ATR NO.	ATR LOCATION	PERIOD	ADT[a]			PEAK HOUR TRAFFIC				K factor[d]
			VOLUMES (vpd)[b]	DIRECTIONAL DISTRIBUTION		PERIOD	VOLUMES (vph)[c]	DIRECTIONAL DISTRIBUTION		
1	Nahant Road, south of Wilson Road	Weekday	7,922	50.3%	NB	Morning	588	71%	NB	0.07
						Evening	615	53%	SB	0.08
2	Nahant Road, west of Pleasant Street	Weekday	1,697	51.6%	EB	Morning	147	51%	EB	0.09
						Evening	151	51%	WB	0.09
3	Nahant Road, west of Northeastern Driveway	Weekday	175	50.3%	WB	Morning	30	88%	EB	0.17
						Evening	22	100%	WB	0.12

[a] Average Daily Traffic; [b] Vehicles per day; [c] Vehicles per hour; [d] Percent of daily traffic

3.2 Seasonal Adjustment

Nitsch Engineering queried MassDOT statewide traffic data to establish if any seasonal data was available near the project and to determine if the traffic counts needed to be adjusted for the volumes we measured in November. No such data was available, so we used MassDOT's 2013 Weekday Seasonal Factors. Nahant Road is functionally classified as an urban minor arterial, which falls within "Group U4." Counts within Group U4 collected during the month of November experience volumes that are 3% higher than average counted volumes. To present a conservative approach, we made no reduction in the counted volumes. MassDOT's 2013 Weekday Seasonal Factors is included in Appendix B.

3.3 Additional Development

Nitsch Engineering contacted the Town of Nahant Planning Department to establish if there are any planned developments that will potentially add traffic to the study area, proximate to the Northeastern University Marine Science Center. The Town indicated there are no such projects.

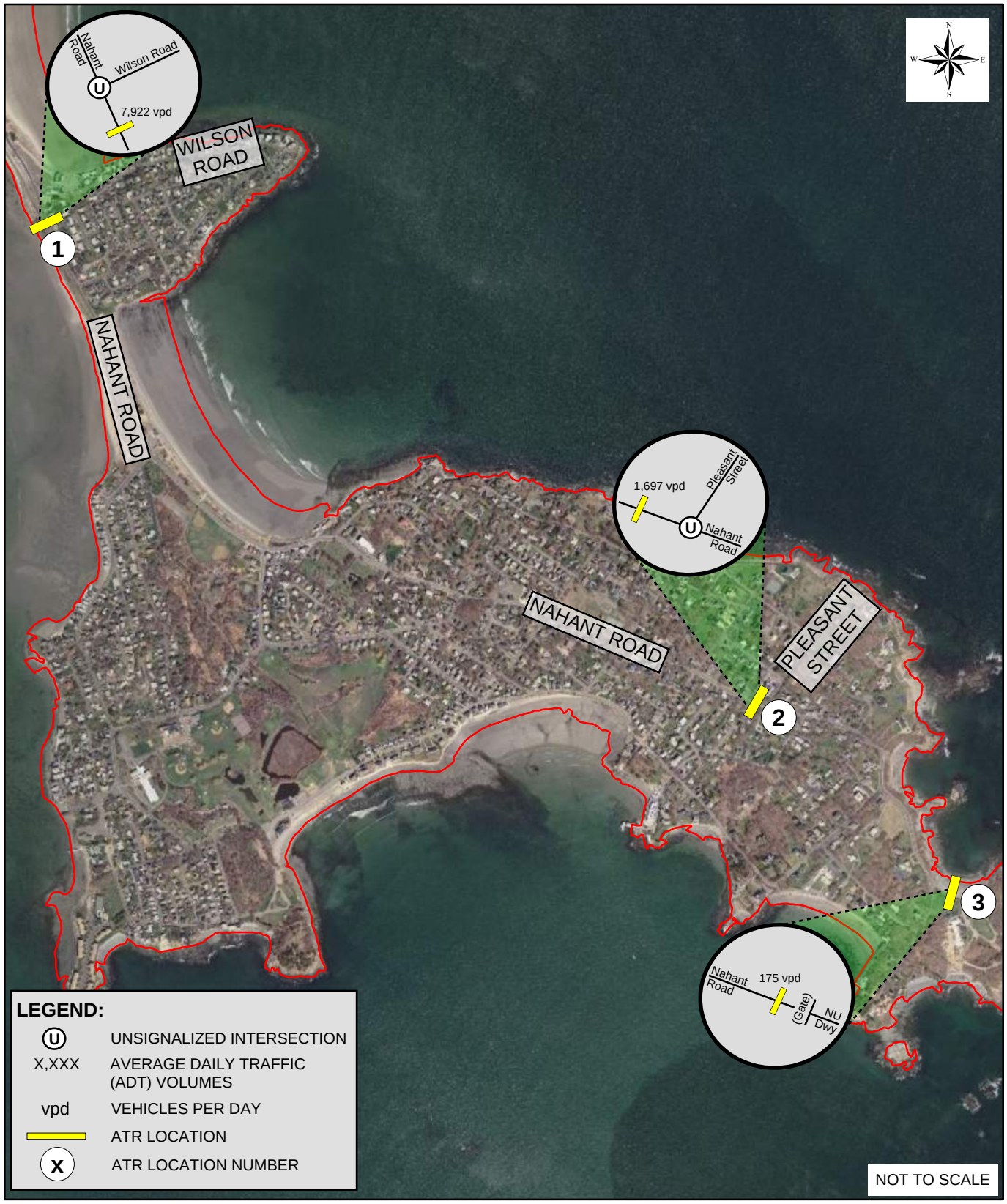

Figure 5: 2018 Automatic Traffic Recorder (ATR) Volumes

Northeastern University Marine Science Center

Nahant, MA

Data Source: MassGIS

Nitsch Project #12125.2

Nitsch Engineering

4 SAFETY ANALYSIS

4.1 Crash Data

Nitsch Engineering researched the crash data near the Northeastern University Marine Science Center and the locations of the ATRs for the three most recent years available from MassDOT records, 2014 to 2016. Table 2 summarizes the total crashes, severity, manner of collision, and percentage that occurred during peak hours or wet/icy conditions. The MassDOT crash data is included in Appendix C.

Table 2 – Crash Summary

Location	Number of Crashes			Severity				Manner of Collision					Percent During	
	Year	Total Crashes	Average	PD[a]	PI[b]	NR[c]	F[d]	A[e]	RE[f]	HO[g]	Other[h]	Incl. Ped-Bike	Peak Hours[i]	Wet/Icy Conditions
Nahant Road at Wilson Road	2014	1	2.67	1	0	0	0	0	0	0	1	0	100%	0%
	2015	3		2	0	1	0	1	1	0	1	0	0%	0%
	2016	4		4	0	0	0	0	2	0	2	0	25%	0%
	TOTAL	***8***		***7***	***0***	***1***	***0***	***1***	***3***	***0***	***4***	***0***	***25%***	***0%***
Nahant Road at Pleasant Street	2014	1	0.33	1	0	0	0	0	0	0	1	0	0%	100%
	2015	0		0	0	0	0	0	0	0	0	0	0%	0%
	2016	0		0	0	0	0	0	0	0	0	0	0%	0%
	TOTAL	***1***		***1***	***0***	***0***	***0***	***0***	***0***	***0***	***1***	***0***	***0%***	***100%***
Near Northeastern University Marine Science Center	2014	0	0.50	0	0	0	0	0	0	0	0	0	0%	0%
	2015	0		0	0	0	0	0	0	0	0	0	0%	0%
	2016	1		1	0	0	0	0	0	0	1	0	0%	0%
	TOTAL	***1***		***1***	***0***	***0***	***0***	***0***	***0***	***0***	***1***	***0***	***0%***	***0%***

[a]Property Damage Only; [b]Personal Injury Only (non-Fatal Injury); [c]Not Reported; [d]Fatality; [e]Angle; [f]Rear end; [g]Head on; [h]Sideswipe, opposite direction; sideswipe, same direction, single vehicle crash, rear-to-rear, not reported, unknown, etc.; [i]Occurred between 7-9am or 4-6pm

From Table 2, a total of eight crashes were reported at the intersection of Nahant Road and Wilson Road from 2014 to 2016, one crash was reported at the intersection of Nahant Road and Pleasant Street and one crash was reported near the Northeastern University Marine Science Center during the same three-year period. In terms of severity, all crashes reported property-damage only, except for one crash, which did not report the severity. The most frequent type of crash was rear-end, with three occurring at the intersection of Nahant Road and Wilson Road. Of the remaining crashes, one was an angle crash and six were of other type, which included single vehicle crashes, rear-to-rear crashes, and unreported types. No crashes involved a pedestrian or bicycle. Approximately 20% of all crashes occurred during peak hours and 10% occurred during wet/icy conditions.

5 CONCLUSIONS

Nitsch Engineering prepared this Preliminary Traffic Impact Study to report the existing conditions of the study area surrounding the Northeastern University Marine Science Center in the Town of Nahant. We will use the existing conditions presented in herein as the basis of our traffic assessment for the Final Traffic Impact Study.

Nitsch Engineering

Preliminary Traffic Impact Study Appendix
Existing Conditions

Northeastern University Marine Science Center

Nahant, MA

December 5, 2018

Prepared for:

Northeastern University
360 Huntington Avenue
Boston, MA 02115

Submitted by:

Nitsch Engineering
2 Center Plaza, Suite 430
Boston, MA 02108

Nitsch Engineering Project #12125.2

Building better communities with you.

CONTENTS

Section Number	DESCRIPTION
A	Traffic Count Data
B	Seasonal Adjustment
C	Crash Data

Appendix A

Traffic Count Data

PRECISION DATA INDUSTRIES, LLC
46 Morton Street, Framingham, MA 01702
Office: 508-875-0100 Fax: 508-875-0118
Email: datarequests@pdillc.com

Northestern Gated Driveway
east of Nahant Street
City, State: Nahant, MA
Client: Nitsch/ J. Bandini
WB

186501 AA Class
Site Code: 122661

Start Time	Cars	Medium Heavy	Large Heavy											Total
11/07/1														
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
06:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00	3	0	0	0	0	0	0	0	0	0	0	0	0	3
08:00	2	0	0	0	0	0	0	0	0	0	0	0	0	2
09:00	2	1	0	0	0	0	0	0	0	0	0	0	0	3
10:00	6	0	0	0	0	0	0	0	0	0	0	0	0	6
11:00	6	0	0	0	0	0	0	0	0	0	0	0	0	6
12 PM	6	0	0	0	0	0	0	0	0	0	0	0	0	6
13:00	3	0	0	0	0	0	0	0	0	0	0	0	0	3
14:00	3	0	0	0	0	0	0	0	0	0	0	0	0	3
15:00	8	1	0	0	0	0	0	0	0	0	0	0	0	9
16:00	22	0	0	0	0	0	0	0	0	0	0	0	0	22
17:00	12	0	0	0	0	0	0	0	0	0	0	0	0	12
18:00	1	0	0	0	0	0	0	0	0	0	0	0	0	1
19:00	1	0	0	0	0	0	0	0	0	0	0	0	0	1
20:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21:00	1	0	0	0	0	0	0	0	0	0	0	0	0	1
22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	76	2	0	0	0	0	0	0	0	0	0	0	0	78
Percent	97.4%	2.6%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
AM Peak	10:00	09:00												10:00
Vol.	6	1												6
PM Peak	16:00	15:00												16:00
Vol.	22	1												22

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east of Nahant Street
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Client: Nitsch/ J. Bandini
WB

186501 AA Class
Site Code: 122661

Start Time	Cars	Medium Heavy	Large Heavy											Total
11/08/1														
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:00	1	0	0	0	0	0	0	0	0	0	0	0	0	1
06:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
07:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
08:00	3	1	0	0	0	0	0	0	0	0	0	0	0	4
09:00	2	1	0	0	0	0	0	0	0	0	0	0	0	3
10:00	4	0	0	0	0	0	0	0	0	0	0	0	0	4
11:00	4	0	0	0	0	0	0	0	0	0	0	0	0	4
12 PM	10	1	0	0	0	0	0	0	0	0	0	0	0	11
13:00	8	1	0	0	0	0	0	0	0	0	0	0	0	9
14:00	7	0	0	0	0	0	0	0	0	0	0	0	0	7
15:00	7	0	0	0	0	0	0	0	0	0	0	0	0	7
16:00	21	0	0	0	0	0	0	0	0	0	0	0	0	21
17:00	16	0	0	0	0	0	0	0	0	0	0	0	0	16
18:00	5	0	0	0	0	0	0	0	0	0	0	0	0	5
19:00	3	0	0	0	0	0	0	0	0	0	0	0	0	3
20:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21:00	2	0	0	0	0	0	0	0	0	0	0	0	0	2
22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:00	1	0	0	0	0	0	0	0	0	0	0	0	0	1
Total	94	4	0	0	0	0	0	0	0	0	0	0	0	98
Percent	95.9%	4.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
AM Peak	10:00	08:00												08:00
Vol.	4	1												4
PM Peak	16:00	12:00												16:00
Vol.	21	1												21

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EB

186501 AA Class
Site Code: 122661

Start Time	Cars	Medium Heavy	Large Heavy											Total
11/07/1														
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:00	2	0	0	0	0	0	0	0	0	0	0	0	0	2
06:00	1	0	0	0	0	0	0	0	0	0	0	0	0	1
07:00	7	0	0	0	0	0	0	0	0	0	0	0	0	7
08:00	19	0	0	0	0	0	0	0	0	0	0	0	0	19
09:00	13	1	0	0	0	0	0	0	0	0	0	0	0	14
10:00	12	0	0	0	0	0	0	0	0	0	0	0	0	12
11:00	5	0	0	0	0	0	0	0	0	0	0	0	0	5
12 PM	7	0	0	0	0	0	0	0	0	0	0	0	0	7
13:00	4	0	0	0	0	0	0	0	0	0	0	0	0	4
14:00	2	0	0	0	0	0	0	0	0	0	0	0	0	2
15:00	2	0	0	0	0	0	0	0	0	0	0	0	0	2
16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:00	1	0	0	0	0	0	0	0	0	0	0	0	0	1
19:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21:00	1	0	0	0	0	0	0	0	0	0	0	0	0	1
22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	76	1	0	0	0	0	0	0	0	0	0	0	0	77
Percent	98.7%	1.3%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
AM Peak	08:00	09:00												08:00
Vol.	19	1												19
PM Peak	12:00													12:00
Vol.	7													7

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east of Nahant Street
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Client: Nitsch/ J. Bandini
EB

186501 AA Class
Site Code: 122661

Start Time	Cars	Medium Heavy	Large Heavy											Total
11/08/1														
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:00	1	0	0	0	0	0	0	0	0	0	0	0	0	1
06:00	2	0	0	0	0	0	0	0	0	0	0	0	0	2
07:00	2	0	0	0	0	0	0	0	0	0	0	0	0	2
08:00	28	2	0	0	0	0	0	0	0	0	0	0	0	30
09:00	16	0	0	0	0	0	0	0	0	0	0	0	0	16
10:00	10	0	0	0	0	0	0	0	0	0	0	0	0	10
11:00	6	1	0	0	0	0	0	0	0	0	0	0	0	7
12 PM	5	0	0	0	0	0	0	0	0	0	0	0	0	5
13:00	7	1	0	0	0	0	0	0	0	0	0	0	0	8
14:00	9	0	0	0	0	0	0	0	0	0	0	0	0	9
15:00	3	0	0	0	0	0	0	0	0	0	0	0	0	3
16:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18:00	1	0	0	0	0	0	0	0	0	0	0	0	0	1
19:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20:00	1	0	0	0	0	0	0	0	0	0	0	0	0	1
21:00	2	0	0	0	0	0	0	0	0	0	0	0	0	2
22:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	93	4	0	0	0	0	0	0	0	0	0	0	0	97
Percent	95.9%	4.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
AM Peak	08:00	08:00												08:00
Vol.	28	2												30
PM Peak	14:00	13:00												14:00
Vol.	9	1												9

PRECISION DATA INDUSTRIES, LLC
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Northestern Gated Driveway
east of Nahant Street
City, State: Nahant, MA
Client: Nitsch/ J. Bandini

186501 AA Volume
Site Code: 122661

Start	WB				EB				Combined				11/7/2018
Time	A.M.		P.M.		A.M.		P.M.		A.M.		P.M.		Wed
12:00	0		2		0		0		0		2		
12:15	0		2		0		2		0		4		
12:30	0		2		0		3		0		5		
12:45	0	0	0	6	0	0	2	7	0	0	2	13	
01:00	0		1		0		2		0		3		
01:15	0		1		0		0		0		1		
01:30	0		0		0		0		0		0		
01:45	0	0	1	3	0	0	2	4	0	0	3	7	
02:00	0		1		0		1		0		2		
02:15	0		0		0		0		0		0		
02:30	0		2		0		0		0		2		
02:45	0	0	0	3	0	0	1	2	0	0	1	5	
03:00	0		0		0		1		0		1		
03:15	0		1		0		0		0		1		
03:30	0		2		0		0		0		2		
03:45	0	0	6	9	0	0	1	2	0	0	7	11	
04:00	0		6		0		0		0		6		
04:15	0		4		0		0		0		4		
04:30	0		2		0		0		0		2		
04:45	0	0	10	22	0	0	0	0	0	0	10	22	
05:00	0		1		0		0		0		1		
05:15	0		6		0		0		0		6		
05:30	0		2		0		0		0		2		
05:45	0	0	3	12	2	2	0	0	2	2	3	12	
06:00	0		0		0		0		0		0		
06:15	0		1		0		0		0		1		
06:30	0		0		0		0		0		0		
06:45	0	0	0	1	1	1	1	1	1	1	1	2	
07:00	0		1		0		0		0		1		
07:15	1		0		1		0		2		0		
07:30	1		0		2		0		3		0		
07:45	1	3	0	1	4	7	0	0	5	10	0	1	
08:00	1		0		3		0		4		0		
08:15	0		0		3		0		3		0		
08:30	0		0		7		0		7		0		
08:45	1	2	0	0	6	19	0	0	7	21	0	0	
09:00	2		0		6		0		8		0		
09:15	0		0		4		0		4		0		
09:30	0		0		1		1		1		1		
09:45	1	3	1	1	3	14	0	1	4	17	1	2	
10:00	0		0		4		0		4		0		
10:15	3		0		3		0		6		0		
10:30	1		0		3		0		4		0		
10:45	2	6	0	0	2	12	0	0	4	18	0	0	
11:00	1		0		1		0		2		0		
11:15	2		0		1		0		3		0		
11:30	2		0		1		0		3		0		
11:45	1	6	0	0	2	5	0	0	3	11	0	0	
Total	20		58		60		17		80		75		
Percent	25.0%		77.3%		75.0%		22.7%						
Day Total		78				77				155			
Peak	10:15	-	04:00	-	08:30	-	00:15	-	08:30	-	04:00	-	- -
Vol.	7	-	22	-	23	-	9	-	26	-	22	-	- -
P.H.F.	0.583		0.550		0.821		0.750		0.813		0.550		

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east of Nahant Street
City, State: Nahant, MA
Client: Nitsch/ J. Bandini

186501 AA Volume
Site Code: 122661

Start	WB				EB				Combined				11/8/2018
Time	A.M.		P.M.		A.M.		P.M.		A.M.		P.M.		Thu
12:00	0		3		0		1		0		4		
12:15	0		1		0		1		0		2		
12:30	0		5		0		2		0		7		
12:45	0	0	2	11	0	0	1	5	0	0	3	16	
01:00	0		1		0		1		0		2		
01:15	0		1		0		1		0		2		
01:30	0		3		0		5		0		8		
01:45	0	0	4	9	0	0	1	8	0	0	5	17	
02:00	0		5		0		3		0		8		
02:15	0		0		0		1		0		1		
02:30	0		1		0		5		0		6		
02:45	0	0	1	7	0	0	0	9	0	0	1	16	
03:00	0		3		0		1		0		4		
03:15	0		1		0		0		0		1		
03:30	0		0		0		2		0		2		
03:45	0	0	3	7	0	0	0	3	0	0	3	10	
04:00	0		7		0		0		0		7		
04:15	0		3		0		0		0		3		
04:30	0		4		0		0		0		4		
04:45	0	0	7	21	0	0	0	0	0	0	7	21	
05:00	0		7		0		0		0		7		
05:15	0		6		0		0		0		6		
05:30	0		2		0		0		0		2		
05:45	1	1	1	16	1	1	0	0	2	2	1	16	
06:00	0		3		0		0		0		3		
06:15	0		0		0		0		0		0		
06:30	0		2		0		0		0		2		
06:45	0	0	0	5	2	2	1	1	2	2	1	6	
07:00	0		0		1		0		1		0		
07:15	0		1		0		0		0		1		
07:30	0		0		0		0		0		0		
07:45	0	0	2	3	1	2	0	0	1	2	2	3	
08:00	1		0		3		0		4		0		
08:15	0		0		8		0		8		0		
08:30	0		0		10		1		10		1		
08:45	3	4	0	0	9	30	0	1	12	34	0	1	
09:00	1		0		4		0		5		0		
09:15	1		1		4		0		5		1		
09:30	0		0		5		1		5		1		
09:45	1	3	1	2	3	16	1	2	4	19	2	4	
10:00	1		0		5		0		6		0		
10:15	0		0		1		0		1		0		
10:30	1		0		3		0		4		0		
10:45	2	4	0	0	1	10	0	0	3	14	0	0	
11:00	0		1		2		0		2		1		
11:15	3		0		0		0		3		0		
11:30	1		0		2		0		3		0		
11:45	0	4	0	1	3	7	0	0	3	11	0	1	
Total	16		82		68		29		84		111		
Percent	19.0%		73.9%		81.0%		26.1%						
Day Total		98				97				195			
Peak	10:30	-	04:30	-	08:15	-	01:15	-	08:15	-	04:30	-	- -
Vol.	6	-	24	-	31	-	10	-	35	-	24	-	- -
P.H.F.	0.500		0.857		0.775		0.500		0.729		0.750		

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Nahant Road
east of Pleasant Street
City, State: Nahant, MA
Client: Nitsch/ J. Bandini
WB

186501 BB Class
Site Code: 122661

Start Time	Cars	Medium Heavy	Large Heavy											Total
11/07/1														
8	0	0	0	0	0	0	0	0	0	0	0	0	0	0
01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00	2	0	0	0	0	0	0	0	0	0	0	0	0	2
03:00	1	0	0	0	0	0	0	0	0	0	0	0	0	1
04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:00	12	0	0	0	0	0	0	0	0	0	0	0	0	12
06:00	34	2	0	0	0	0	0	0	0	0	0	0	0	36
07:00	50	2	0	0	0	0	0	0	0	0	0	0	0	52
08:00	45	1	1	0	0	0	0	0	0	0	0	0	0	47
09:00	61	5	0	0	0	0	0	0	0	0	0	0	0	66
10:00	60	7	0	0	0	0	0	0	0	0	0	0	0	67
11:00	56	0	1	0	0	0	0	0	0	0	0	0	0	57
12 PM	71	1	0	0	0	0	0	0	0	0	0	0	0	72
13:00	47	3	1	0	0	0	0	0	0	0	0	0	0	51
14:00	55	4	0	0	0	0	0	0	0	0	0	0	0	59
15:00	72	8	0	0	0	0	0	0	0	0	0	0	0	80
16:00	70	2	0	0	0	0	0	0	0	0	0	0	0	72
17:00	41	0	1	0	0	0	0	0	0	0	0	0	0	42
18:00	27	2	0	0	0	0	0	0	0	0	0	0	0	29
19:00	20	0	0	0	0	0	0	0	0	0	0	0	0	20
20:00	9	0	0	0	0	0	0	0	0	0	0	0	0	9
21:00	13	0	0	0	0	0	0	0	0	0	0	0	0	13
22:00	4	0	0	0	0	0	0	0	0	0	0	0	0	4
23:00	4	0	0	0	0	0	0	0	0	0	0	0	0	4
Total	754	37	4	0	0	0	0	0	0	0	0	0	0	795
Percent	94.8%	4.7%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
AM Peak	09:00	10:00	08:00											10:00
Vol.	61	7	1											67
PM Peak	15:00	15:00	13:00											15:00
Vol.	72	8	1											80

PRECISION DATA INDUSTRIES, LLC
46 Morton Street, Framingham, MA 01702
Office: 508-875-0100 Fax: 508-875-0118
Email: datarequests@pdillc.com

Nahant Road
east of Pleasant Street
City, State: Nahant, MA
Client: Nitsch/ J. Bandini
WB

186501 BB Class
Site Code: 122661

Start Time	Cars	Medium Heavy	Large Heavy											Total
11/08/1														
8	3	0	0	0	0	0	0	0	0	0	0	0	0	3
01:00	3	0	0	0	0	0	0	0	0	0	0	0	0	3
02:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
03:00	1	0	0	0	0	0	0	0	0	0	0	0	0	1
04:00	1	0	0	0	0	0	0	0	0	0	0	0	0	1
05:00	10	0	0	0	0	0	0	0	0	0	0	0	0	10
06:00	33	2	0	0	0	0	0	0	0	0	0	0	0	35
07:00	48	3	0	0	0	0	0	0	0	0	0	0	0	51
08:00	48	4	0	0	0	0	0	0	0	0	0	0	0	52
09:00	54	2	0	0	0	0	0	0	0	0	0	0	0	56
10:00	64	4	0	0	0	0	0	0	0	0	0	0	0	68
11:00	80	3	0	0	0	0	0	0	0	0	0	0	0	83
12 PM	70	3	0	0	0	0	0	0	0	0	0	0	0	73
13:00	65	4	0	0	0	0	0	0	0	0	0	0	0	69
14:00	64	3	1	0	0	0	0	0	0	0	0	0	0	68
15:00	69	2	3	0	0	0	0	0	0	0	0	0	0	74
16:00	58	6	0	0	0	0	0	0	0	0	0	0	0	64
17:00	53	3	0	0	0	0	0	0	0	0	0	0	0	56
18:00	25	1	0	0	0	0	0	0	0	0	0	0	0	26
19:00	18	1	0	0	0	0	0	0	0	0	0	0	0	19
20:00	18	0	0	0	0	0	0	0	0	0	0	0	0	18
21:00	12	0	0	0	0	0	0	0	0	0	0	0	0	12
22:00	3	0	0	0	0	0	0	0	0	0	0	0	0	3
23:00	2	0	0	0	0	0	0	0	0	0	0	0	0	2
Total	802	41	4	0	0	0	0	0	0	0	0	0	0	847
Percent	94.7%	4.8%	0.5%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
AM Peak	11:00	08:00												11:00
Vol.	80	4												83
PM Peak	12:00	16:00	15:00											15:00
Vol.	70	6	3											74

PRECISION DATA INDUSTRIES, LLC
46 Morton Street, Framingham, MA 01702
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Nahant Road
east of Pleasant Street
City, State: Nahant, MA
Client: Nitsch/ J. Bandini
EB

186501 BB Class
Site Code: 122661

Start Time	Cars	Medium Heavy	Large Heavy											Total
11/07/1														
8	3	0	0	0	0	0	0	0	0	0	0	0	0	3
01:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
02:00	1	0	0	0	0	0	0	0	0	0	0	0	0	1
03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:00	4	0	0	0	0	0	0	0	0	0	0	0	0	4
06:00	25	3	0	0	0	0	0	0	0	0	0	0	0	28
07:00	32	2	0	0	0	0	0	0	0	0	0	0	0	34
08:00	55	2	0	0	0	0	0	0	0	0	0	0	0	57
09:00	62	1	0	0	0	0	0	0	0	0	0	0	0	63
10:00	76	2	0	0	0	0	0	0	0	0	0	0	0	78
11:00	51	1	1	0	0	0	0	0	0	0	0	0	0	53
12 PM	72	1	0	0	0	0	0	0	0	0	0	0	0	73
13:00	53	2	0	0	0	0	0	0	0	0	0	0	0	55
14:00	64	2	0	0	0	0	0	0	0	0	0	0	0	66
15:00	65	4	0	0	0	0	0	0	0	0	0	0	0	69
16:00	63	1	1	0	0	0	0	0	0	0	0	0	0	65
17:00	37	1	0	0	0	0	0	0	0	0	0	0	0	38
18:00	46	0	0	0	0	0	0	0	0	0	0	0	0	46
19:00	48	0	0	0	0	0	0	0	0	0	0	0	0	48
20:00	25	0	0	0	0	0	0	0	0	0	0	0	0	25
21:00	21	0	0	0	0	0	0	0	0	0	0	0	0	21
22:00	5	0	0	0	0	0	0	0	0	0	0	0	0	5
23:00	10	0	0	0	0	0	0	0	0	0	0	0	0	10
Total	818	22	2	0	0	0	0	0	0	0	0	0	0	842
Percent	97.1%	2.6%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
AM Peak	10:00	06:00	11:00											10:00
Vol.	76	3	1											78
PM Peak	12:00	15:00	16:00											12:00
Vol.	72	4	1											73

PRECISION DATA INDUSTRIES, LLC
46 Morton Street, Framingham, MA 01702
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Nahant Road
east of Pleasant Street
City, State: Nahant, MA
Client: Nitsch/ J. Bandini
EB

186501 BB Class
Site Code: 122661

Start Time	Cars	Medium Heavy	Large Heavy											Total
11/08/1														
8	5	0	0	0	0	0	0	0	0	0	0	0	0	5
01:00	2	0	0	0	0	0	0	0	0	0	0	0	0	2
02:00	1	0	0	0	0	0	0	0	0	0	0	0	0	1
03:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
04:00	0	0	0	0	0	0	0	0	0	0	0	0	0	0
05:00	2	0	0	0	0	0	0	0	0	0	0	0	0	2
06:00	23	2	0	0	0	0	0	0	0	0	0	0	0	25
07:00	44	4	0	0	0	0	0	0	0	0	0	0	0	48
08:00	66	4	4	0	0	0	0	0	0	0	0	0	0	74
09:00	83	2	0	0	0	0	0	0	0	0	0	0	0	85
10:00	60	4	0	0	0	0	0	0	0	0	0	0	0	64
11:00	71	4	0	0	0	0	0	0	0	0	0	0	0	75
12 PM	64	1	0	0	0	0	0	0	0	0	0	0	0	65
13:00	70	6	0	0	0	0	0	0	0	0	0	0	0	76
14:00	62	1	0	0	0	0	0	0	0	0	0	0	0	63
15:00	78	1	0	0	0	0	0	0	0	0	0	0	0	79
16:00	68	4	0	0	0	0	0	0	0	0	0	0	0	72
17:00	35	1	0	0	0	0	0	0	0	0	0	0	0	36
18:00	36	0	0	0	0	0	0	0	0	0	0	0	0	36
19:00	38	0	0	0	0	0	0	0	0	0	0	0	0	38
20:00	22	0	0	0	0	0	0	0	0	0	0	0	0	22
21:00	22	0	0	0	0	0	0	0	0	0	0	0	0	22
22:00	15	0	0	0	0	0	0	0	0	0	0	0	0	15
23:00	5	0	0	0	0	0	0	0	0	0	0	0	0	5
Total	872	34	4	0	0	0	0	0	0	0	0	0	0	910
Percent	95.8%	3.7%	0.4%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
AM Peak	09:00	07:00	08:00											09:00
Vol.	83	4	4											85
PM Peak	15:00	13:00												15:00
Vol.	78	6												79

PRECISION DATA INDUSTRIES, LLC
46 Morton Street, Framingham, MA 01702
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Email: datarequests@pdillc.com

Nahant Road
east of Pleasant Street
City, State: Nahant, MA
Client: Nitsch/ J. Bandini

186501 BB Volume
Site Code: 122661

Start	WB				EB				Combined				11/7/2018
Time	A.M.		P.M.		A.M.		P.M.		A.M.		P.M.		Wed
12:00	0		24		0		20		0		44		
12:15	0		13		1		17		1		30		
12:30	0		19		1		20		1		39		
12:45	0	0	16	72	1	3	16	73	1	3	32	145	
01:00	0		11		0		11		0		22		
01:15	0		17		0		17		0		34		
01:30	0		10		0		13		0		23		
01:45	0	0	13	51	0	0	14	55	0	0	27	106	
02:00	2		17		1		14		3		31		
02:15	0		14		0		14		0		28		
02:30	0		20		0		22		0		42		
02:45	0	2	8	59	0	1	16	66	0	3	24	125	
03:00	0		23		0		16		0		39		
03:15	1		15		0		15		1		30		
03:30	0		20		0		20		0		40		
03:45	0	1	22	80	0	0	18	69	0	1	40	149	
04:00	0		20		0		15		0		35		
04:15	0		16		0		14		0		30		
04:30	0		20		0		18		0		38		
04:45	0	0	16	72	0	0	18	65	0	0	34	137	
05:00	2		9		0		9		2		18		
05:15	3		17		0		10		3		27		
05:30	1		7		1		11		2		18		
05:45	6	12	9	42	3	4	8	38	9	16	17	80	
06:00	7		13		2		7		9		20		
06:15	7		3		5		9		12		12		
06:30	10		7		6		11		16		18		
06:45	12	36	6	29	15	28	19	46	27	64	25	75	
07:00	9		2		6		16		15		18		
07:15	17		5		8		11		25		16		
07:30	14		4		7		7		21		11		
07:45	12	52	9	20	13	34	14	48	25	86	23	68	
08:00	15		2		11		8		26		10		
08:15	9		3		10		9		19		12		
08:30	13		3		16		6		29		9		
08:45	10	47	1	9	20	57	2	25	30	104	3	34	
09:00	16		4		20		8		36		12		
09:15	16		1		17		3		33		4		
09:30	19		4		11		5		30		9		
09:45	15	66	4	13	15	63	5	21	30	129	9	34	
10:00	14		1		19		0		33		1		
10:15	21		2		21		1		42		3		
10:30	18		1		17		2		35		3		
10:45	14	67	0	4	21	78	2	5	35	145	2	9	
11:00	15		0		15		1		30		1		
11:15	13		2		9		6		22		8		
11:30	17		0		17		2		34		2		
11:45	12	57	2	4	12	53	1	10	24	110	3	14	
Total	340		455		321		521		661		976		
Percent	51.4%		46.6%		48.6%		53.4%						
Day Total		795				842				1637			
Peak	09:30	-	03:00	-	10:00	-	12:00	-	10:00	-	03:00	-	- -
Vol.	69	-	80	-	78	-	73	-	145	-	149	-	- -
P.H.F.	0.821		0.870		0.929		0.913		0.863		0.887		

PRECISION DATA INDUSTRIES, LLC
46 Morton Street, Framingham, MA 01702
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Nahant Road
east of Pleasant Street
City, State: Nahant, MA
Client: Nitsch/ J. Bandini

186501 BB Volume
Site Code: 122661

Start	WB				EB				Combined				11/8/2018
Time	A.M.		P.M.		A.M.		P.M.		A.M.		P.M.		Thu
12:00	0		15		0		14		0		29		
12:15	1		18		3		18		4		36		
12:30	0		22		0		14		0		36		
12:45	2	3	18	73	2	5	19	65	4	8	37	138	
01:00	0		9		1		14		1		23		
01:15	0		20		1		22		1		42		
01:30	3		19		0		23		3		42		
01:45	0	3	21	69	0	2	17	76	0	5	38	145	
02:00	0		19		0		13		0		32		
02:15	0		12		0		22		0		34		
02:30	0		17		1		17		1		34		
02:45	0	0	20	68	0	1	11	63	0	1	31	131	
03:00	0		22		0		17		0		39		
03:15	0		17		0		19		0		36		
03:30	1		14		0		27		1		41		
03:45	0	1	21	74	0	0	16	79	0	1	37	153	
04:00	0		19		0		22		0		41		
04:15	0		18		0		15		0		33		
04:30	0		16		0		14		0		30		
04:45	1	1	11	64	0	0	21	72	1	1	32	136	
05:00	1		24		0		11		1		35		
05:15	1		13		0		9		1		22		
05:30	2		11		0		6		2		17		
05:45	6	10	8	56	2	2	10	36	8	12	18	92	
06:00	5		11		4		10		9		21		
06:15	11		8		4		5		15		13		
06:30	7		3		7		9		14		12		
06:45	12	35	4	26	10	25	12	36	22	60	16	62	
07:00	12		8		15		12		27		20		
07:15	13		5		8		9		21		14		
07:30	11		2		14		7		25		9		
07:45	15	51	4	19	11	48	10	38	26	99	14	57	
08:00	9		3		15		7		24		10		
08:15	12		2		20		6		32		8		
08:30	18		11		19		3		37		14		
08:45	13	52	2	18	20	74	6	22	33	126	8	40	
09:00	6		2		13		5		19		7		
09:15	20		4		23		5		43		9		
09:30	16		3		17		4		33		7		
09:45	14	56	3	12	32	85	8	22	46	141	11	34	
10:00	14		0		11		7		25		7		
10:15	20		1		11		5		31		6		
10:30	17		2		17		1		34		3		
10:45	17	68	0	3	25	64	2	15	42	132	2	18	
11:00	22		1		23		1		45		2		
11:15	16		0		17		1		33		1		
11:30	21		1		15		1		36		2		
11:45	24	83	0	2	20	75	2	5	44	158	2	7	
Total	363		484		381		529		744		1013		
Percent	48.8%		47.8%		51.2%		52.2%						
Day Total		847				910				1757			
Peak	11:00	-	01:15	-	09:00	-	03:15	-	11:00	-	03:15	-	- -
Vol.	83	-	79	-	85	-	84	-	158	-	155	-	- -
P.H.F.	0.865		0.898		0.664		0.778		0.878		0.923		

PRECISION DATA INDUSTRIES, LLC
46 Morton Street, Framingham, MA 01702
Office: 508-875-0100 Fax: 508-875-0118
Email: datarequests@pdillc.com

Nahant Road
south of Wilson Road
City, State: Nahant, MA
Client: Nitsch/ J. Bandini
SB

186501 CC Class
Site Code: 122661

Start Time	Cars	Medium Heavy	Large Heavy											Total
11/07/1														
8	23	0	0	0	0	0	0	0	0	0	0	0	0	23
01:00	11	1	0	0	0	0	0	0	0	0	0	0	0	12
02:00	3	0	0	0	0	0	0	0	0	0	0	0	0	3
03:00	4	0	0	0	0	0	0	0	0	0	0	0	0	4
04:00	11	0	0	0	0	0	0	0	0	0	0	0	0	11
05:00	22	2	0	0	0	0	0	0	0	0	0	0	0	24
06:00	85	8	0	0	0	0	0	0	0	0	0	0	0	93
07:00	161	14	0	0	0	0	0	0	0	0	0	0	0	175
08:00	184	18	1	0	0	0	0	0	0	0	0	0	0	203
09:00	210	15	2	0	0	0	0	0	0	0	0	0	0	227
10:00	213	8	0	0	0	0	0	0	0	0	0	0	0	221
11:00	218	12	3	0	0	0	0	0	0	0	0	0	0	233
12 PM	241	2	0	0	0	0	0	0	0	0	0	0	0	243
13:00	223	10	1	0	0	0	0	0	0	0	0	0	0	234
14:00	247	10	0	0	0	0	0	0	0	0	0	0	0	257
15:00	312	5	0	0	0	0	0	0	0	0	0	0	0	317
16:00	324	7	0	0	0	0	0	0	0	0	0	0	0	331
17:00	337	1	0	0	0	0	0	0	0	0	0	0	0	338
18:00	301	1	0	0	0	0	0	0	0	0	0	0	0	302
19:00	238	1	1	0	0	0	0	0	0	0	0	0	0	240
20:00	179	0	0	0	0	0	0	0	0	0	0	0	0	179
21:00	148	0	0	0	0	0	0	0	0	0	0	0	0	148
22:00	68	0	0	0	0	0	0	0	0	0	0	0	0	68
23:00	48	0	0	0	0	0	0	0	0	0	0	0	0	48
Total	3811	115	8	0	0	0	0	0	0	0	0	0	0	3934
Percent	96.9%	2.9%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
AM Peak	11:00	08:00	11:00											11:00
Vol.	218	18	3											233
PM Peak	17:00	13:00	13:00											17:00
Vol.	337	10	1											338

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Nahant Road
south of Wilson Road
City, State: Nahant, MA
Client: Nitsch/ J. Bandini
SB

186501 CC Class
Site Code: 122661

Start Time	Cars	Medium Heavy	Large Heavy											Total
11/08/1														
8	18	0	0	0	0	0	0	0	0	0	0	0	0	18
01:00	6	0	0	0	0	0	0	0	0	0	0	0	0	6
02:00	3	0	0	0	0	0	0	0	0	0	0	0	0	3
03:00	6	0	0	0	0	0	0	0	0	0	0	0	0	6
04:00	8	0	0	0	0	0	0	0	0	0	0	0	0	8
05:00	15	0	1	0	0	0	0	0	0	0	0	0	0	16
06:00	63	12	0	0	0	0	0	0	0	0	0	0	0	75
07:00	144	19	1	0	0	0	0	0	0	0	0	0	0	164
08:00	178	15	2	0	0	0	0	0	0	0	0	0	0	195
09:00	194	9	0	0	0	0	0	0	0	0	0	0	0	203
10:00	199	13	1	0	0	0	0	0	0	0	0	0	0	213
11:00	244	6	1	0	0	0	0	0	0	0	0	0	0	251
12 PM	210	7	1	0	0	0	0	0	0	0	0	0	0	218
13:00	249	8	0	0	0	0	0	0	0	0	0	0	0	257
14:00	292	9	0	0	0	0	0	0	0	0	0	0	0	301
15:00	320	6	0	0	0	0	0	0	0	0	0	0	0	326
16:00	301	5	1	0	0	0	0	0	0	0	0	0	0	307
17:00	343	4	0	0	0	0	0	0	0	0	0	0	0	347
18:00	278	0	0	0	0	0	0	0	0	0	0	0	0	278
19:00	267	2	0	0	0	0	0	0	0	0	0	0	0	269
20:00	180	0	0	0	0	0	0	0	0	0	0	0	0	180
21:00	143	0	0	0	0	0	0	0	0	0	0	0	0	143
22:00	111	1	0	0	0	0	0	0	0	0	0	0	0	112
23:00	46	1	0	0	0	0	0	0	0	0	0	0	0	47
Total	3818	117	8	0	0	0	0	0	0	0	0	0	0	3943
Percent	96.8%	3.0%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
AM Peak	11:00	07:00	08:00											11:00
Vol.	244	19	2											251
PM Peak	17:00	14:00	12:00											17:00
Vol.	343	9	1											347

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186501 CC Class
Site Code: 122661

Start Time	Cars	Medium Heavy	Large Heavy											Total
11/07/1														
8	13	0	0	0	0	0	0	0	0	0	0	0	0	13
01:00	5	0	0	0	0	0	0	0	0	0	0	0	0	5
02:00	10	0	0	0	0	0	0	0	0	0	0	0	0	10
03:00	10	0	0	0	0	0	0	0	0	0	0	0	0	10
04:00	35	0	0	0	0	0	0	0	0	0	0	0	0	35
05:00	132	3	0	0	0	0	0	0	0	0	0	0	0	135
06:00	304	4	0	0	0	0	0	0	0	0	0	0	0	308
07:00	411	1	0	0	0	0	0	0	0	0	0	0	0	412
08:00	314	8	1	0	0	0	0	0	0	0	0	0	0	323
09:00	307	7	0	0	0	0	0	0	0	0	0	0	0	314
10:00	260	14	0	0	0	0	0	0	0	0	0	0	0	274
11:00	243	11	0	0	0	0	0	0	0	0	0	0	0	254
12 PM	227	10	0	0	0	0	0	0	0	0	0	0	0	237
13:00	229	7	1	0	0	0	0	0	0	0	0	0	0	237
14:00	228	13	1	0	0	0	0	0	0	0	0	0	0	242
15:00	259	13	0	0	0	0	0	0	0	0	0	0	0	272
16:00	267	4	2	0	0	0	0	0	0	0	0	0	0	273
17:00	199	4	3	0	0	0	0	0	0	0	0	0	0	206
18:00	150	4	0	0	0	0	0	0	0	0	0	0	0	154
19:00	104	1	1	0	0	0	0	0	0	0	0	0	0	106
20:00	56	0	0	0	0	0	0	0	0	0	0	0	0	56
21:00	52	1	0	0	0	0	0	0	0	0	0	0	0	53
22:00	36	0	0	0	0	0	0	0	0	0	0	0	0	36
23:00	28	0	0	0	0	0	0	0	0	0	0	0	0	28
Total	3879	105	9	0	0	0	0	0	0	0	0	0	0	3993
Percent	97.1%	2.6%	0.2%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
AM Peak	07:00	10:00	08:00											07:00
Vol.	411	14	1											412
PM Peak	16:00	14:00	17:00											16:00
Vol.	267	13	3											273

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Start Time	Cars	Medium Heavy	Large Heavy											Total
11/08/1														
8	1	0	0	0	0	0	0	0	0	0	0	0	0	1
01:00	5	0	0	0	0	0	0	0	0	0	0	0	0	5
02:00	5	0	0	0	0	0	0	0	0	0	0	0	0	5
03:00	13	0	0	0	0	0	0	0	0	0	0	0	0	13
04:00	33	0	0	0	0	0	0	0	0	0	0	0	0	33
05:00	114	0	0	0	0	0	0	0	0	0	0	0	0	114
06:00	276	9	0	0	0	0	0	0	0	0	0	0	0	285
07:00	411	6	0	0	0	0	0	0	0	0	0	0	0	417
08:00	324	13	0	0	0	0	0	0	0	0	0	0	0	337
09:00	247	11	0	0	0	0	0	0	0	0	0	0	0	258
10:00	242	12	0	0	0	0	0	0	0	0	0	0	0	254
11:00	250	15	0	0	0	0	0	0	0	0	0	0	0	265
12 PM	248	11	0	0	0	0	0	0	0	0	0	0	0	259
13:00	238	7	0	0	0	0	0	0	0	0	0	0	0	245
14:00	267	7	3	0	0	0	0	0	0	0	0	0	0	277
15:00	277	17	2	0	0	0	0	0	0	0	0	0	0	296
16:00	240	6	0	0	0	0	0	0	0	0	0	0	0	246
17:00	189	2	0	0	0	0	0	0	0	0	0	0	0	191
18:00	152	3	0	0	0	0	0	0	0	0	0	0	0	155
19:00	98	1	0	0	0	0	0	0	0	0	0	0	0	99
20:00	90	0	0	0	0	0	0	0	0	0	0	0	0	90
21:00	63	0	0	0	0	0	0	0	0	0	0	0	0	63
22:00	43	2	0	0	0	0	0	0	0	0	0	0	0	45
23:00	20	0	0	0	0	0	0	0	0	0	0	0	0	20
Total	3846	122	5	0	0	0	0	0	0	0	0	0	0	3973
Percent	96.8%	3.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
AM Peak	07:00	11:00												07:00
Vol.	411	15												417
PM Peak	15:00	15:00	14:00											15:00
Vol.	277	17	3											296

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186501 CC Volume
Site Code: 122661

Start	SB				NB				Combined				11/7/2018
Time	A.M.		P.M.		A.M.		P.M.		A.M.		P.M.		Wed
12:00	9		52		3		66		12		118		
12:15	3		68		3		64		6		132		
12:30	8		66		3		56		11		122		
12:45	3	23	57	243	4	13	51	237	7	36	108	480	
01:00	1		49		0		54		1		103		
01:15	5		62		2		54		7		116		
01:30	3		54		2		67		5		121		
01:45	3	12	69	234	1	5	62	237	4	17	131	471	
02:00	0		53		2		55		2		108		
02:15	1		62		0		55		1		117		
02:30	2		68		4		75		6		143		
02:45	0	3	74	257	4	10	57	242	4	13	131	499	
03:00	0		74		1		62		1		136		
03:15	2		75		2		75		4		150		
03:30	2		95		1		73		3		168		
03:45	0	4	73	317	6	10	62	272	6	14	135	589	
04:00	0		100		3		81		3		181		
04:15	2		82		9		64		11		146		
04:30	6		81		12		54		18		135		
04:45	3	11	68	331	11	35	74	273	14	46	142	604	
05:00	2		96		26		57		28		153		
05:15	5		87		36		56		41		143		
05:30	6		85		31		46		37		131		
05:45	11	24	70	338	42	135	47	206	53	159	117	544	
06:00	10		84		63		48		73		132		
06:15	27		69		47		35		74		104		
06:30	23		77		97		39		120		116		
06:45	33	93	72	302	101	308	32	154	134	401	104	456	
07:00	43		62		84		28		127		90		
07:15	37		60		97		30		134		90		
07:30	43		66		132		27		175		93		
07:45	52	175	52	240	99	412	21	106	151	587	73	346	
08:00	38		54		90		24		128		78		
08:15	57		45		77		12		134		57		
08:30	56		42		74		10		130		52		
08:45	52	203	38	179	82	323	10	56	134	526	48	235	
09:00	62		47		73		18		135		65		
09:15	40		38		84		16		124		54		
09:30	65		26		74		8		139		34		
09:45	60	227	37	148	83	314	11	53	143	541	48	201	
10:00	55		15		75		11		130		26		
10:15	54		18		63		9		117		27		
10:30	65		18		66		10		131		28		
10:45	47	221	17	68	70	274	6	36	117	495	23	104	
11:00	54		18		70		7		124		25		
11:15	45		12		56		10		101		22		
11:30	62		12		63		4		125		16		
11:45	72	233	6	48	65	254	7	28	137	487	13	76	
Total	1229		2705		2093		1900		3322		4605		
Percent	37.0%		58.7%		63.0%		41.3%						
Day Total		3934				3993				7927			
Peak	09:30	-	03:30	-	07:15	-	03:15	-	07:15	-	03:15	-	- -
Vol.	234	-	350	-	418	-	291	-	588	-	634	-	- -
P.H.F.	0.900		0.875		0.792		0.898		0.840		0.876		

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186501 CC Volume
Site Code: 122661

Start	SB				NB				Combined				11/8/2018
Time	A.M.		P.M.		A.M.		P.M.		A.M.		P.M.		Thu
12:00	3		47		0		71		3		118		
12:15	6		59		0		62		6		121		
12:30	6		52		0		61		6		113		
12:45	3	18	60	218	1	1	65	259	4	19	125	477	
01:00	1		64		1		50		2		114		
01:15	2		72		1		58		3		130		
01:30	2		62		1		63		3		125		
01:45	1	6	59	257	2	5	74	245	3	11	133	502	
02:00	0		72		1		67		1		139		
02:15	1		77		0		64		1		141		
02:30	1		70		1		81		2		151		
02:45	1	3	82	301	3	5	65	277	4	8	147	578	
03:00	1		82		1		69		2		151		
03:15	1		92		0		82		1		174		
03:30	2		72		8		73		10		145		
03:45	2	6	80	326	4	13	72	296	6	19	152	622	
04:00	1		69		4		55		5		124		
04:15	5		79		7		55		12		134		
04:30	1		67		9		68		10		135		
04:45	1	8	92	307	13	33	68	246	14	41	160	553	
05:00	1		92		20		66		21		158		
05:15	6		90		23		55		29		145		
05:30	6		81		40		45		46		126		
05:45	3	16	84	347	31	114	25	191	34	130	109	538	
06:00	14		64		61		53		75		117		
06:15	20		73		62		29		82		102		
06:30	18		62		85		48		103		110		
06:45	23	75	79	278	77	285	25	155	100	360	104	433	
07:00	32		89		82		36		114		125		
07:15	50		68		116		22		166		90		
07:30	34		55		112		21		146		76		
07:45	48	164	57	269	107	417	20	99	155	581	77	368	
08:00	39		58		82		22		121		80		
08:15	48		31		77		21		125		52		
08:30	55		48		83		25		138		73		
08:45	53	195	43	180	95	337	22	90	148	532	65	270	
09:00	34		35		65		19		99		54		
09:15	44		45		65		18		109		63		
09:30	55		33		71		16		126		49		
09:45	70	203	30	143	57	258	10	63	127	461	40	206	
10:00	40		39		62		12		102		51		
10:15	61		26		67		18		128		44		
10:30	55		24		70		12		125		36		
10:45	57	213	23	112	55	254	3	45	112	467	26	157	
11:00	72		19		54		9		126		28		
11:15	67		11		67		5		134		16		
11:30	64		8		85		4		149		12		
11:45	48	251	9	47	59	265	2	20	107	516	11	67	
Total	1158		2785		1987		1986		3145		4771		
Percent	36.8%		58.4%		63.2%		41.6%						
Day Total		3943				3973				7916			
Peak	10:45	-	04:45	-	07:00	-	02:30	-	07:15	-	02:30	-	-	-
Vol.	260	-	355	-	417	-	297	-	588	-	623	-	-	-
P.H.F.	0.903		0.965		0.899		0.905		0.886		0.895			

Appendix B

Seasonal Adjustment

Massachusetts Highway Department
Statewide Traffic Data Collection
2013 Weekday Seasonal Factors

Factor Group	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
R1	1.14	1.13	1.12	1.04	0.96	0.93	0.87	0.84	0.96	0.99	1.02	1.15
R2	1.14	1.09	1.06	1.00	0.94	0.90	0.89	0.87	0.94	0.94	1.01	0.99
R3	1.14	1.09	1.06	1.00	0.94	0.90	0.89	0.87	0.94	0.94	1.01	0.99
R4-R7	1.10	1.09	1.11	1.01	0.92	0.92	0.91	0.91	0.93	0.92	1.04	1.08
U1-Boston	1.01	1.02	1.00	0.95	0.92	0.89	0.90	0.87	0.91	0.91	0.96	1.02
U1-Essex	1.05	1.04	1.03	0.97	0.94	0.91	0.89	0.87	0.93	0.92	0.97	1.01
U1-Southeast	1.08	1.05	1.04	0.97	0.94	0.91	0.89	0.86	0.93	0.94	0.99	1.03
U1-West	1.01	0.98	0.98	0.97	0.95	0.93	0.95	0.91	0.92	0.91	0.97	0.96
U1-Worcester	1.00	0.98	1.00	0.93	0.92	0.91	0.94	0.90	0.92	0.92	0.96	1.02
U2	0.99	1.01	1.03	0.96	0.93	0.91	0.92	0.89	0.91	0.90	0.95	1.00
U3	1.02	1.01	1.01	0.94	0.92	0.90	0.93	0.91	0.91	0.91	0.96	0.98
U4-U7	1.00	1.00	0.98	0.93	0.89	0.87	0.93	0.93	0.93	0.93	0.97	0.99

Round off:
0-999 = 10
>1000 = 100

U = Urban
R= Rural

1 - Interstate
2 - Freeway and Expressway
3 - Other Principal Arterial
4 - Minor Arterial
5 - Major Collector
6 - Minor Collector
7 - Local Road and Street

2013 Weekday Axle Correction Factors

Group	Factor
R1	0.94
R2	0.96
R3	0.97
R4-R7	0.98
U1	0.94
U2	0.96
U3	0.96
U4-U7	0.97

Appendix C

Crash Data

MassDOT Crash Reports for Nahant Road at Wilson Road, Nahant, MA

MassDOT Crash Number	Crash Date	Crash Time	Crash Severity	Number of Vehicles	Total Nonfatal Injuries	Total Fatal Injuries	Manner of Collision	Vehicle Action Prior to Crash	Vehicle Travel Directions	Most Harmful Events	Vehicle Configuration	Road Surface Condition	Ambient Light	Weather Condition	Distance from Nearest Roadway Intersection	Non Motorist Type
4119553	30-Jul-14	8:48 AM	Property damage only (none injured)	1	0	0	Single vehicle crash	V1: Turning right	V1:E	V1:(Collision with median barrier)	V1:(Light truck(van, mini-van, panel, pickup, sport utility) with only four tires)	Dry	Daylight	Clear	NAHANT ROAD / WILSON ROAD	
4119561	30-May-15	9:04 PM	Not Reported	1	0	0	Unknown	V1: Parked	V1:8	V1:(Collision with parked motor vehicle)	V1:(Passenger car)	Dry	Dusk	Clear	NAHANT RD	
4119569	21-Jul-15	9:35 AM	Property damage only (none injured)	2	0	0	Angle	V1: Turning left / V2:Travelling straight ahead	V1:S / V2:W	V1:(Collision with motor vehicle in traffic) V2:(Collision with motor vehicle in traffic)	V1:(Passenger car) V2:(Passenger car)	Dry	Daylight	Cloudy	WILSON RD / NAHANT RD	
4119572	28-Aug-15	7:02 PM	Property damage only (none injured)	2	0	0	Rear-end	V1: Parked / V2:Backing	V1:E / V2:W	V1:(Collision with motor vehicle in traffic) V2:(Collision with parked motor vehicle)	V1:(Passenger car) V2:(Passenger car)	Dry	Daylight	Clear	WILSON RD	
4193294	21-May-16	4:25 PM	Property damage only (none injured)	1	0	0	Rear-end	V1: Parked	V1:W	V1:(Collision with motor vehicle in traffic)	V1:(Passenger car)	Dry	Daylight	Clear/Cloudy	WILSON RD	
4210164	15-Jun-16	10:10 AM	Property damage only (none injured)	2	0	0	Rear-to-rear	V1: Parked / V2:Backing	V1:E / V2:E	V1:(Collision with motor vehicle in traffic) V2:(Collision with parked motor vehicle)	V1:(Passenger car) V2:(Light truck(van, mini-van, panel, pickup, sport utility) with only four tires)	Dry	Daylight	Clear	NAHANT RD	
4241969	19-Aug-2016	8:04 PM	Property damage only (none injured)	1	0	0	Single vehicle crash	V1: Travelling straight ahead	V1:S	V1:(Collision with other fixed object (wall, building, tunnel, etc.))	V1:(Bus (seats for more than 15 people, including driver))	Dry	Dark - lighted roadway	Clear	NAHANT ROAD	
4440135	26-Oct-16	1:12 PM	Property damage only (none injured)	2	0	0	Rear-end	V1: Slowing or stopped in traffic / V2:Backing	V1:E / V2:E	V1:(Collision with motor vehicle in traffic) V2:(Collision with parked motor vehicle)	V1:(Passenger car) V2:(Truck/trailer)	Dry	Daylight	Cloudy	WILSON ROAD	

MassDOT Crash Report for Nahant Road at Pleasant Street, Nahant, MA

MassDOT Crash Number	Crash Date	Crash Time	Crash Severity	Number of Vehicles	Total Nonfatal Injuries	Total Fatal Injuries	Manner of Collision	Vehicle Action Prior to Crash	Vehicle Travel Directions	Most Harmful Events	Vehicle Configuration	Road Surface Condition	Ambient Light	Weather Condition	Distance from Nearest Roadway Intersection	Non Motorist Type
3757184	11-Feb-14	1:45 PM	Property damage only (none injured)	1	0	0	Rear-to-rear	V1: Travelling straight ahead	V1:E	V1:(Collision with other fixed object (wall, building, tunnel, etc.))	V1:(Passenger car)	Wet	Daylight	Clear	NAHANT ROAD	

MassDOT Crash Report near Northeastern University Marine Science Center, Nahant, MA

MassDOT Crash Number	Crash Date	Crash Time	Crash Severity	Number of Vehicles	Total Nonfatal Injuries	Total Fatal Injuries	Manner of Collision	Vehicle Action Prior to Crash	Vehicle Travel Directions	Most Harmful Events	Vehicle Configuration	Road Surface Condition	Ambient Light	Weather Condition	Distance from Nearest Roadway Intersection	Non Motorist Type
4257511	26-Sep-16	5:10 PM	Property damage only (none injured)	2	0	0	Rear-to-rear	V1: Parked / V2:Backing	V1:8 / V2:S	V1:(Collision with motor vehicle in traffic) V2:(Collision with parked motor vehicle)	V1:(Light truck(van, mini-van, panel, pickup, sport utility) with only four tires) V2:(Unknown heavy truck, cannot classify)	Sand, mud, dirt, oil, gravel	Daylight	Clear	SWALLOW CAVE ROAD	

April 29, 2019

DRAFT STORMWATER REPORT

For

NORTHEASTERN UNIVERSITY
COASTAL SUSTAINABILITY INSTITUTE
Nahant, Massachusetts

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Nitsch Project #12125.1

DRAFT

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1.0 INTRODUCTION

Nitsch Engineering has prepared this Stormwater Report to support the Notice of Intent application to the Town of Nahant Conservation Commission for the new Northeastern University Coastal Sustainability Institute located in Nahant. The Project site is located at 430 Nahant Road in Nahant, Massachusetts (subsequently referred to as the "Site").

Northeastern University is proposing the construction of a new building above an existing subgrade bunker. The project will maintain the existing buildings onsite and will include some driveway realignment and resurfacing. The proposed building will require new utility services and walkway improvements. Two new parking areas are also proposed on-site along the existing driveway: one on the northern side of the site near the existing driveway entrance and one on the southern side of the site to the east of an existing Bordering Vegetated Wetland (BVW). These improvements represent a mix of new and redevelopment under the DEP Stormwater Management Standards as further described within this report.

The building and landscape design incorporate measures to protect wildlife and restore and enhance the existing habitat by removing invasive species and restoring native vegetation within the limit of work. Review and add language from landscape narrative if relevant.

The project also includes a proposed stormwater management system that to complies with the requirements of the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards.

2.0 EXISTING CONDITIONS

The Site is located at 430 Nahant Road at East Point in Nahant, Massachusetts on approximately 25 acres of open land with over 3,500 feet of ocean frontage. The Nahant Bay is located to the North of the Site and the Atlantic Ocean is located to the south of the Site. The Center abuts Swallow Cave Road to the west and Nahant Road to the north, with access provided by an existing driveway located off of Nahant Road.

The main laboratory building, the Edwards Laboratory, is located on the western portion of the site, near Swallow Cave Road, with smaller supporting buildings located to the north and south of the main lab. The central portion of the site is open space that includes a large depressed grassed lawn area to the north and a wooded wetland area to the south. In the eastern portion of the site, there is a historic bunker constructed below grade that is surrounded by wooded areas and access paths.

2.1 Existing Drainage Infrastructure

There is minimal drainage infrastructure onsite. Stormwater runoff from some roof areas is collected below grade and piped to a small closed drainage system that discharges offsite. There are limited catch basins onsite and the majority of the site flows overland to either low points onsite or directly to the Atlantic Ocean or Nahant Bay. The existing drainage system provides minimal treatment and peak rate mitigation.

2.2 NRCS Soil Designations

The Soil Classification Summary (Table 1) outlines the Natural Resources Conservation Services (NRCS) designation of the soil series at the Site. The majority of soils are classified as Udorthents with a hydrologic soil group (HSG) rating that is to be determined by field investigation. The Hollis-

Urban Land-Rock Outcrop Complex series are located on the western portion of the site is and the HSG rating is to be determined by field investigation. The Chatfield-Hollis-Rock outcrop complex soils are located on the eastern portion of the site and are HSG D (minimal infiltration).

Table 1. NRCS Soil Classification Summary

Soil Unit	Soil Series	Hydrologic Soil Group
102E	Chatfield-Hollis-Rock outcrop complex, 15 to 35 percent slopes	D
651	Udorthents, smoothed	---
724C	Hollis-Urban Land-Rock outcrop complex, sloping	---

2.3 On-Site Soil Investigations

Approximately 11 test pits were performed on the Site in 2017 by Haley & Aldrich. Five of the test pits are in the general vicinity of the proposed work on the western and eastern portions of the Site. These test pit logs are provided in Appendix E.

The results of HA17-TP1 and HA17-TP10 on the eastern portion of the site indicated glacial till comprised of sandy loam, which is classified as HSG B. Fill was found in both of the test pits at variable depths. Ledge was not encountered in either of the two test pits. Groundwater was found in HA17-TP10 at a depth of 10.5-feet.

HA17-TP2, HA17-TP8 and HA17-TP9 are located on the western portion of the site. HA17-TP8 and HA17-TP9 indicated glaciofluvial deposits comprised of a fine sand, which is classified as HSG A. Fill was found in the three test pits at variable depths. Probable bedrock was encountered in HA17-TP2 at a depth of 11-feet. Groundwater was not found in either of the three test pits.

For the purposes of the drainage design we have used an infiltration rate consistent with Sandy Loam (1.02 in/hr) to account for a conservative approach in the design. Test pits will be conducted prior to construction to confirm the soils information in the areas of the proposed stormwater systems is consistent with the Haley & Aldrich information.

For the purposes of the drainage design, Nitsch Engineering assumed an elevation of 11 feet for seasonal high groundwater. No groundwater was observed in the test pits performed by Nitsch Engineering. Elevation 11 is 2 feet above the elevation of the BVW.

2.4 Wetland Resource Areas

The Project site is bordered by the Nahant Bay to the North and the Atlantic Ocean to the South. The Site contains Coastal Bank, 100-foot buffer to Coastal Bank, Bordering Vegetated Wetland (BVW), and 100-foot buffer to BVW.

CLE Engineering conducted a site visit on October 11, 2017 to delineate these resource areas. Detailed information on these resources is provided in the Wetland Delineation Memorandum, prepared by CLE Engineering, INC, provided in Attachment B of the Notice of Intent. Refer to The NOI for a description of the locations of each of the resource areas.

2.5 FEMA Flood Zone

There are three different types of FEMA Floodplain Zones located on the project site. The FEMA zones extend from Nahant Bay, across the site and to the Atlantic Ocean.

- There is a 100-year Zone AE Floodplain at Elevation 13 associated with the Atlantic Ocean along the southern part of the property.
- There is a 100-year Zone AO Floodplain associated with Nahant Bay along the northern and central part of the property.
- There is a 100-year Zone VE Floodplain associated with Nahant Bay along the northern part of the property. There is a 100-year Zone VE floodplain associated with the Atlantic Ocean along the southern edge of the property.

The FEMA Flood Zones onsite are considered Land Subject to Coastal Flowage because they are subject to inundation caused by coastal storms up to and including the 100-year storm event. The FEMA Flood Zones onsite provide connectivity between Nahant Bay and the Atlantic Ocean during the 100-year storm event. The proposed work in these flood zones is minimal and does not change the surface elevation within the Land Subject to Coastal Storm Flowage.

Refer to the NOI for specific information regarding the regulatory requirements and the impacts of the project on the Flood Hazard Zones.

2.6 Total Maximum Daily Load (TMDL)

There is an existing TMDL for Nahant Bay for pathogens. The TMDL is titled, “Final Pathogen TMDL for the North Coastal Watershed, March 2012.” The Project has been designed to minimize stormwater discharge and associated pathogen pollutants through extensive filtration and infiltration practices to meet the intent of the TMDL.

3.0 PROPOSED CONDITIONS

Northeastern University is proposing the construction of a new building above the existing bunker. Two new parking areas are proposed onsite, one on the northerly side of the site near the existing driveway entrance, and one on the southerly side of the site to the east of the existing BVW.

The project will maintain the existing buildings onsite and will include some driveway realignment and resurfacing. The proposed building will require new utility services and walkway improvements. The limit of work for the project will not be the full extents of the property and portions of the site will remain untouched.

The building and landscape design will incorporate measures to protect wildlife and restore and enhance the existing habitat by removing invasive species and restoring native vegetation within the limit of work.

The proposed stormwater management system has been designed to comply with the requirements of the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards.

The Project is anticipated to increase the overall impervious area for the Project by approximately 1.15 acres. Refer to Table 2 for a comparison of the existing and proposed land use within the limit of work for this project.

Table 2. Proposed land use for 430 Nahant Road (in acres)

Land Use	Existing Site (acres)	Proposed Site (acres)	Change
Buildings	0.07	0.92	+0.85
Site Pavement	1.09	1.66	+0.57
Gravel Driveway	0.25	0.20	-0.05
Wooded Areas	5.78	0.00	-5.78
Landscape/Lawn	2.17	6.58	+4.41
Total	9.36	9.36	---

4.0 STORMWATER MANAGEMENT ANALYSIS

4.1 Methodology

Nitsch Engineering completed a hydrologic analysis of the existing project site utilizing Soil Conservation Service (SCS) Runoff Curve Number (CN) methodology. The SCS method calculates the rate at which the runoff reaches the design point considering several factors: the slope and flow lengths of the subcatchment area, the soil type of the subcatchment area, and the type of surface cover in the subcatchment area. HydroCAD Version 20.00 computer modeling software was used in conjunction with the SCS method to determine the peak runoff rates and runoff volumes for the 2-, 10-, and 100-year, 24-hour storm events. The proposed project site is being analyzed with the same methodology.

The Site was divided into multiple drainage areas, or subcatchments, which drain to the design points along the property boundary and within the site. For each subcatchment area, SCS Runoff Curve Numbers (CNs) were selected by using the cover type and hydrologic soil group of each area. The peak runoff rates and runoff volumes for the 2-, 10-, and 100-year 24-hour storm events were then determined by inputting the drainage areas, CNs, and time of concentration (T_c) paths into the HydroCAD model.

The National Oceanic and Atmospheric Administration Atlas 14 precipitation frequency estimates for Essex Country, Massachusetts were used to calculate the 2-, 10-, and 100- year 24-hour storm events in HydroCAD as follows:

Storm Event	24–hour Rainfall Depth
2-year	3.15 in.
10-year	4.83 in.
100-year	8.94 in.

4.2 HydroCAD Version 20.00

The HydroCAD computer program uses SCS and TR-20 methods to model drainage systems. TR-20 (Technical Release 20) was developed by the Soil Conservation Service to estimate runoff and peak discharges in small watersheds. TR-20 is generally accepted by engineers and reviewing authorities as the standard method for estimating runoff and peak discharges.

HydroCAD Version 20.00 uses up to four types of components to analyze the hydrology of a given site: subcatchments, reaches, basins, and links. Subcatchments are areas of land that produce surface runoff. The area, weighted CN, and T_c characterize each individual subcatchment area. Reaches are generally uniform streams, channels, or pipes that convey water from one point to another. A basin is any impoundment that fills with water from one or more sources and empties via an outlet structure. Links are used to introduce hydrographs into a project from another source or to provide a junction for more than one hydrograph within a project. The time span for the model was set for 0-48 hours in order to prevent truncation of the hydrograph.

4.3 Existing Hydrologic Conditions

Stormwater runoff from the existing site ultimately discharges to the Atlantic Ocean; however, Nitsch Engineering has delineated the project into subcatchment areas discharging to four (4) design points utilizing an existing conditions survey and on-site observations. Design Point 1 (DP-1) is the onsite BVW located on the South side of the site, Design Point 2 (DP-2) is the southern property boundary which discharges to the Atlantic Ocean, Design Point 3 (DP-3) is the northern property boundary which discharges to Nahant Bay and ultimately the Atlantic Ocean, and Design Point 4 (DP-4) discharges directly to the Atlantic Ocean. The BVW (DP-1) is hydraulically connected to DP-2 through an existing 18-inch outfall to the beach along the Atlantic Ocean.

There is an existing depression through the central part of the site where much of the stormwater runoff collects and either infiltrates or overflows to DP-1 or DP-3. No stormwater ponding has been observed in the existing depression. The depression has a highpoint in the middle of it which splits it into two parts, one in the north and one in the south. The northern part drains to a 15-inch outfall to DP-3 and the southern part drains to a 12-inch outfall to DP-1 (BVW).

The hydrologic analysis includes the entire property boundary and not just the limit of work because there are areas outside of the limit work that generate stormwater runoff the flows to each of the design points.

Figure DR-1 shows the delineation of the existing subcatchments and design points. The HydroCAD model for existing conditions is provided in Appendix B and results from the HydroCAD calculations are summarized below in Table 3.

4.4 Proposed Hydrologic Conditions

The four (4) design points from the existing conditions analysis are used for the proposed analysis. The project has been designed to mitigate any increase in stormwater runoff to the BVW (DP-1) but not to DP-2, DP-3, or DP-4 because they are connected to Lands Subject to Coastal Storm Flowage. Under MassDEP Standards, pre- and post-development peak discharge rates are not required to be met for discharges to Lands Subject to Coastal Storm Flowage.

Refer to Figure DR-2 for the breakdown of the site into subcatchments. The HydroCAD model for proposed conditions is provided in Appendix C and results from the calculations for stormwater runoff to DP-1 are summarized in Table 3.

The proposed hydrologic analysis continues to show the entire property boundary and not just the area within the LOW. Refer to Figure DR-3 for a visual depiction of subcatchment areas outside the LOW, areas within the LOW that are considered New Development, and areas within the LOW that are considered redevelopment.

4.5 Peak Flow Rates

The proposed stormwater management system is expected to reduce the proposed peak runoff rates to at or below the existing rates for Design Point 1 (BVW). Table 3 below summarize the existing and proposed hydrologic analyses for the design point in the 2-, 10-, and 100-year storm events.

Table 3 – Peak Rates of Runoff in Cubic Feet per Second (cfs)

	Storm Event	2-year	10-year	100-year
DP-1	Existing	1.52	5.54	18.62
	Proposed	1.10	4.30	17.94

5.0 MassDEP Stormwater Management Standards

The Site will include the installation of a stormwater management system that is designed to meet the MassDEP Stormwater Management Standards. The Project is considered a mix of ***redevelopment*** and ***new development*** under the DEP Stormwater Management System.

The following is a summary of the new development and redevelopment areas. Also refer to Figure DP-3: Summary of New Development and Redevelopment Areas for additional clarity on these areas.

- Subcatchments PR-1C, PR-1D, PR-3B, PR-3C, PR-4A, and PR-4B are considered to be New Development under the Standards because new impervious area is proposed.

- Subcatchments PR-1B, PR-3A, PR-4D, and PR-4E are considered to be Redevelopment under the Standards because these areas are developed in the existing condition and no new impervious area is proposed.

- Subcatchments PR-1A, PR-2A, PR-2B, PR-4C, and PR-4F are outside the limit of work but contribute runoff to the project area, so they were included in the analysis of runoff quantities.

The portions of the site that are considered new development will meet the MassDEP Stormwater Management Standards. The portions of the site that are considered redevelopment are required to meet Standards 2, 3 and the pretreatment and structural best management practice requirements of Standards 4,5, and 6 only to the maximum extent practicable. Existing stormwater discharges need to comply with Standard 1 only to the maximum extent practicable. The portions of the site considered redevelopment will comply with all other Standards. The site will be designed to meet the MassDEP Stormwater Management Standards to the maximum extent practicable.

The Site will meet the MassDEP Stormwater Management Standards as summarized below:

Standard 1: No New Untreated Discharges

The Project will not discharge any new untreated stormwater directly to or cause erosion in wetlands or waters of the Commonwealth. Stormwater from the Site will be collected and treated in accordance with the MassDEP Stormwater Management Standards and stormwater outfalls will be stabilized to prevent erosion.

Standard 2: Peak Rate Attenuation

The proposed stormwater management system will be designed so that the post-development peak discharge rates do not exceed pre-development peak discharge rates for stormwater discharging to DP-1 (BVW). To prevent storm damage and downstream flooding, the proposed stormwater management practices will mitigate peak runoff rates for the 2-, 10-, and 100-year, 24-hour storm events.

The pre- and post-development rates to DP-2, DP-3, and DP-4 were not analyzed under Standard 2 because they discharge to Land Subject to Coastal Storm Flowage and matching peak runoff rates is not required in these areas. Refer to Table 3 for a pre- and post- development peak runoff rate comparison to DP-1.

Standard 3: Groundwater Recharge

The required groundwater recharge was calculated using all of the impervious area within the project limit of work including all redevelopment and new development areas. Areas outside of the limit of work were not considered as part of this requirement.

The Site was designed using stormwater BMP treatment trains to minimize the loss of annual recharge to groundwater. The annual recharge from the post-development site will approximate the annual recharge from pre-development conditions based on soil type using the guidelines provided in the MassDEP Stormwater Management Handbook.

Impervious Area in HSG B	= 2.78 acres (Including paved, roof, and gravel areas)
Rv (Recharge Volume)	= 2.78 acres x 43,560 sf x 0.35 in. / (12 inches/ft)
	= 3,532 cubic feet
Total Required Recharge Volume	= 3,532 cubic feet

Percentage of the site within the Limit of Work directed to an infiltration BMP:

Total Impervious within Limit of Work	=2.78 acres
Total Impervious Directed to Infiltration	=1.87 acres
% of Impervious Directed to Infiltration	=67%

Adjusted Required Recharge Volume = [1/ (67% to recharge system)] x Required Recharge Volume
= [1/0.67] x 3,532 cubic feet
= 1.49 x 3,532 cubic feet
= **5,272 cubic feet**

The infiltration BMPs are sized to exceed the recharge volume required under the MassDEP Stormwater Management Standards. Table 5 below summarizes the proposed recharge volume provided by each BMP.

Table 5 – Proposed Recharge Volumes for Stormwater BMPs

Infiltration BMP	Recharge Volume (cf)
Bioretention Basin	7,100
Subsurface Infiltration System 1	8,260
Subsurface Infiltration System 2	9,070
Stormwater Garden 1	5,985
Stormwater Garden 2	2,670
Total	**33,085**

The proposed Recharge volume for each BMP was calculated using the simple dynamic method as follows:

SA=Rv/(D+KT) so Rv=SA(D+KT) where
Rv=Recharge Volume
D=Depth of infiltration facility
SA= Surface area of the infiltration system
K=Saturated hydraulic conductivity
T=Allowable drawdown during the peak of the storm (2 hours)

Bioretention Basin
SA(D+KT)=Rv
2,338(1+1.02x2) = 7,100 cf

Subsurface Infiltration System #1 (North)
SA(D+KT)=Rv
67.28X44.83(0.7+1.02x2) = 8,260 cf

Subsurface Infiltration System #2 (South)
SA(D+KT)=Rv
74.82x44.25(0.7+1.02x2)=9,070 cf

Stormwater Garden #1
SA(D+KT)=Rv
2,558(0.3+1.02x2)=5,985 cf

Stormwater Garden #2
SA(D+KT)=Rv
845(1+1.02x2)=2,670 cf

The calculations provided in Appendix A show that all proposed infiltration BMPs will drain within 72 hours for the 2-, 10-, and 100-year storm events, meeting the 72-hour MassDEP drawdown requirement.

Parts of the proposed site discharge to a bathing beach and as such, those portions of the site are subject to the 44% TSS removal prior to discharge into an infiltration BMP requirement. DP-1, DP-2, and DP-3 discharge to potential bathing beaches. Refer to Appendix A for TSS removal calculations.

Standard 4: Water Quality Treatment

Because portions of the site are outside of the limit of work or are considered redevelopment, only the portions of the site that are new development have been included in this analysis. PR-4B does not contain any non-roof impervious area and was therefore not included as part of this analysis.

The proposed stormwater management system will be designed to remove greater than 80% of the average annual post-construction load of Total Suspended Solids (TSS). Structural stormwater BMPs including deep-sump and hooded catch basins, a bioretention basin, an isolator row, and Stormceptor® water quality units are sized to capture the required water quality volume (1 inch over the project site), provide 44% pretreatment prior to infiltration, and remove a minimum of 80% of total suspended solids.

Table 6. Proposed Treatment Train for New Impervious Area Summary

Watershed	Treatment Train
PR1C	Trench Drain with Stone Sump- Bioretention Basin- Underground Infiltration System
PR1D	Deep Sump and Hooded Catch Basin- Isolator Row- Underground Infiltration System
PR3B	Deep Sump and Hooded Catch Basin- Isolator Row- Underground Infiltration System
PR3C	Water Quality Structure
PR4A	Sediment Forebay, Isolator Row, Underground Infiltration System

Portions of the site are subject to the 44% TSS removal pretreatment requirement and the 1-inch rule for calculating water quality volumes because Nitsch has approached the design conservatively and is assuming DP-2 and DP-3 are bathing beaches.

Pretreatment for the infiltration BMPs discharging to a bathing beach will meet the 44% TSS removal requirement. Stormwater runoff will flow into trench drains that cross beneath the proposed sidewalks and then continue to stone sumps located on the basin side of the trench drains prior to discharge into the bioretention basin. Pretreatment for the subsurface infiltration systems will be provided using deep sump and hooded catch basins and isolator rows that have been sized using the flow rate associated with the water quality volume.

TSS removal calculation spreadsheets and water quality structure sizing calculations are provided in Appendix A.

The proposed stormwater management system for the Project will include deep-sump and hooded catch basins, bioretention basins, subsurface infiltration systems with isolator rows, stormwater surface basin, and proprietary water quality structures.

<u>Deep-Sump and Hooded Catch Basins</u>

Deep-sump and hooded catch basins are proposed to provide pretreatment in the impervious areas of the parking lot and driveways. Stormwater captured in the catch basins will be directed to another treatment or infiltration BMP prior to discharge.

Subsurface Infiltration Systems with Isolator Row

Stormwater will be collected and infiltrated using two (2) subsurface infiltration systems. Subsurface Infiltration System #1 is located in the northern parking lot and is proposed to collect, treat, and infiltrate the runoff from the northern parking lot and adjacent landscaped area. The system consists of StormTech SC-310 chambers surrounded by crushed stone. Overflow from the underground system will flow into an existing pipe which discharges to the Nahant Bay (DP-3).

Subsurface Infiltration System 2 is proposed in the southern parking lot and will collect, treat, and infiltrate stormwater runoff from the access driveway to the south of the building, and the adjacent landscaped areas. The system consists of StormTech SC-740 chambers surrounded by crushed stone. Overflow from the underground system will discharge through a flared end section and flow overland into the BVW (DP-1).

Site impervious area that is tributary to the underground infiltration systems will be pretreated using deep sump and hooded catch basins and isolator rows to meet the 44% TSS removal requirement set forth by the MassDEP Stormwater Standards for discharge to a bathing beach. Isolator row sizing calculations are included in Appendix A.

Bioretention Basin

A bioretention basin is proposed to treat stormwater runoff generated by the southern parking lot. The bioretention basin includes a minimum 24-inch media filter to provide TSS and nutrient pollutant removal and will provide infiltration. An infiltration media will be provided underneath the bioretention basin to allow for mitigation of storm events.

Runoff from the parking lot will be directed into trench drains that cross beneath the proposed sidewalks. Stone sumps will be located on the basin side of the trench drains to provide pretreatment before overflowing to the basin. The pretreatment in combination with the bioretention basin will provide the 44% pretreatment and 80% TSS removal before the stormwater reaches the infiltration media.

The Bioretention Basin in combination with Subsurface Infiltration System #2 are designed to mitigate peak runoff rates in the 2-, 10-, and 100- year storms to the BVW (DP-1).

Stormwater Surface Basin

A stormwater surface basin is proposed to infiltrate stormwater generated by the building roof. The stormwater basin will include a 1-foot deep infiltration media beneath the surface to promote infiltration to the maximum extent possible. The basin has been sized to infiltrate 0.35 inches of runoff generated by the roof and will overflow overland to the Atlantic Ocean. No pretreatment is required because the runoff from the roof is considered clean.

Water Quality Structures/Inlets

Proprietary water quality structures and water quality inlets are proposed for water quality pretreatment in areas of the Site where space is limited. These BMPs have been designed to remove 80% TSS. Sizing calculations are provided in Appendix A.

Source control and pollution prevention measures, such as vacuum cleaning, street sweeping, proper snow management, and stabilization of eroded surfaces, are included in the Long-Term Pollution Prevention Plan and Operation and Maintenance Plan (Appendix D).

Standard 5: Land Uses with Higher Potential Pollutant Loads

The project is not considered a LUHPPL and therefore, this standard is not applicable.

Standard 6: Critical Areas

Stormwater discharges directed to a critical area, require the use of the specific source control and pollution prevention measures and the specific structural stormwater BMPs determined to be suitable for managing discharges to such areas, as provided in the Massachusetts Stormwater Handbook.

The Project discharges stormwater runoff to a bathing beach; therefore, this standard is applicable.

All projects that have the potential to impact critical areas shall implement a source control and pollution prevention program that includes proper management of snow and deicing chemicals. Stormwater discharge to a bathing beach requires the use of a treatment train that provides 80% TSS removal prior to discharge. With the exception of runoff from a non-metal roof, the treatment train shall provide at least 44% TSS removal prior to discharge to the infiltration structure. For discharges to a bathing beach, the treatment BMPs must be designed to treat the required water quality volume, a volume equal to 1-inch times the total impervious surfaces at the post-development site. TSS removal calculations have been provided in Appendix A.

The Project will comply with these requirements. A Long-Term Pollution Prevention Plan (LTPPP) is included that states requirements for proper management and storage of snow and deicing chemicals. Stormwater BMPs were chosen based on recommendations listed under Standard 6 in the Stormwater Handbook. BMPs remove at least 80% TSS, and systems and basins were sized to treat the 1-inch water quality volume.

Standard 7: Redevelopments

Portions of the site are considered a redevelopment under the MassDEP Stormwater Management Standards. Therefore, the project is required to meet Standard 2, Standard 3, and the pretreatment and structural stormwater BMP requirements of Standards 4, 5, and 6 to the maximum extent practicable. The projects should comply with all other requirements of the Stormwater Management Standards and improve existing conditions. The Project meets this standard.

Standard 8: Construction Period Pollution Prevention and Sedimentation Control

Erosion and sedimentation controls are proposed to reduce the construction-related impact of the proposed project on adjacent wetland resource areas (Refer to the Erosion and Sedimentation Control Plan provided under separate cover). Control measures will include, but are not limited to, minimizing land disturbance, providing temporary stabilization and covers, installing perimeter controls (silt fence and straw wattles/bales), and providing stormwater inlet protection (silt sack, straw wattles/bales). These erosion and sediment controls are shown in the plan set submitted with the Stormwater Report and NOI.

The Site Contractor will be responsible for stormwater management of the active construction site and is required to adhere to the conditions of the 2017 Construction General Permit under the Environmental Protection Agency (through the preparation and implementation of a Rockland and Hingham Conservation Commissions and MassDEP. A draft SWPPP will be prepared in accordance with the MassDEP Stormwater Management Standards and the 2017 Construction General Permit and will be submitted for review prior to the start of construction.

The contractor will be required to do inspections of all controls regularly to ensure that the controls are working properly. The contractor shall clean and reinstall any control that needs to be cleaned or

replaced. Additionally, the contractor will clean/flush the entire stormwater management system prior to final acceptance by the owner.

Because the Project will disturb more than one (1) acre of land, a Notice of Intent will be submitted to the Environmental Protection Agency (EPA) for coverage under the National Pollution Discharge Elimination System (NPDES) Construction General Permit. As part of this application the Applicant is required to prepare a Stormwater Pollution Prevention Plan (SWPPP) and implement the measures in the SWPPP. The SWPPP, which is to be kept on site, includes erosion and sediment controls (stabilization practices and structural practices), temporary and permanent stormwater management measures, Contractor inspection schedules and reporting of all SWPPP features, materials management, waste disposal, off-site vehicle tracking, spill prevention and response, sanitation, and non-stormwater discharges. The SWPPP will be submitted for review prior to any land disturbance.

Standard 9: Operation and Maintenance Plan

A post-construction operation and maintenance plan has been prepared and will be implemented to ensure that stormwater management systems function as designed. Source control and stormwater BMP operation requirements for the Site are summarized in the Long-Term Pollution Prevention Plan and Operation and Maintenance Plan provided in Appendix D.

Standard 10: Prohibition of Illicit Discharges

There will be no illicit discharges to the stormwater management system associated with the Project. An Illicit Discharge Compliance Statement is provided in Appendix A.

6.0 CONCLUSION

In conclusion, the Project's stormwater management system will reduce or maintain peak runoff rates to the BVW through the widespread use of infiltration BMPs and is not required to reduce the peak runoff rates to discharges to land subject to coastal storm flowage. The system is designed to improve the water quality of stormwater being discharged from the Site. Environmentally sensitive site design techniques will be implemented throughout the Site. The Project is being designed to meet the MassDEP Stormwater Management Standards.

FIGURES

DR-1 Existing Watershed Areas
DR-2 Proposed Watershed Areas
DR-3 Summary of New Development and Redevelopment Areas

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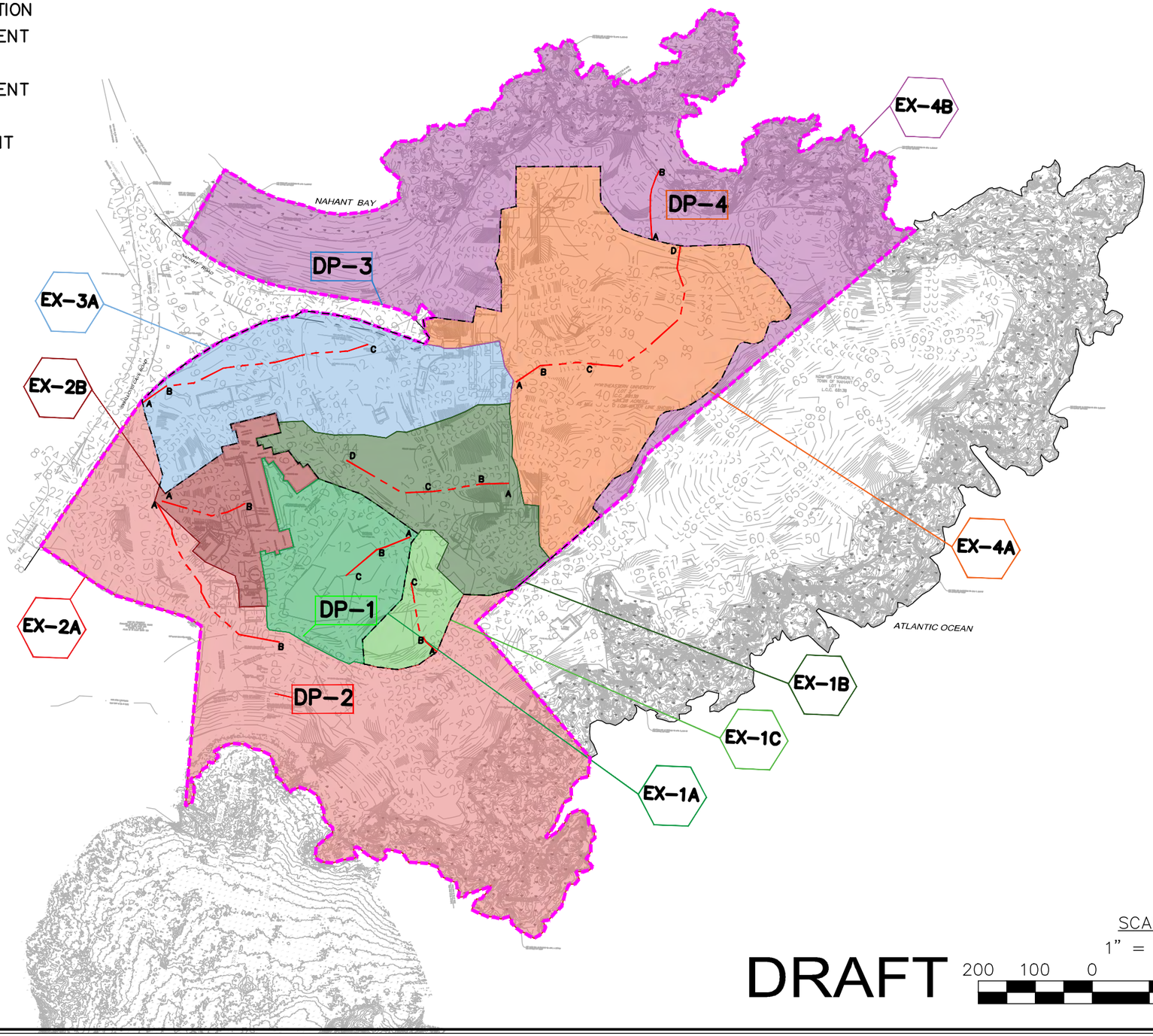
LEGEND

A — B TIME OF CONCENTRATION

SUBCATCHMENT AREA

EX-2 SUBCATCHMENT AREA

DP-1 DESIGN POINT



DRAFT

SCALE:
1" = 200'
200 100 0 200 400

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EXISTING DRAINAGE PLAN

NORTHEASTERN UNIVERSITY COASTAL SUSTAINABILITY INSTITUTE
430 NAHANT ROAD, NAHANT, MA

PREPARED FOR:
NORTHEASTERN UNIVERSITY
360 HUNTINGTON AVENUE, BOSTON, MA

PROJECT #	12125
FILE:	12125CDT-EX.DWG
SCALE:	1"=200'
DATE:	04-29-2019
PROJECT MGR:	WM
SURVEYOR:	NITSCH
DRAFTED BY:	AM
CHECKED BY:	BV

DR-1

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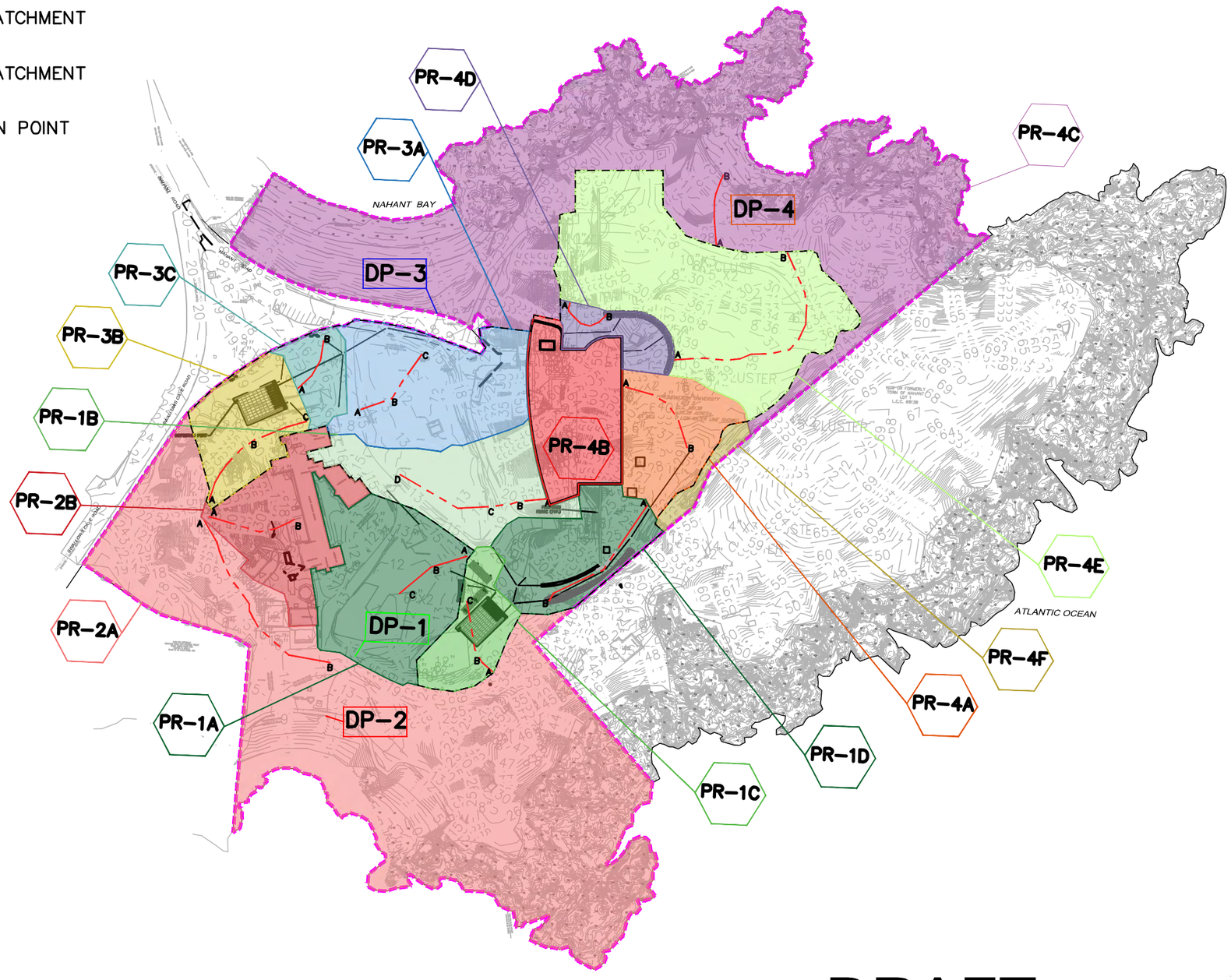
LEGEND

A — B TIME OF CONCENTRATION

SUBCATCHMENT AREA

PR-2 SUBCATCHMENT AREA

DP-1 DESIGN POINT



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PROPOSED DRAINAGE PLANS
NORTHEASTERN UNIVERSITY COASTAL SUSTAINABILITY INSTITUTE
430 NAHANT ROAD, NAHANT, MA

PREPARED FOR:
NORTHEASTERN UNIVERSITY
360 HUNTINGTON AVENUE, BOSTON, MA

PROJECT #	12125
FILE:	12125CDT-PR.DWG
SCALE:	1"=200'
DATE:	04-29-2019
PROJECT MGR:	WM
SURVEYOR:	NITSCH
DRAFTED BY:	AM
CHECKED BY:	BV

DR-2

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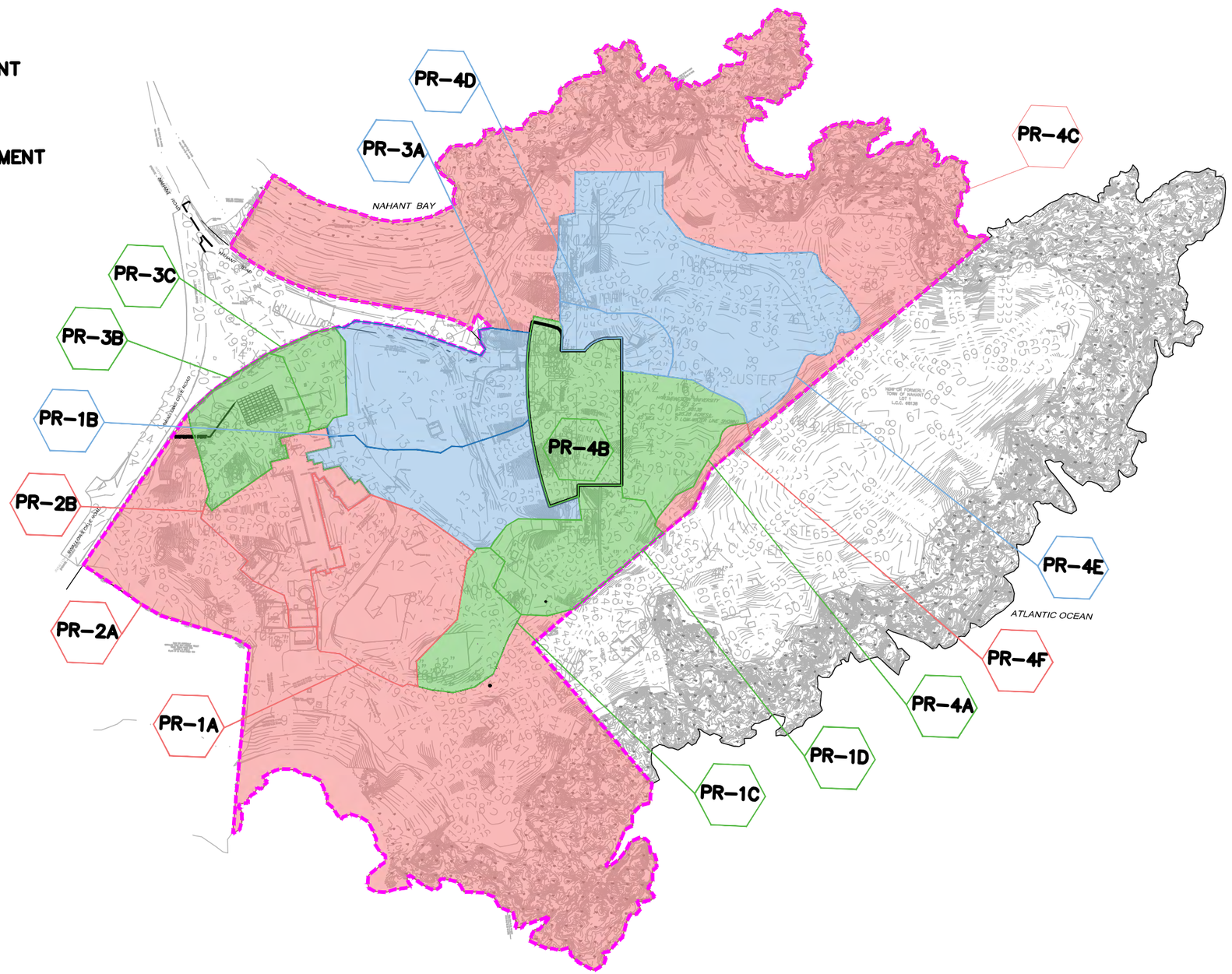
LEGEND

- PR-1A OUTSIDE LIMIT OF WORK
- PR-1B REDEVELOPMENT
- PR-1C NEW DEVELOPMENT



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SCALE:
1" = 200'
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SUMMARY OF NEW DEVELOPMENT AND REDEVELOPMENT AREAS

NORTHEASTERN UNIVERSITY COASTAL SUSTAINABILITY INSTITUTE
430 NAHANT ROAD, NAHANT, MA

PREPARED FOR:
NORTHEASTERN UNIVERSITY
360 HUNTINGTON AVENUE, BOSTON, MA

PROJECT #	12125
FILE:	12125DR3.DWG
SCALE:	1"=200'
DATE:	04-29-2019
PROJECT MGR:	WM
SURVEYOR:	NITSCH
DRAFTED BY:	AM
CHECKED BY:	BV

DR-3

APPENDIX A

Stormwater Management Standards Documentation

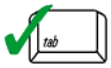
MassDEP Checklist for Stormwater Report
Standard 3: 72-Hr Drawdown Calculations
Standard 4: TSS Removal Calculations
Standard 4: Proprietary Water Quality Structure Calculations
Standard 10: Illicit Discharge Compliance Statement

Massachusetts Department of Environmental Protection
Bureau of Resource Protection - Wetlands Program

Checklist for Stormwater Report

A. Introduction

Important: When filling out forms on the computer, use only the tab key to move your cursor - do not use the return key.



A Stormwater Report must be submitted with the Notice of Intent permit application to document compliance with the Stormwater Management Standards. The following checklist is NOT a substitute for the Stormwater Report (which should provide more substantive and detailed information) but is offered here as a tool to help the applicant organize their Stormwater Management documentation for their Report and for the reviewer to assess this information in a consistent format. As noted in the Checklist, the Stormwater Report must contain the engineering computations and supporting information set forth in Volume 3 of the Massachusetts Stormwater Handbook. The Stormwater Report must be prepared and certified by a Registered Professional Engineer (RPE) licensed in the Commonwealth.

The Stormwater Report must include:

- The Stormwater Checklist completed and stamped by a Registered Professional Engineer (see page 2) that certifies that the Stormwater Report contains all required submittals.[1] This Checklist is to be used as the cover for the completed Stormwater Report.
- Applicant/Project Name
- Project Address
- Name of Firm and Registered Professional Engineer that prepared the Report
- Long-Term Pollution Prevention Plan required by Standards 4-6
- Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan required by Standard 8[2]
- Operation and Maintenance Plan required by Standard 9

In addition to all plans and supporting information, the Stormwater Report must include a brief narrative describing stormwater management practices, including environmentally sensitive site design and LID techniques, along with a diagram depicting runoff through the proposed BMP treatment train. Plans are required to show existing and proposed conditions, identify all wetland resource areas, NRCS soil types, critical areas, Land Uses with Higher Potential Pollutant Loads (LUHPPL), and any areas on the site where infiltration rate is greater than 2.4 inches per hour. The Plans shall identify the drainage areas for both existing and proposed conditions at a scale that enables verification of supporting calculations.

As noted in the Checklist, the Stormwater Management Report shall document compliance with each of the Stormwater Management Standards as provided in the Massachusetts Stormwater Handbook. The soils evaluation and calculations shall be done using the methodologies set forth in Volume 3 of the Massachusetts Stormwater Handbook.

To ensure that the Stormwater Report is complete, applicants are required to fill in the Stormwater Report Checklist by checking the box to indicate that the specified information has been included in the Stormwater Report. If any of the information specified in the checklist has not been submitted, the applicant must provide an explanation. The completed Stormwater Report Checklist and Certification must be submitted with the Stormwater Report.

---

[1] The Stormwater Report may also include the Illicit Discharge Compliance Statement required by Standard 10. If not included in the Stormwater Report, the Illicit Discharge Compliance Statement must be submitted prior to the discharge of stormwater runoff to the post-construction best management practices.

[2] For some complex projects, it may not be possible to include the Construction Period Erosion and Sedimentation Control Plan in the Stormwater Report. In that event, the issuing authority has the discretion to issue an Order of Conditions that approves the project and includes a condition requiring the proponent to submit the Construction Period Erosion and Sedimentation Control Plan before commencing any land disturbance activity on the site.

Checklist for Stormwater Report

B. Stormwater Checklist and Certification

The following checklist is intended to serve as a guide for applicants as to the elements that ordinarily need to be addressed in a complete Stormwater Report. The checklist is also intended to provide conservation commissions and other reviewing authorities with a summary of the components necessary for a comprehensive Stormwater Report that addresses the ten Stormwater Standards.

Note: Because stormwater requirements vary from project to project, it is possible that a complete Stormwater Report may not include information on some of the subjects specified in the Checklist. If it is determined that a specific item does not apply to the project under review, please note that the item is not applicable (N.A.) and provide the reasons for that determination.

A complete checklist must include the Certification set forth below signed by the Registered Professional Engineer who prepared the Stormwater Report.

Registered Professional Engineer's Certification

I have reviewed the Stormwater Report, including the soil evaluation, computations, Long-term Pollution Prevention Plan, the Construction Period Erosion and Sedimentation Control Plan (if included), the Long-term Post-Construction Operation and Maintenance Plan, the Illicit Discharge Compliance Statement (if included) and the plans showing the stormwater management system, and have determined that they have been prepared in accordance with the requirements of the Stormwater Management Standards as further elaborated by the Massachusetts Stormwater Handbook. I have also determined that the information presented in the Stormwater Checklist is accurate and that the information presented in the Stormwater Report accurately reflects conditions at the site as of the date of this permit application.

Registered Professional Engineer Block and Signature

Signature and Date

Checklist

Project Type: Is the application for new development, redevelopment, or a mix of new and redevelopment?

☐ New development

☐ Redevelopment

☒ Mix of New Development and Redevelopment

Checklist for Stormwater Report

Checklist (continued)

LID Measures: Stormwater Standards require LID measures to be considered. Document what environmentally sensitive design and LID Techniques were considered during the planning and design of the project:

- ☐ No disturbance to any Wetland Resource Areas
- ☐ Site Design Practices (e.g. clustered development, reduced frontage setbacks)
- ☐ Reduced Impervious Area (Redevelopment Only)
- ☐ Minimizing disturbance to existing trees and shrubs
- ☐ LID Site Design Credit Requested:
  - ☐ Credit 1
  - ☐ Credit 2
  - ☐ Credit 3
- ☐ Use of "country drainage" versus curb and gutter conveyance and pipe
- ☒ Bioretention Cells (includes Rain Gardens)
- ☐ Constructed Stormwater Wetlands (includes Gravel Wetlands designs)
- ☐ Treebox Filter
- ☐ Water Quality Swale
- ☐ Grass Channel
- ☐ Green Roof
- ☒ Other (describe): Subsurface Infiltration System, Grass Swale

Standard 1: No New Untreated Discharges

- ☒ No new untreated discharges
- ☒ Outlets have been designed so there is no erosion or scour to wetlands and waters of the Commonwealth
- ☒ Supporting calculations specified in Volume 3 of the Massachusetts Stormwater Handbook included.

Checklist for Stormwater Report

Checklist (continued)

Standard 2: Peak Rate Attenuation

☒ Standard 2 waiver requested because the project is located in land subject to coastal storm flowage and stormwater discharge is to a wetland subject to coastal flooding.

☐ Evaluation provided to determine whether off-site flooding increases during the 100-year 24-hour storm.

☐ Calculations provided to show that post-development peak discharge rates do not exceed pre-development rates for the 2-year and 10-year 24-hour storms. If evaluation shows that off-site flooding increases during the 100-year 24-hour storm, calculations are also provided to show that post-development peak discharge rates do not exceed pre-development rates for the 100-year 24-hour storm.

Standard 3: Recharge

☒ Soil Analysis provided.

☒ Required Recharge Volume calculation provided.

☐ Required Recharge volume reduced through use of the LID site Design Credits.

☒ Sizing the infiltration, BMPs is based on the following method: Check the method used.

☐ Static ☒ Simple Dynamic ☐ Dynamic Field[1]

☐ Runoff from all impervious areas at the site discharging to the infiltration BMP.

☒ Runoff from all impervious areas at the site is *not* discharging to the infiltration BMP and calculations are provided showing that the drainage area contributing runoff to the infiltration BMPs is sufficient to generate the required recharge volume.

☒ Recharge BMPs have been sized to infiltrate the Required Recharge Volume.

☐ Recharge BMPs have been sized to infiltrate the Required Recharge Volume *only* to the maximum extent practicable for the following reason:

- ☐ Site is comprised solely of C and D soils and/or bedrock at the land surface
- ☐ M.G.L. c. 21E sites pursuant to 310 CMR 40.0000
- ☐ Solid Waste Landfill pursuant to 310 CMR 19.000
- ☐ Project is otherwise subject to Stormwater Management Standards only to the maximum extent practicable.

☒ Calculations showing that the infiltration BMPs will drain in 72 hours are provided.

☐ Property includes a M.G.L. c. 21E site or a solid waste landfill and a mounding analysis is included.

[1] 80% TSS removal is required prior to discharge to infiltration BMP if Dynamic Field method is used.

Checklist for Stormwater Report

Checklist (continued)

Standard 3: Recharge (continued)

☐ The infiltration BMP is used to attenuate peak flows during storms greater than or equal to the 10-year 24-hour storm and separation to seasonal high groundwater is less than 4 feet and a mounding analysis is provided.

☐ Documentation is provided showing that infiltration BMPs do not adversely impact nearby wetland resource areas.

Standard 4: Water Quality

The Long-Term Pollution Prevention Plan typically includes the following:

- Good housekeeping practices;
- Provisions for storing materials and waste products inside or under cover;
- Vehicle washing controls;
- Requirements for routine inspections and maintenance of stormwater BMPs;
- Spill prevention and response plans;
- Provisions for maintenance of lawns, gardens, and other landscaped areas;
- Requirements for storage and use of fertilizers, herbicides, and pesticides;
- Pet waste management provisions;
- Provisions for operation and management of septic systems;
- Provisions for solid waste management;
- Snow disposal and plowing plans relative to Wetland Resource Areas;
- Winter Road Salt and/or Sand Use and Storage restrictions;
- Street sweeping schedules;
- Provisions for prevention of illicit discharges to the stormwater management system;
- Documentation that Stormwater BMPs are designed to provide for shutdown and containment in the event of a spill or discharges to or near critical areas or from LUHPPL;
- Training for staff or personnel involved with implementing Long-Term Pollution Prevention Plan;
- List of Emergency contacts for implementing Long-Term Pollution Prevention Plan.

☒ A Long-Term Pollution Prevention Plan is attached to Stormwater Report and is included as an attachment to the Wetlands Notice of Intent.

☒ Treatment BMPs subject to the 44% TSS removal pretreatment requirement and the one inch rule for calculating the water quality volume are included, and discharge:

- ☐ is within the Zone II or Interim Wellhead Protection Area
- ☒ is near or to other critical areas
- ☐ is within soils with a rapid infiltration rate (greater than 2.4 inches per hour)
- ☐ involves runoff from land uses with higher potential pollutant loads.

☐ The Required Water Quality Volume is reduced through use of the LID site Design Credits.

☒ Calculations documenting that the treatment train meets the 80% TSS removal requirement and, if applicable, the 44% TSS removal pretreatment requirement, are provided.

Checklist (continued)

Standard 4: Water Quality (continued)

☒ The BMP is sized (and calculations provided) based on:

- ☒ The ½" or 1" Water Quality Volume or
- ☒ The equivalent flow rate associated with the Water Quality Volume and documentation is provided showing that the BMP treats the required water quality volume.

☒ The applicant proposes to use proprietary BMPs, and documentation supporting use of proprietary BMP and proposed TSS removal rate is provided. This documentation may be in the form of the propriety BMP checklist found in Volume 2, Chapter 4 of the Massachusetts Stormwater Handbook and submitting copies of the TARP Report, STEP Report, and/or other third party studies verifying performance of the proprietary BMPs.

☒ A TMDL exists that indicates a need to reduce pollutants other than TSS and documentation showing that the BMPs selected are consistent with the TMDL is provided.

Standard 5: Land Uses With Higher Potential Pollutant Loads (LUHPPLs)

☐ The NPDES Multi-Sector General Permit covers the land use and the Stormwater Pollution Prevention Plan (SWPPP) has been included with the Stormwater Report.

☐ The NPDES Multi-Sector General Permit covers the land use and the SWPPP will be submitted ***prior to*** the discharge of stormwater to the post-construction stormwater BMPs.

☐ The NPDES Multi-Sector General Permit does ***not*** cover the land use.

☐ LUHPPLs are located at the site and industry specific source control and pollution prevention measures have been proposed to reduce or eliminate the exposure of LUHPPLs to rain, snow, snow melt and runoff, and been included in the long term Pollution Prevention Plan.

☐ All exposure has been eliminated.

☐ All exposure has ***not*** been eliminated and all BMPs selected are on MassDEP LUHPPL list.

☐ The LUHPPL has the potential to generate runoff with moderate to higher concentrations of oil and grease (e.g. all parking lots with >1000 vehicle trips per day) and the treatment train includes an oil grit separator, a filtering bioretention area, a sand filter or equivalent.

Standard 6: Critical Areas

☒ The discharge is near or to a critical area and the treatment train includes only BMPs that MassDEP has approved for stormwater discharges to or near that particular class of critical area.

☒ Critical areas and BMPs are identified in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 7: Redevelopments and Other Projects Subject to the Standards only to the maximum extent practicable

☒ The project is subject to the Stormwater Management Standards only to the maximum Extent Practicable as a:

- ☐ Limited Project
- ☐ Small Residential Projects: 5-9 single family houses or 5-9 units in a multi-family development provided there is no discharge that may potentially affect a critical area.
- ☐ Small Residential Projects: 2-4 single family houses or 2-4 units in a multi-family development with a discharge to a critical area
- ☐ Marina and/or boatyard provided the hull painting, service and maintenance areas are protected from exposure to rain, snow, snow melt and runoff
- ☐ Bike Path and/or Foot Path
- ☐ Redevelopment Project
- ☒ Redevelopment portion of mix of new and redevelopment.

☒ Certain standards are not fully met (Standard No. 1, 8, 9, and 10 must always be fully met) and an explanation of why these standards are not met is contained in the Stormwater Report.

☐ The project involves redevelopment and a description of all measures that have been taken to improve existing conditions is provided in the Stormwater Report. The redevelopment checklist found in Volume 2 Chapter 3 of the Massachusetts Stormwater Handbook may be used to document that the proposed stormwater management system (a) complies with Standards 2, 3 and the pretreatment and structural BMP requirements of Standards 4-6 to the maximum extent practicable and (b) improves existing conditions.

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control

A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan must include the following information:

- Narrative;
- Construction Period Operation and Maintenance Plan;
- Names of Persons or Entity Responsible for Plan Compliance;
- Construction Period Pollution Prevention Measures;
- Erosion and Sedimentation Control Plan Drawings;
- Detail drawings and specifications for erosion control BMPs, including sizing calculations;
- Vegetation Planning;
- Site Development Plan;
- Construction Sequencing Plan;
- Sequencing of Erosion and Sedimentation Controls;
- Operation and Maintenance of Erosion and Sedimentation Controls;
- Inspection Schedule;
- Maintenance Schedule;
- Inspection and Maintenance Log Form.

☒ A Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan containing the information set forth above has been included in the Stormwater Report.

Checklist for Stormwater Report

Checklist (continued)

Standard 8: Construction Period Pollution Prevention and Erosion and Sedimentation Control (continued)

☐ The project is highly complex and information is included in the Stormwater Report that explains why it is not possible to submit the Construction Period Pollution Prevention and Erosion and Sedimentation Control Plan with the application. A Construction Period Pollution Prevention and Erosion and Sedimentation Control has ***not*** been included in the Stormwater Report but will be submitted ***before*** land disturbance begins.

☐ The project is ***not*** covered by a NPDES Construction General Permit.

☐ The project is covered by a NPDES Construction General Permit and a copy of the SWPPP is in the Stormwater Report.

☒ The project is covered by a NPDES Construction General Permit but no SWPPP been submitted. The SWPPP will be submitted BEFORE land disturbance begins.

Standard 9: Operation and Maintenance Plan

☒ The Post Construction Operation and Maintenance Plan is included in the Stormwater Report and includes the following information:

- ☒ Name of the stormwater management system owners;
- ☒ Party responsible for operation and maintenance;
- ☒ Schedule for implementation of routine and non-routine maintenance tasks;
- ☒ Plan showing the location of all stormwater BMPs maintenance access areas;
- ☐ Description and delineation of public safety features;
- ☒ Estimated operation and maintenance budget; and
- ☒ Operation and Maintenance Log Form.

☐ The responsible party is ***not*** the owner of the parcel where the BMP is located and the Stormwater Report includes the following submissions:

- ☐ A copy of the legal instrument (deed, homeowner's association, utility trust or other legal entity) that establishes the terms of and legal responsibility for the operation and maintenance of the project site stormwater BMPs;
- ☐ A plan and easement deed that allows site access for the legal entity to operate and maintain BMP functions.

Standard 10: Prohibition of Illicit Discharges

☒ The Long-Term Pollution Prevention Plan includes measures to prevent illicit discharges;

☒ An Illicit Discharge Compliance Statement is attached;

☐ NO Illicit Discharge Compliance Statement is attached but will be submitted ***prior to*** the discharge of any stormwater to post-construction BMPs.

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Form S3-G: Standard 3 – Recharge
72-Hour Drawdown Calculation

Project Name: NU Coastal Institute	Nitsch Project #: 12125.1
Location: Nahant, Massachusetts	Checked by:
Prepared by: BMV	Sheet No. 1 of 4
Date: 4/12/2019	**Bioretention and Subsurface Storage**

INSTRUCTIONS:
1. In 'Method' Column, Click on Blue Cell to Activate Drop Down Menu
2. Enter the "Required recharge Volume" (in cubic feet) in Blue Cell for the appropriate chosen Method
3. Enter the "Bottom Area" (in square feet) in the blue cell as the maximum infiltration surface area. Do not use sidewalls.
4. **For "Dynamic: In-Situ Method" ONLY** (if other go to 4b) Enter hydraulic Conductivity Rate in Blue Cell
5. In 'Texture Class' Column, Click on Blue Cell to Activate Drop Down Menu

Step No.				
1	Method:	**Static**		
2	Required Recharge Volume (in cubic feet):	*7100*	as determined by the	Static Method
3	Bottom Area (in Sq.Ft.)	*2338*		
4a	ONLY - If using Dynamic: In-Situ Method --> Enter Hydraulic Conductivity Rate	Hydraulic Conductivity Rate:	In-Situ Saturated Hydraulic Conductivity Rate	
			0	

	Texture Class	NRCS Hydrologic Soil Group (HSG)	Infiltration Rate (Inches/Hour)	
4b	Loam	B	1.02	**Hours**

$Time_{drawdown}$ = 35.73

72-Hour Drawdown Requirement Check: ***OK***

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Form S3-G: Standard 3 – Recharge
72-Hour Drawdown Calculation

Project Name: NU Coastal Institute	Nitsch Project #: 12125.1
Location: Nahant, Massachusetts	Checked by:
Prepared by: BMV	Sheet No. 2 of 4
Date: 4/12/2019	**Subsurface Infiltration System #1**

INSTRUCTIONS:
6. In 'Method' Column, Click on Blue Cell to Activate Drop Down Menu
7. Enter the "Required recharge Volume" (in cubic feet) in Blue Cell for the appropriate chosen Method
8. Enter the "Bottom Area" (in square feet) in the blue cell as the maximum infiltration surface area. Do not use sidewalls.
9. **For "Dynamic: In-Situ Method" ONLY** (if other go to 4b) Enter hydraulic Conductivity Rate in Blue Cell
10. In 'Texture Class' Column, Click on Blue Cell to Activate Drop Down Menu

Step No.				
1	Method:	**Static**		
2	Required Recharge Volume (in cubic feet):	*8260*	as determined by the	Static Method
3	Bottom Area (in Sq.Ft.)	*3016*		
4a	ONLY - If using Dynamic: In-Situ Method --> Enter Hydraulic Conductivity Rate	Hydraulic Conductivity Rate:	In-Situ Saturated Hydraulic Conductivity Rate	
			0	
4b	Texture Class	NRCS Hydrologic Soil Group (HSG)	Infiltration Rate (Inches/Hour)	
	Loam	B	0.52	**Hours**
			$Time_{drawdown}$ =	63.20
			72-Hour Drawdown Requirement Check:	***OK***

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Form S3-G: Standard 3 – Recharge
72-Hour Drawdown Calculation

Project Name: NU Coastal Institute	Nitsch Project #: 12125.1
Location: Nahant, Massachusetts	Checked by:
Prepared by: BMV	Sheet No. 3 of 4
Date: 4/12/2019	**Stormwater Garden #1**

INSTRUCTIONS:
11. In 'Method' Column, Click on Blue Cell to Activate Drop Down Menu
12. Enter the "Required recharge Volume" (in cubic feet) in Blue Cell for the appropriate chosen Method
13. Enter the "Bottom Area" (in square feet) in the blue cell as the maximum infiltration surface area. Do not use sidewalls.
14. **For "Dynamic: In-Situ Method" ONLY** (if other go to 4b) Enter hydraulic Conductivity Rate in Blue Cell
15. In 'Texture Class' Column, Click on Blue Cell to Activate Drop Down Menu

Step No.				
1	Method:	**Static**		
2	Required Recharge Volume (in cubic feet):	*5985*	as determined by the	Static Method
3	Bottom Area (in Sq.Ft.)	*2558*		
4a	ONLY - If using Dynamic: In-Situ Method --> Enter Hydraulic Conductivity Rate	Hydraulic Conductivity Rate:	In-Situ Saturated Hydraulic Conductivity Rate	
			0	
4b	Texture Class	NRCS Hydrologic Soil Group (HSG)	Infiltration Rate (Inches/Hour)	
	Loam	B	0.52	**Hours**
			$Time_{drawdown}$ =	53.99
			72-Hour Drawdown Requirement Check:	***OK***

Nitsch Engineering

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www.nitscheng.com

Form S3-G: Standard 3 – Recharge
72-Hour Drawdown Calculation

Project Name: NU Coastal Institute	Nitsch Project #: 12125.1
Location: Nahant, Massachusetts	Checked by:
Prepared by: BMV	Sheet No. 4 of 4
Date: 4/12/2019	**Subsurface Infiltration System #2**

INSTRUCTIONS:
16. In 'Method' Column, Click on Blue Cell to Activate Drop Down Menu
17. Enter the "Required recharge Volume" (in cubic feet) in Blue Cell for the appropriate chosen Method
18. Enter the "Bottom Area" (in square feet) in the blue cell as the maximum infiltration surface area. Do not use sidewalls.
19. **For "Dynamic: In-Situ Method" ONLY** (if other go to 4b) Enter hydraulic Conductivity Rate in Blue Cell
20. In 'Texture Class' Column, Click on Blue Cell to Activate Drop Down Menu

Step No.				
1	Method:	**Static**		
2	Required Recharge Volume (in cubic feet):	*9070*	as determined by the	Static Method
3	Bottom Area (in Sq.Ft.)	*3310*		
4a	ONLY - If using Dynamic: In-Situ Method --> Enter Hydraulic Conductivity Rate	Hydraulic Conductivity Rate:	In-Situ Saturated Hydraulic Conductivity Rate	
			0	
4b	Texture Class	NRCS Hydrologic Soil Group (HSG)	Infiltration Rate (Inches/Hour)	
	Loam	B	0.52	**Hours**
			$Time_{drawdown}$ =	63.23
			72-Hour Drawdown Requirement Check:	***OK***

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NORTHEASTERN UNIVERSITY COASTAL SUSTAINABILITY INSTITUTE
WATER QUALITY TREATMENT SUMMARY (04/29/2019)

Nitsch Engineering has prepared this Water Quality Treatment Summary for the proposed Northeastern University Coastal Sustainability Institute. In compliance with MassDEP Stormwater Management Standard #4, the proposed stormwater management system is designed to remove at least 80% of the average annual post-construction load of TSS prior to discharge. The stormwater management system is designed to remove at least 44% of the average annual post-construction TSS load prior to discharge to the infiltration systems because the infiltration systems are located within areas where soils with rapid infiltration rates were observed.

A summary of treatment trains proposed to provide water quantity control and water quality improvement at the proposed project site is provided below.

Treatment Train A
Catchment Areas: PR-1D & PR-3B
Deep Sump & Hooded Catch Basin → Isolator Row → Underground Infiltration System→ Discharge

Treatment Train B
Catchment Areas: PR-1C
Trench Drain with Stone Sump → Bioretention Basin → Underground Infiltration System →Discharge

Treatment Train C
Catchment Areas: PR-3C
Water Quality Inlet →Discharge

Treatment Train D
Catchment Areas: PR-4A
Sediment Forebay → Isolator Row → Underground Infiltration System →Discharge

Treatment Train A:
Deep Sump & Hooded Catch Basin → Isolator Row → Underground Infiltration System→ Discharge

Pretreatment Spreadsheet

B BMP	C TSS Removal Rate	D Starting TSS Load	E Amount Removed (C*D)	F Remaining Load (D-E)
Deep Sump & Hooded Catch Basin	**0.25**	**1.00**	**0.25**	**0.75**
Isolator Row	**0.80**	**0.75**	**0.60**	**0.15**

Refer to dry water quality swale design summary below.

Total TSS Removal = **85%**

Meets 44% TSS removal pretreatment requirement

Treatment Spreadsheet

B BMP	C TSS Removal Rate	D Starting TSS Load	E Amount Removed (C*D)	F Remaining Load (D-E)
Underground Infiltration	**0.80**	**1.00**	**0.80**	**0.20**

Total TSS Removal = **80%**

Meets 80% TSS removal requirement

Treatment Train B:
Trench Drain with Stone Sump → Bioretention Basin → Underground Infiltration System →Discharge

Pretreatment Spreadsheet

B BMP	C TSS Removal Rate	D Starting TSS Load	E Amount Removed (C*D)	F Remaining Load (D-E)
Trench Drain with Stone Sump	**0.25**	**1.00**	**0.25**	**0.75**
Bioretention Media	**0.90**	**0.75**	**0.68**	**0.07**

Refer to dry water quality swale design summary below.

Total TSS Removal = **93%**

Meets 44% TSS removal pretreatment requirement

Treatment Spreadsheet

B BMP	C TSS Removal Rate	D Starting TSS Load	E Amount Removed (C*D)	F Remaining Load (D-E)
Underground Infiltration Media	**0.80**	**1.00**	**0.80**	**0.20**

Total TSS Removal = **80%**

Meets 80% TSS removal requirement

Treatment Train C:
Water Quality Inlet →Discharge

Treatment Spreadsheet

B BMP	C TSS Removal Rate	D Starting TSS Load	E Amount Removed (C*D)	F Remaining Load (D-E)
Water Quality Inlet	**0.80**	**1.00**	**0.80**	**0.20**

Total TSS Removal = **80%** **Meets 80% TSS removal requirement**

Treatment Train D:
Sediment Forebay → Isolator Row → Underground Infiltration System →Discharge

Pretreatment Spreadsheet

B BMP	C TSS Removal Rate	D Starting TSS Load	E Amount Removed (C*D)	F Remaining Load (D-E)
Sediment Forebay	**0.25**	**1.00**	**0.25**	**0.75**
Isolator Row	**0.80**	**0.75**	**0.60**	**0.15**

Refer to dry water quality swale design summary below.

Total TSS Removal = **85%**

Meets 44% TSS removal pretreatment requirement

Treatment Spreadsheet

B BMP	C TSS Removal Rate	D Starting TSS Load	E Amount Removed (C*D)	F Remaining Load (D-E)
Underground Infiltration System	**0.80**	**1.00**	**0.80**	**0.20**

Total TSS Removal = **80%**

Meets 80% TSS removal requirement

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1" Calculation Sheet

Nitsch Job # 12125
Calc:
Date: 4/12/2019

This spreadsheet should be used to convert water quality volume to an equivilent water quality peak flow rate as outlined in the new MA DEP guidelines that take effect on October 15, 2013.

Glossary

Water Quality Flow Rate =	WQF
Water Quality Volume =	WQV*
unit peak discharge (csm/in) =	qu**
Impervious Area in watershed (square miles) =	Ai

*WQV is expressed in watershed inches (you must use 1.0-inches in all cases with this method and not 0.5-inches)
** calculate the qu based on the time of concentration (see 1" - qu Table)

Compute Water Quality Flow with the following Equation

WQF = (qu)(A)(WQV)

Input Information (in colored cells only)

Site Plan Callout		Enter qu (from 1" - qu Table)	Enter Impervious Area (SF)	Ai (sq/mi)	WQV		WQF	
WQI-1	=	774	5358	0.000192	1	=	0.15	cfs
WQI-2	=	774	4269	0.000153	1	=	0.12	cfs
WQI-3	=	774	2134	0.000077	1	=	0.06	cfs
SSI-1	=	774	12807	0.000459	1	=	0.36	cfs
SSI-2	=	774	13329	0.000478	1	=	0.37	cfs

Water Quality Inlet Sizing

Structure Name	Minimum WQF (cfs)	Peak Flow Rate (cfs)	Min Sediment Storage Capacity (cf)	Water Quality Structure Model
WQI-1	0.15	0.81	40	STC 450i
WQI-2	0.12	0.64	40	STC 450i
WQI-3	0.06	0.3	40	STC 450i

StormTech®

Detention - Retention - Water Quality

Division of ADS

STORMTECH ISOLATOR ROW SIZING CHART					
	SC-310	SC-740	DC-780	MC-3500	MC-4500
Chamber Area (Sq.Ft.)	20	27.8	27.8	43.2	30.1
Treated Flow Rate per chamber (CFS)	0.11	0.15	0.15	0.24	0.17

NOTE: *Testing of the Isolator Row completed by Tennesse Tech has been verified by NJCAT and it has shown to have a TSS removal efficiency of 84% for SIL-CO-SIL 250*

NJCAT verified Treated Flow Rate (GPM / Sq.Ft.) 2.5

Subsurface Infiltration System #1 (SC-310)

Treated Flow Rate/WQF* per chamber (CFS) x Number of Chambers = Required Treated Flow Rate/WQF (CFS)

0.11 CFS x 9 chambers = 0.99 CFS > 0.36 CFS OK ✓

Subsurface Infiltration System #2 (SC-740)

Treated Flow Rate/WQF* per chamber (CFS) x Number of Chambers = Required Treated Flow Rate/WQF (CFS)

0.15 CFS x 9 chambers = 1.35 CFS > 0.37 CFS OK ✓

* Water Quality Flow Rate from MA DEP Calculation Worksheet

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STANDARD 10: Illicit Discharge Compliance Statement

Project Name: NU Coastal Sustainability Institute	Nitsch Project #: 12125.1
Location: Nahant, MA	Checked by: WRM
Prepared by: BMV	Sheet No. 1 of 1
Date: 4/29/2019	

Standard 10 states: All illicit discharges to the stormwater management system are prohibited.

This is to verify:

1. Based on the information available there are no known or suspected illicit discharges to the stormwater management system at the Northeastern University Coastal Sustainability Institute site as defined in the MassDEP Stormwater Handbook.

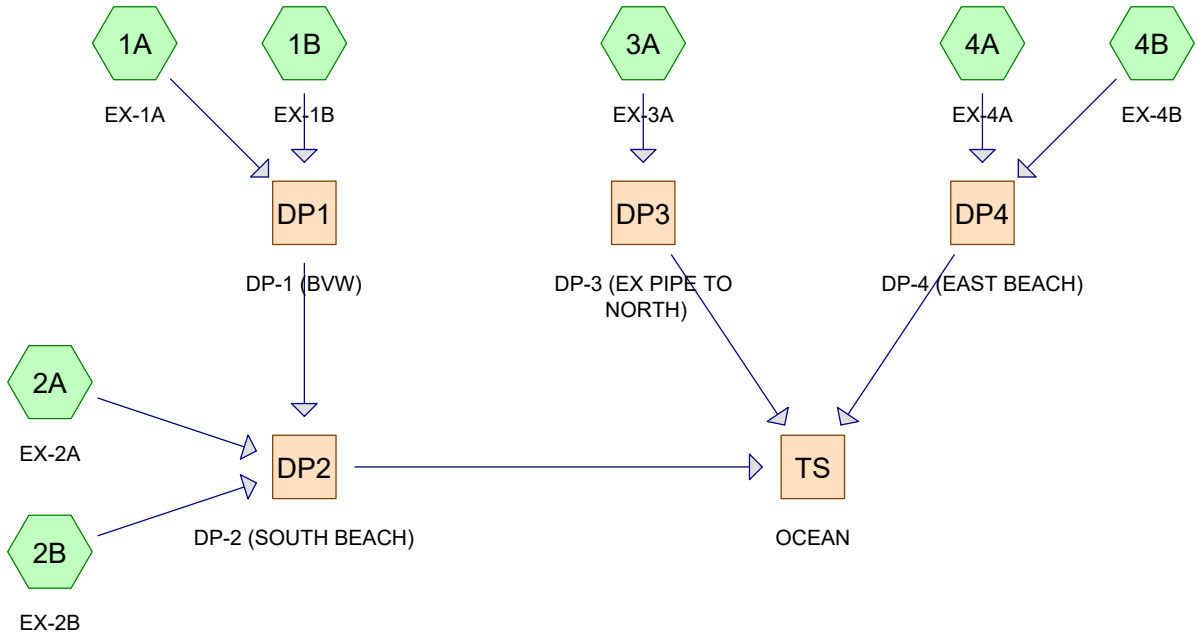
2. The design of the stormwater system includes no proposed illicit discharges.

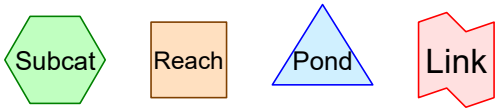
William Maher, PE

Date

APPENDIX B

Pre-Development Conditions – HydroCAD Calculations





Routing Diagram for SW Calc - Existing
Prepared by Nitsch Engineering, Printed 4/11/2019
HydroCAD® 10.00-20 s/n 00546 © 2017 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
2.492	61	>75% Grass cover, Good, HSG B (1B, 2B, 3A)
0.597	85	Gravel roads, HSG B (1A, 1B, 2A, 2B, 3A, 4B)
0.205	91	Gravel roads, HSG D (4A)
1.275	98	Paved parking, HSG B (1A, 1B, 2A, 3A, 4B)
0.474	98	Roofs, HSG B (2B, 3A)
0.287	98	Unconnected pavement, HSG D (4A)
15.764	55	Woods, Good, HSG B (1A, 1B, 2A, 3A, 4B)
4.056	77	Woods, Good, HSG D (4A)
0.188	58	Woods/grass comb., Good, HSG B (1A)
25.337	**64**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
20.789	HSG B	1A, 1B, 2A, 2B, 3A, 4B
0.000	HSG C	
4.548	HSG D	4A
0.000	Other	
25.337		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	2.492	0.000	0.000	0.000	2.492	>75% Grass cover, Good	1B, 2B, 3A
0.000	0.597	0.000	0.205	0.000	0.802	Gravel roads	1A, 1B, 2A, 2B, 3A, 4A, 4B
0.000	1.275	0.000	0.000	0.000	1.275	Paved parking	1A, 1B, 2A, 3A, 4B
0.000	0.474	0.000	0.000	0.000	0.474	Roofs	2B, 3A
0.000	0.000	0.000	0.287	0.000	0.287	Unconnected pavement	4A
0.000	15.764	0.000	4.056	0.000	19.819	Woods, Good	1A, 1B, 2A, 3A, 4A, 4B
0.000	0.188	0.000	0.000	0.000	0.188	Woods/grass comb., Good	1A
0.000	**20.789**	**0.000**	**4.548**	**0.000**	**25.337**	**TOTAL AREA**	

Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1A: EX-1A Runoff Area=83,747 sf 11.43% Impervious Runoff Depth=0.46"
Flow Length=187' Tc=8.4 min CN=62 Runoff=0.62 cfs 0.074 af

Subcatchment1B: EX-1B Runoff Area=80,571 sf 19.16% Impervious Runoff Depth=0.62"
Flow Length=303' Tc=6.5 min CN=66 Runoff=1.05 cfs 0.095 af

Subcatchment2A: EX-2A Runoff Area=293,625 sf 4.21% Impervious Runoff Depth=0.32"
Flow Length=347' Tc=15.3 min CN=58 Runoff=0.99 cfs 0.182 af

Subcatchment2B: EX-2B Runoff Area=41,460 sf 42.97% Impervious Runoff Depth=1.50"
Flow Length=153' Tc=6.2 min CN=82 Runoff=1.65 cfs 0.119 af

Subcatchment3A: EX-3A Runoff Area=106,567 sf 19.00% Impervious Runoff Depth=0.66"
Flow Length=415' Tc=10.4 min CN=67 Runoff=1.34 cfs 0.135 af

Subcatchment4A: EX-4A Runoff Area=198,108 sf 6.31% Impervious Runoff Depth=1.24"
Flow Length=453' Tc=11.0 min UI Adjusted CN=78 Runoff=5.44 cfs 0.469 af

Subcatchment4B: EX-4B Runoff Area=299,620 sf 0.26% Impervious Runoff Depth=0.24"
Flow Length=123' Tc=6.0 min CN=55 Runoff=0.65 cfs 0.135 af

Reach DP1: DP-1 (BVW) Inflow=1.63 cfs 0.169 af
Outflow=1.63 cfs 0.169 af

Reach DP2: DP-2 (SOUTH BEACH) Inflow=3.37 cfs 0.470 af
Outflow=3.37 cfs 0.470 af

Reach DP3: DP-3 (EX PIPE TO NORTH) Inflow=1.34 cfs 0.135 af
Outflow=1.34 cfs 0.135 af

Reach DP4: DP-4 (EAST BEACH) Inflow=5.87 cfs 0.604 af
Outflow=5.87 cfs 0.604 af

Reach TS: OCEAN Inflow=10.41 cfs 1.209 af
Outflow=10.41 cfs 1.209 af

Total Runoff Area = 25.337 ac Runoff Volume = 1.209 af Average Runoff Depth = 0.57"
91.96% Pervious = 23.301 ac 8.04% Impervious = 2.036 ac

Summary for Subcatchment 1A: EX-1A

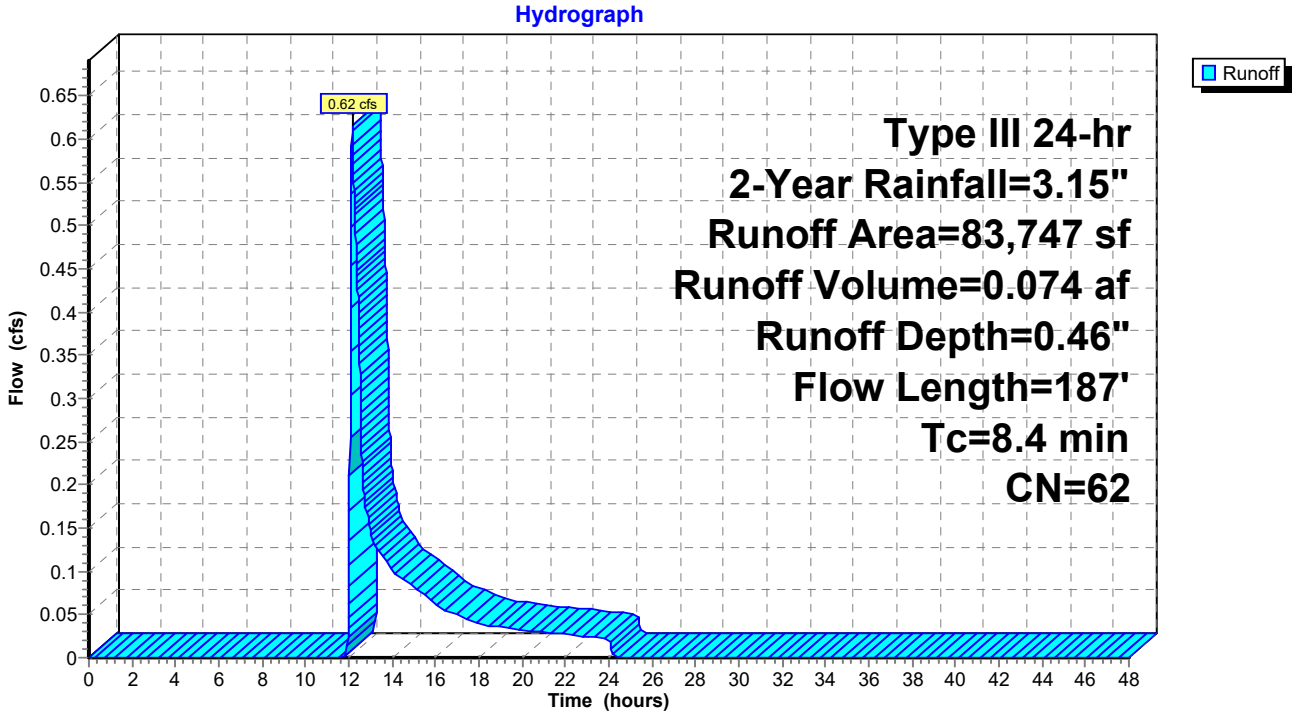
Runoff = 0.62 cfs @ 12.16 hrs, Volume= 0.074 af, Depth= 0.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
9,572	98	Paved parking, HSG B
61,186	55	Woods, Good, HSG B
4,818	85	Gravel roads, HSG B
8,171	58	Woods/grass comb., Good, HSG B
83,747	62	Weighted Average
74,175		88.57% Pervious Area
9,572		11.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	50	0.1100	0.13		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.18"
2.1	137	0.0470	1.08		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
8.4	187	Total			

Subcatchment 1A: EX-1A



Summary for Subcatchment 1B: EX-1B

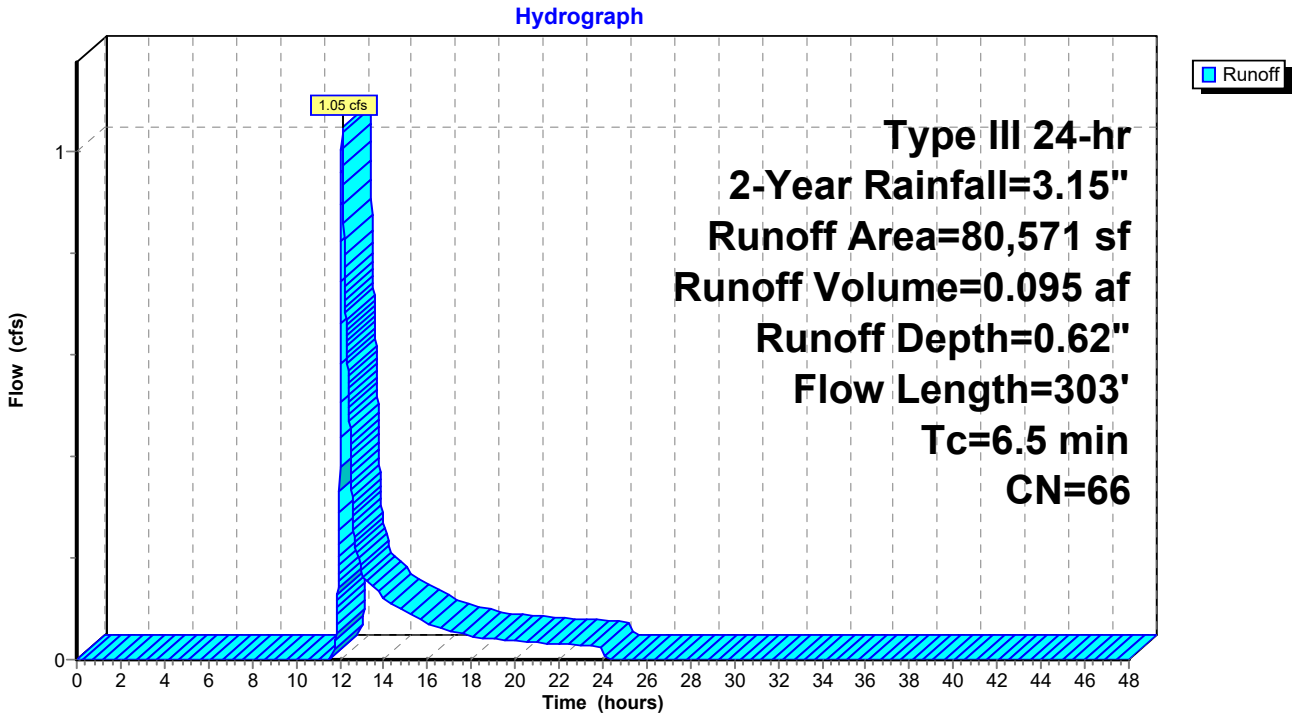
Runoff = 1.05 cfs @ 12.11 hrs, Volume= 0.095 af, Depth= 0.62"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
15,441	98	Paved parking, HSG B
36,095	55	Woods, Good, HSG B
27,884	61	>75% Grass cover, Good, HSG B
1,151	85	Gravel roads, HSG B
80,571	66	Weighted Average
65,130		80.84% Pervious Area
15,441		19.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	50	0.4800	0.24		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.18"
0.2	89	0.1800	6.83		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.8	164	0.0190	0.96		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.5	303	Total			

Subcatchment 1B: EX-1B



Summary for Subcatchment 2A: EX-2A

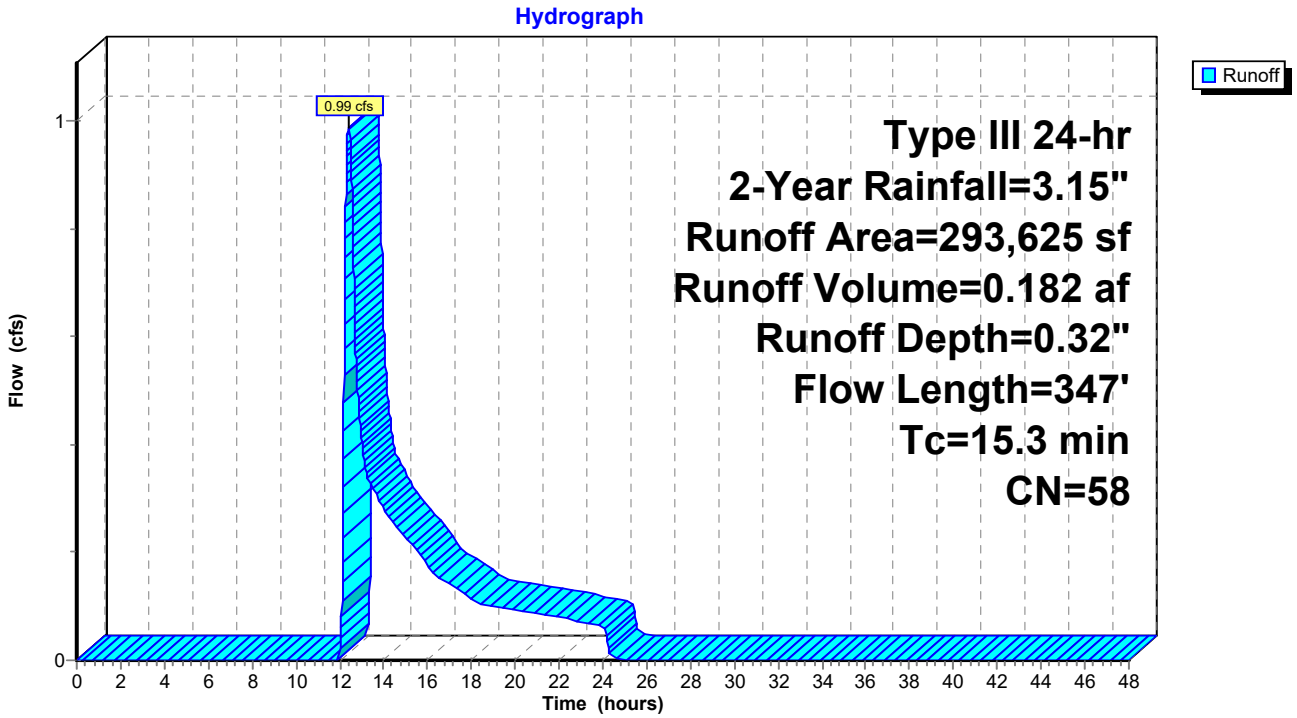
Runoff = 0.99 cfs @ 12.42 hrs, Volume= 0.182 af, Depth= 0.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
12,348	98	Paved parking, HSG B
273,466	55	Woods, Good, HSG B
7,811	85	Gravel roads, HSG B
293,625	58	Weighted Average
281,277		95.79% Pervious Area
12,348		4.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.4	50	0.0800	0.07		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 3.18"
2.9	297	0.1200	1.73		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	347	Total			

Subcatchment 2A: EX-2A



Summary for Subcatchment 2B: EX-2B

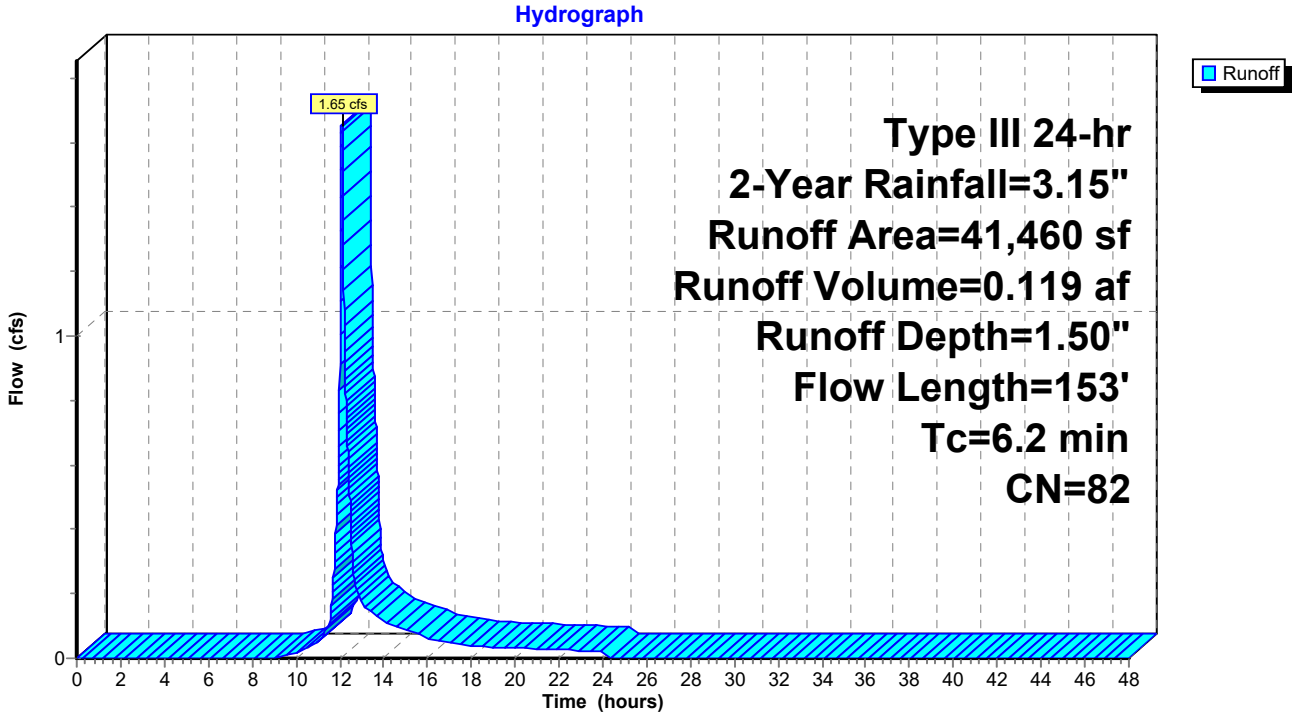
Runoff = 1.65 cfs @ 12.09 hrs, Volume= 0.119 af, Depth= 1.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
17,814	98	Roofs, HSG B
14,033	61	>75% Grass cover, Good, HSG B
9,613	85	Gravel roads, HSG B
41,460	82	Weighted Average
23,646		57.03% Pervious Area
17,814		42.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	50	0.1200	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.18"
0.2	103	0.2900	8.67		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.2	153	Total			

Subcatchment 2B: EX-2B



Summary for Subcatchment 3A: EX-3A

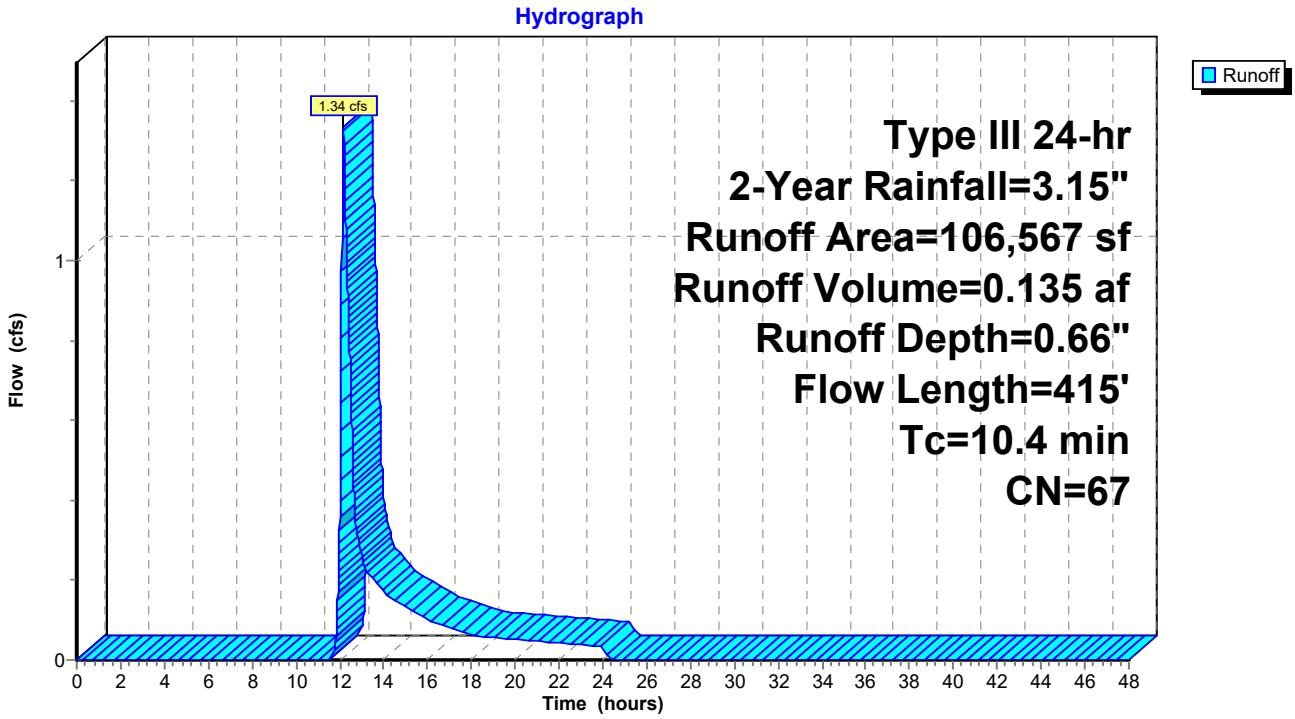
Runoff = 1.34 cfs @ 12.17 hrs, Volume= 0.135 af, Depth= 0.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
17,393	98	Paved parking, HSG B
66,636	61	>75% Grass cover, Good, HSG B
18,921	55	Woods, Good, HSG B
763	85	Gravel roads, HSG B
2,854	98	Roofs, HSG B
106,567	67	Weighted Average
86,320		81.00% Pervious Area
20,247		19.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.18"
6.1	365	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.4	415	Total			

Subcatchment 3A: EX-3A



Summary for Subcatchment 4A: EX-4A

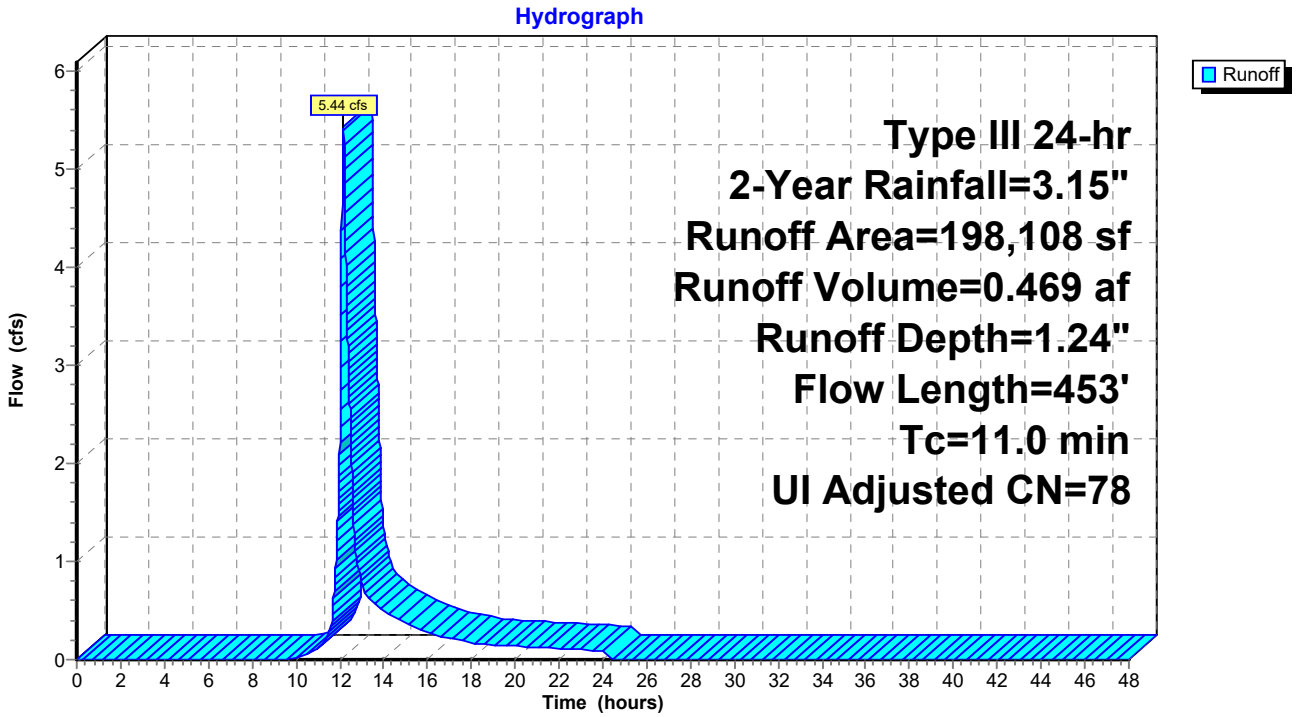
Runoff = 5.44 cfs @ 12.16 hrs, Volume= 0.469 af, Depth= 1.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Adj	Description
12,500	98		Unconnected pavement, HSG D
176,670	77		Woods, Good, HSG D
8,938	91		Gravel roads, HSG D
198,108	79	78	Weighted Average, UI Adjusted
185,608			93.69% Pervious Area
12,500			6.31% Impervious Area
12,500			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.9	50	0.2000	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.18"
0.8	88	0.1250	1.77		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.2	315	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.0	453	Total			

Subcatchment 4A: EX-4A



Summary for Subcatchment 4B: EX-4B

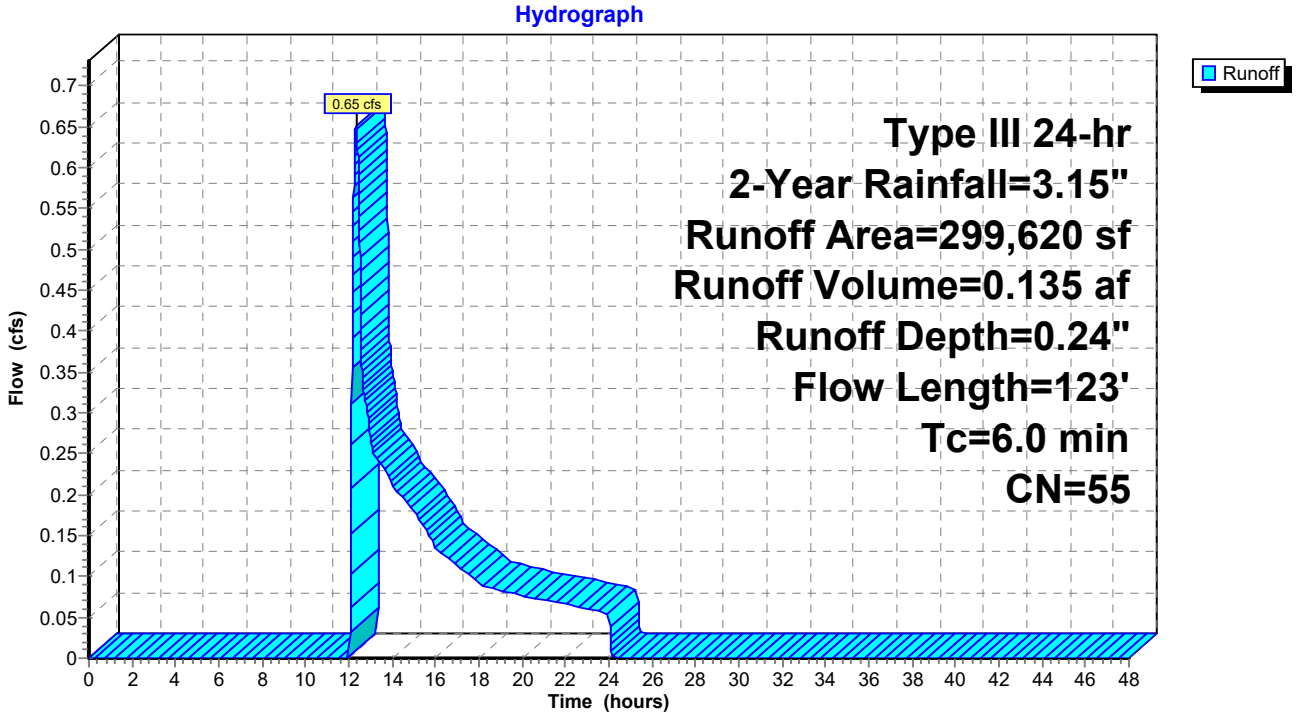
Runoff = 0.65 cfs @ 12.34 hrs, Volume= 0.135 af, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
774	98	Paved parking, HSG B
296,991	55	Woods, Good, HSG B
1,855	85	Gravel roads, HSG B
299,620	55	Weighted Average
298,846		99.74% Pervious Area
774		0.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	123		0.34		**Direct Entry,**

Subcatchment 4B: EX-4B



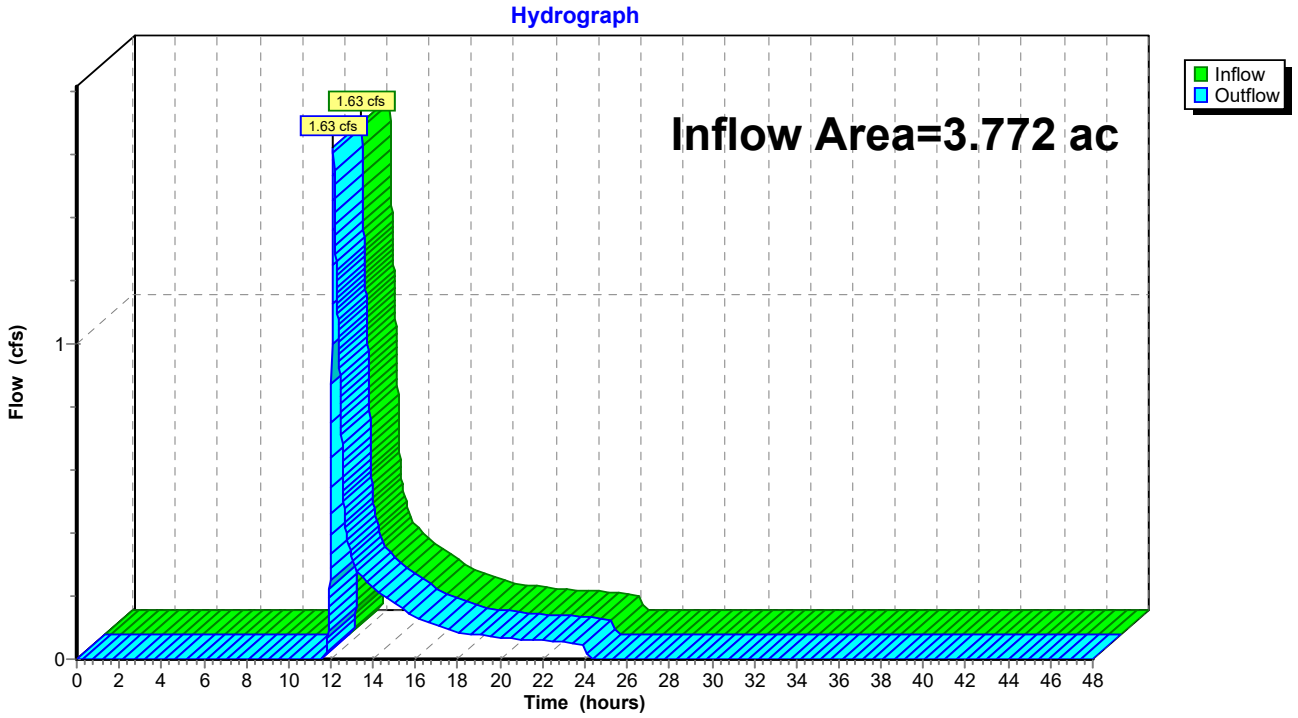
Summary for Reach DP1: DP-1 (BVW)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 3.772 ac, 15.22% Impervious, Inflow Depth = 0.54" for 2-Year event
Inflow = 1.63 cfs @ 12.13 hrs, Volume= 0.169 af
Outflow = 1.63 cfs @ 12.13 hrs, Volume= 0.169 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach DP1: DP-1 (BVW)



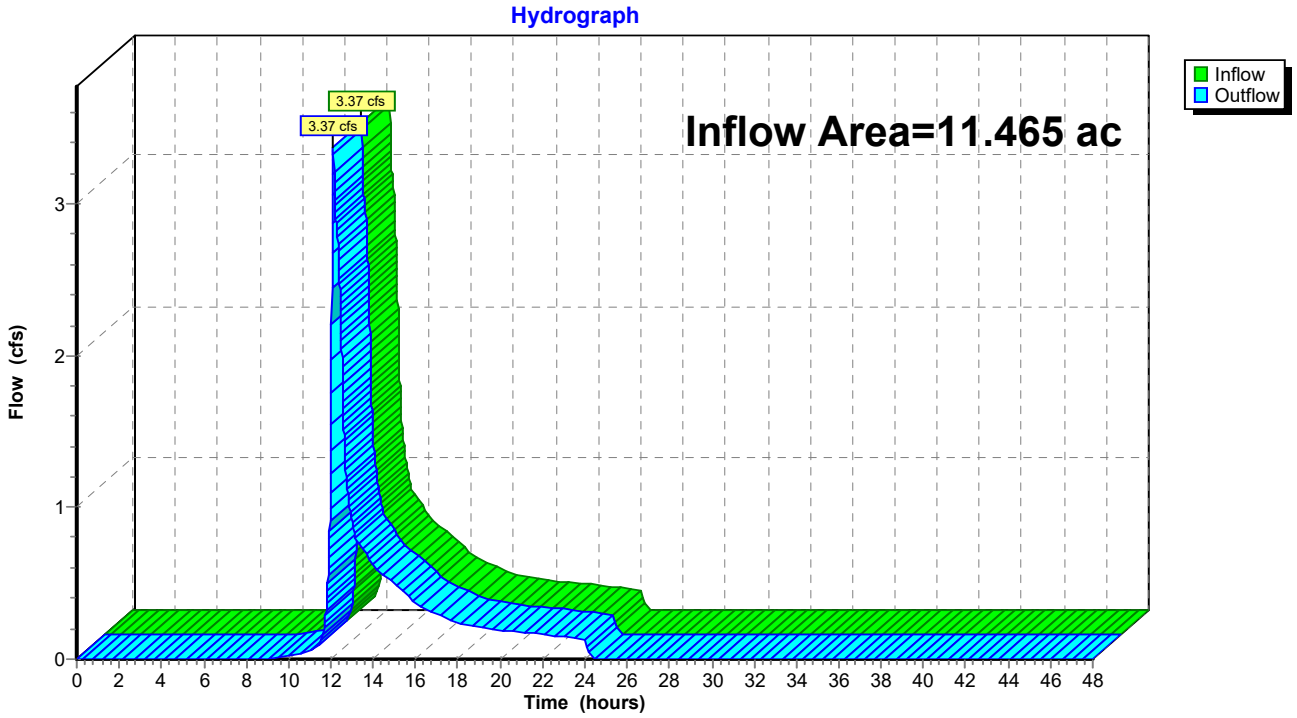
Summary for Reach DP2: DP-2 (SOUTH BEACH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11.465 ac, 11.05% Impervious, Inflow Depth = 0.49" for 2-Year event
Inflow = 3.37 cfs @ 12.12 hrs, Volume= 0.470 af
Outflow = 3.37 cfs @ 12.12 hrs, Volume= 0.470 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach DP2: DP-2 (SOUTH BEACH)



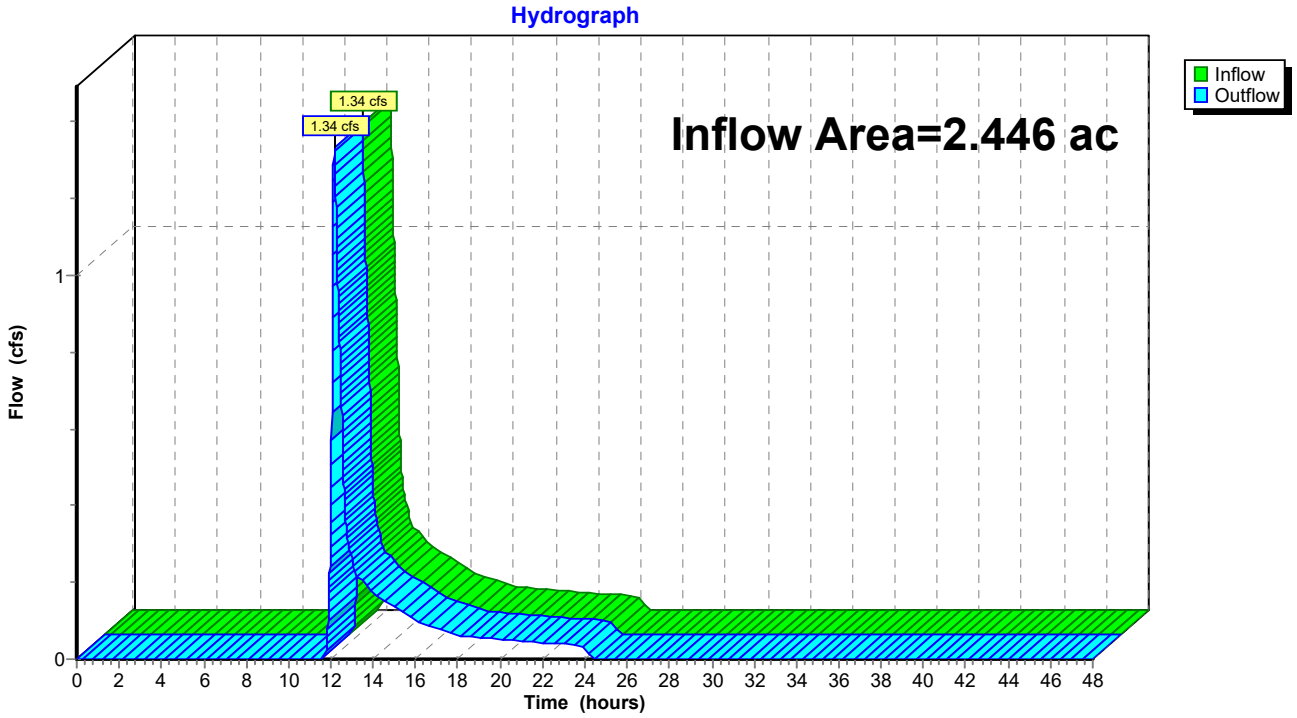
Summary for Reach DP3: DP-3 (EX PIPE TO NORTH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 2.446 ac, 19.00% Impervious, Inflow Depth = 0.66" for 2-Year event
Inflow = 1.34 cfs @ 12.17 hrs, Volume= 0.135 af
Outflow = 1.34 cfs @ 12.17 hrs, Volume= 0.135 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach DP3: DP-3 (EX PIPE TO NORTH)



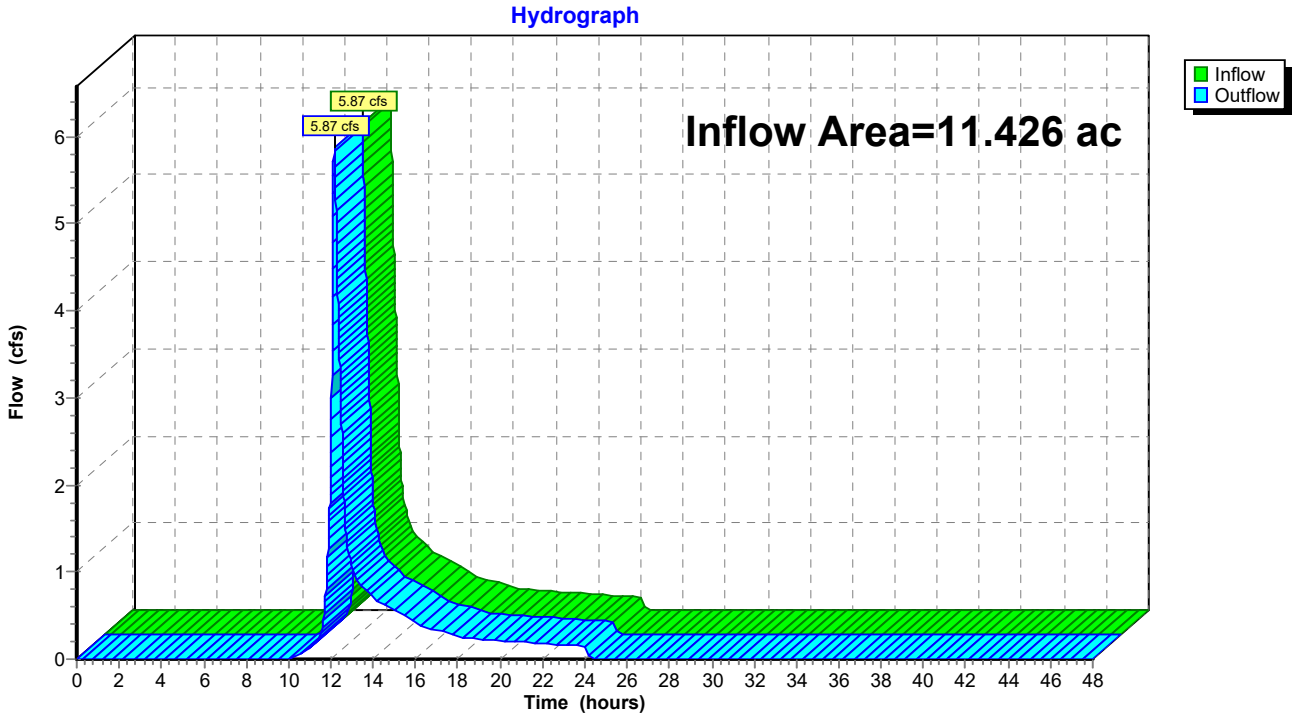
Summary for Reach DP4: DP-4 (EAST BEACH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11.426 ac, 2.67% Impervious, Inflow Depth = 0.63" for 2-Year event
Inflow = 5.87 cfs @ 12.16 hrs, Volume= 0.604 af
Outflow = 5.87 cfs @ 12.16 hrs, Volume= 0.604 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach DP4: DP-4 (EAST BEACH)



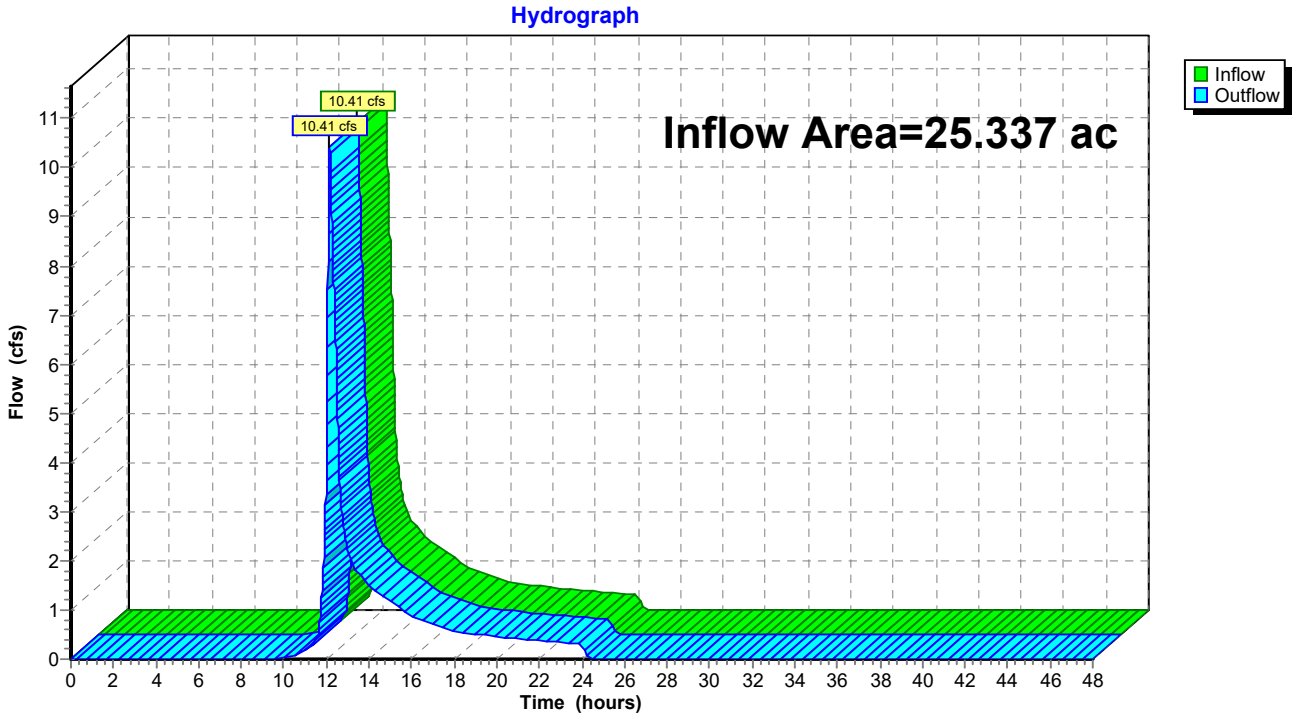
Summary for Reach TS: OCEAN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 25.337 ac, 8.04% Impervious, Inflow Depth = 0.57" for 2-Year event
Inflow = 10.41 cfs @ 12.16 hrs, Volume= 1.209 af
Outflow = 10.41 cfs @ 12.16 hrs, Volume= 1.209 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach TS: OCEAN



Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1A: EX-1A Runoff Area=83,747 sf 11.43% Impervious Runoff Depth=1.33"
Flow Length=187' Tc=8.4 min CN=62 Runoff=2.51 cfs 0.214 af

Subcatchment1B: EX-1B Runoff Area=80,571 sf 19.16% Impervious Runoff Depth=1.61"
Flow Length=303' Tc=6.5 min CN=66 Runoff=3.27 cfs 0.249 af

Subcatchment2A: EX-2A Runoff Area=293,625 sf 4.21% Impervious Runoff Depth=1.08"
Flow Length=347' Tc=15.3 min CN=58 Runoff=5.34 cfs 0.605 af

Subcatchment2B: EX-2B Runoff Area=41,460 sf 42.97% Impervious Runoff Depth=2.93"
Flow Length=153' Tc=6.2 min CN=82 Runoff=3.24 cfs 0.232 af

Subcatchment3A: EX-3A Runoff Area=106,567 sf 19.00% Impervious Runoff Depth=1.69"
Flow Length=415' Tc=10.4 min CN=67 Runoff=3.99 cfs 0.344 af

Subcatchment4A: EX-4A Runoff Area=198,108 sf 6.31% Impervious Runoff Depth=2.57"
Flow Length=453' Tc=11.0 min UI Adjusted CN=78 Runoff=11.59 cfs 0.973 af

Subcatchment4B: EX-4B Runoff Area=299,620 sf 0.26% Impervious Runoff Depth=0.90"
Flow Length=123' Tc=6.0 min CN=55 Runoff=5.61 cfs 0.514 af

Reach DP1: DP-1 (BVW) Inflow=5.71 cfs 0.462 af
Outflow=5.71 cfs 0.462 af

Reach DP2: DP-2 (SOUTH BEACH) Inflow=12.27 cfs 1.299 af
Outflow=12.27 cfs 1.299 af

Reach DP3: DP-3 (EX PIPE TO NORTH) Inflow=3.99 cfs 0.344 af
Outflow=3.99 cfs 0.344 af

Reach DP4: DP-4 (EAST BEACH) Inflow=16.78 cfs 1.487 af
Outflow=16.78 cfs 1.487 af

Reach TS: OCEAN Inflow=32.98 cfs 3.130 af
Outflow=32.98 cfs 3.130 af

Total Runoff Area = 25.337 ac Runoff Volume = 3.130 af Average Runoff Depth = 1.48"
91.96% Pervious = 23.301 ac 8.04% Impervious = 2.036 ac

Summary for Subcatchment 1A: EX-1A

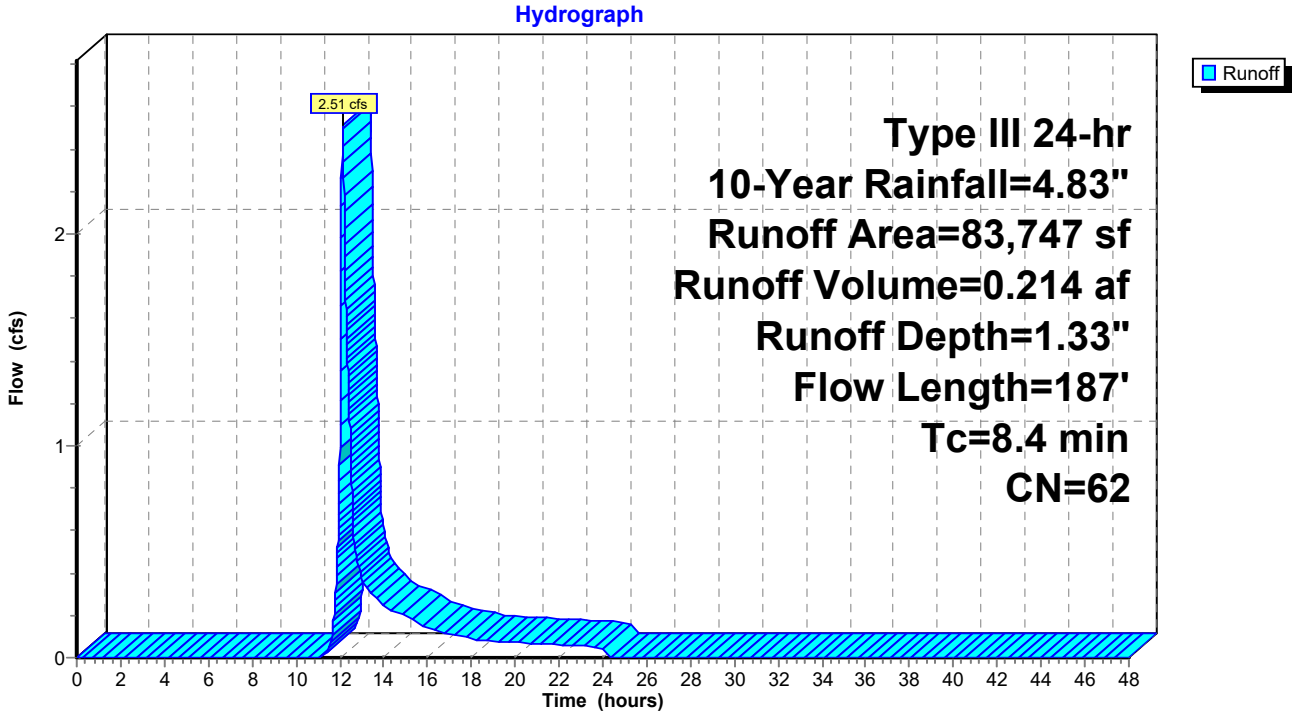
Runoff = 2.51 cfs @ 12.13 hrs, Volume= 0.214 af, Depth= 1.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
9,572	98	Paved parking, HSG B
61,186	55	Woods, Good, HSG B
4,818	85	Gravel roads, HSG B
8,171	58	Woods/grass comb., Good, HSG B
83,747	62	Weighted Average
74,175		88.57% Pervious Area
9,572		11.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	50	0.1100	0.13		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.18"
2.1	137	0.0470	1.08		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
8.4	187	Total			

Subcatchment 1A: EX-1A



Summary for Subcatchment 1B: EX-1B

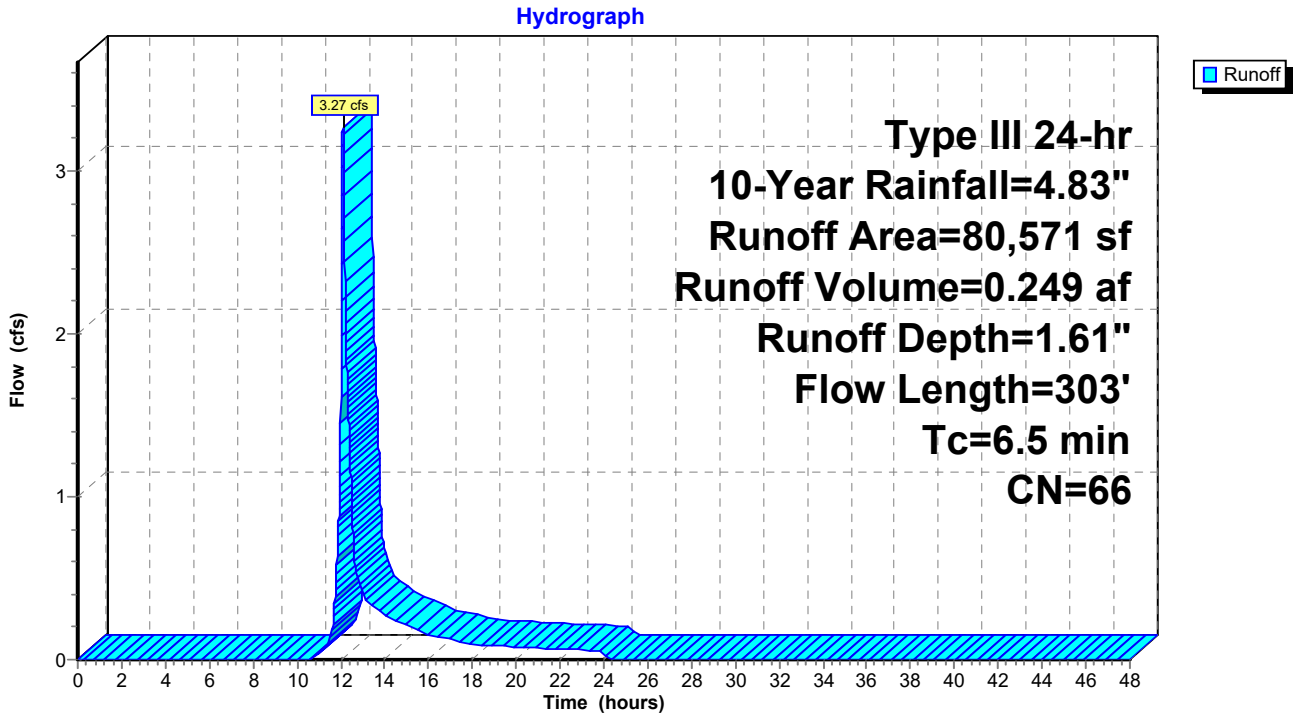
Runoff = 3.27 cfs @ 12.10 hrs, Volume= 0.249 af, Depth= 1.61"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
15,441	98	Paved parking, HSG B
36,095	55	Woods, Good, HSG B
27,884	61	>75% Grass cover, Good, HSG B
1,151	85	Gravel roads, HSG B
80,571	66	Weighted Average
65,130		80.84% Pervious Area
15,441		19.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	50	0.4800	0.24		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.18"
0.2	89	0.1800	6.83		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.8	164	0.0190	0.96		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.5	303	Total			

Subcatchment 1B: EX-1B



Summary for Subcatchment 2A: EX-2A

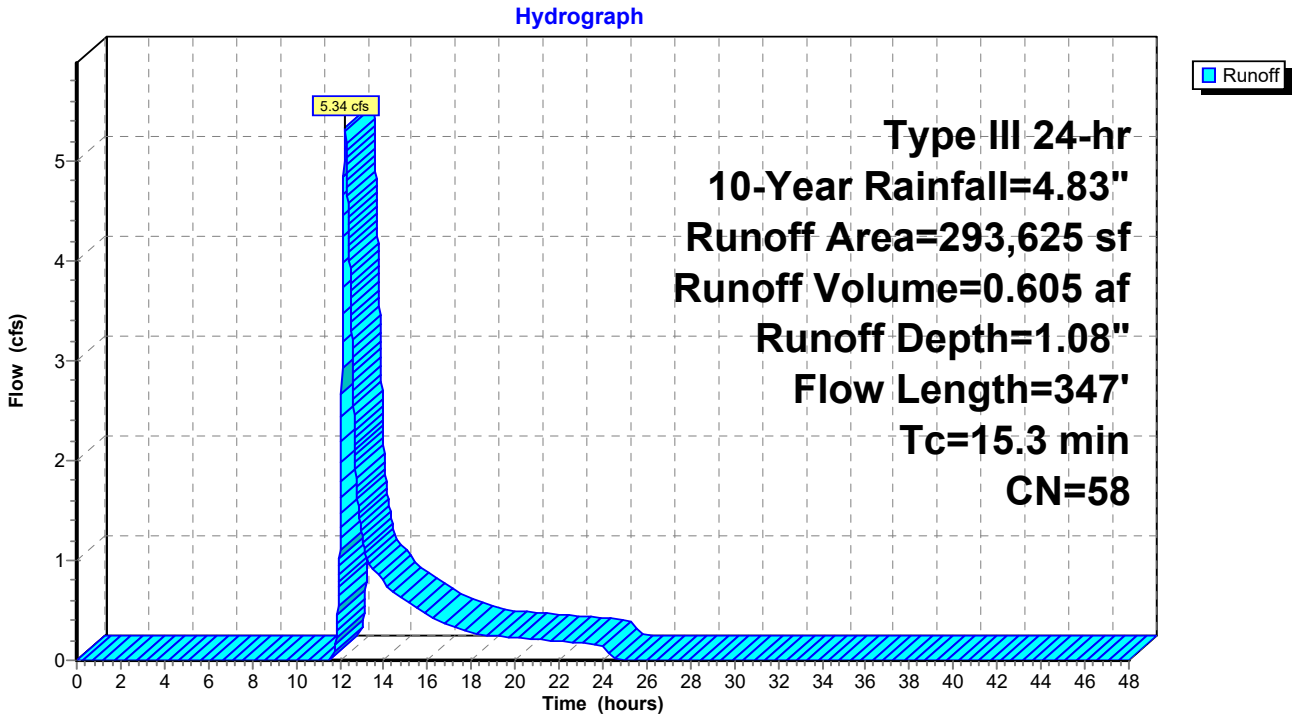
Runoff = 5.34 cfs @ 12.24 hrs, Volume= 0.605 af, Depth= 1.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
12,348	98	Paved parking, HSG B
273,466	55	Woods, Good, HSG B
7,811	85	Gravel roads, HSG B
293,625	58	Weighted Average
281,277		95.79% Pervious Area
12,348		4.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.4	50	0.0800	0.07		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 3.18"
2.9	297	0.1200	1.73		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	347	Total			

Subcatchment 2A: EX-2A



Summary for Subcatchment 2B: EX-2B

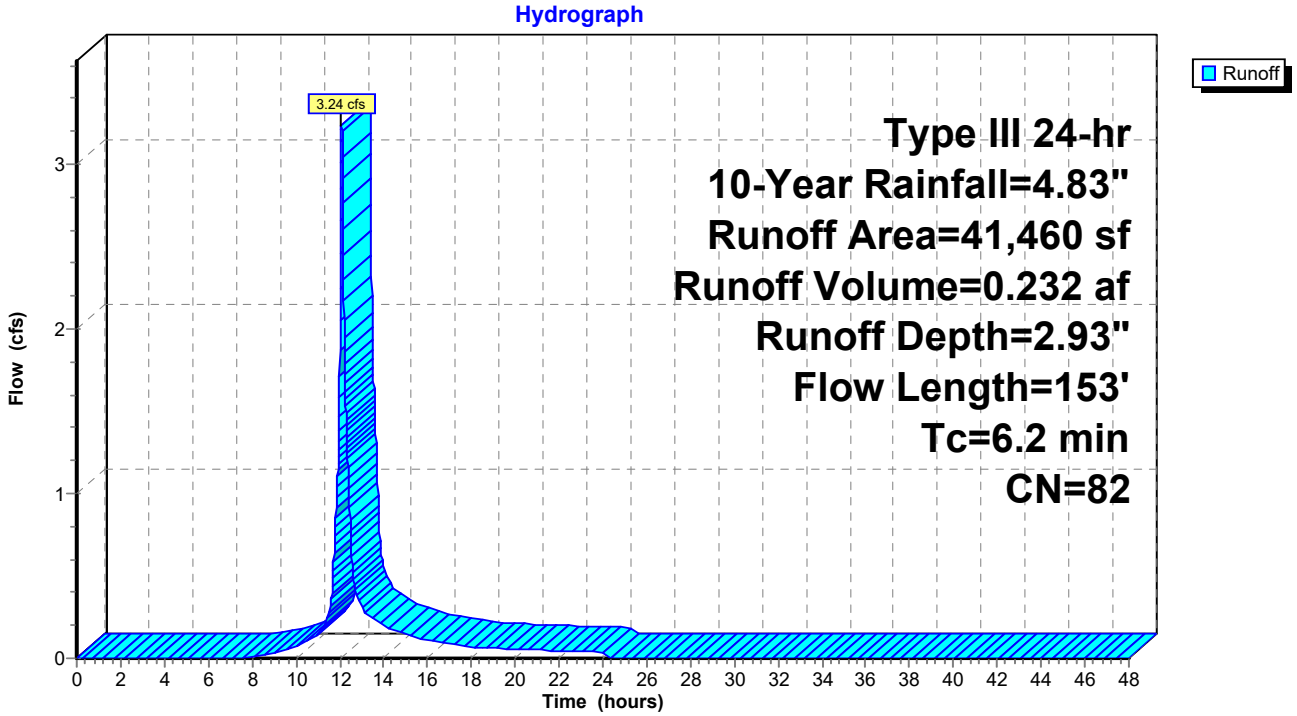
Runoff = 3.24 cfs @ 12.09 hrs, Volume= 0.232 af, Depth= 2.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
17,814	98	Roofs, HSG B
14,033	61	>75% Grass cover, Good, HSG B
9,613	85	Gravel roads, HSG B
41,460	82	Weighted Average
23,646		57.03% Pervious Area
17,814		42.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	50	0.1200	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.18"
0.2	103	0.2900	8.67		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.2	153	Total			

Subcatchment 2B: EX-2B



Summary for Subcatchment 3A: EX-3A

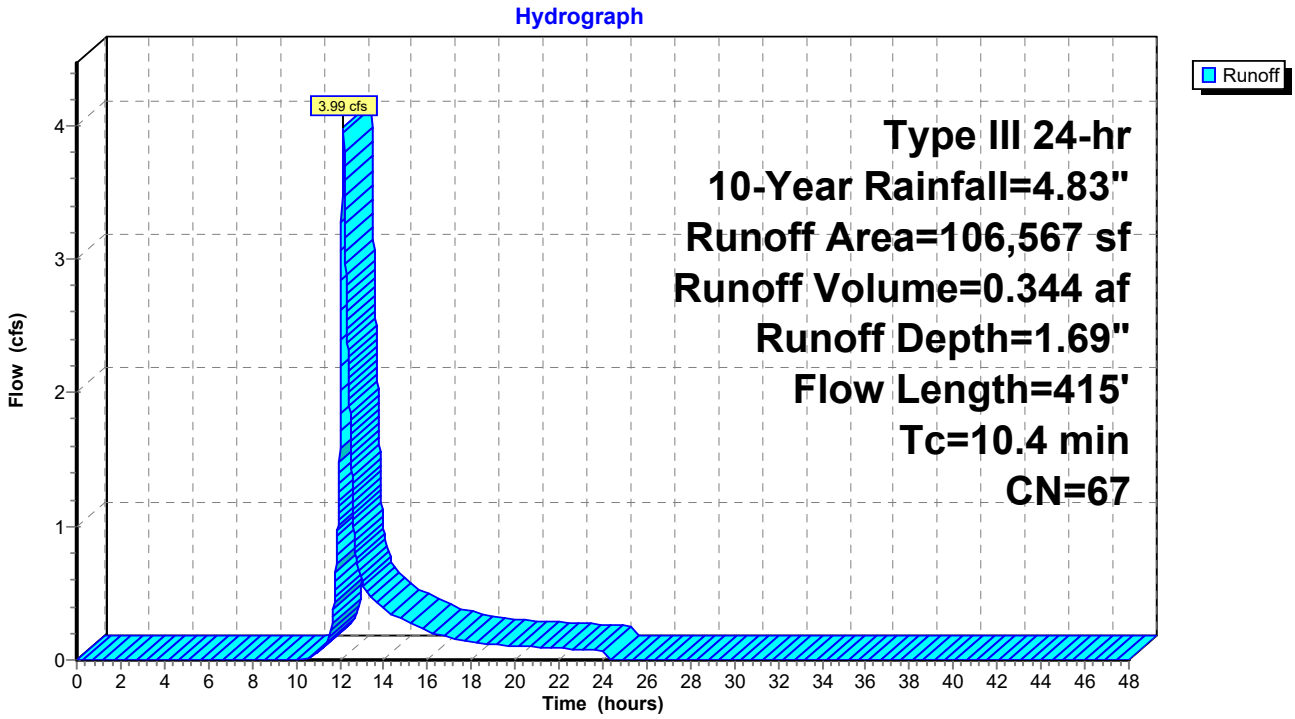
Runoff = 3.99 cfs @ 12.15 hrs, Volume= 0.344 af, Depth= 1.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
17,393	98	Paved parking, HSG B
66,636	61	>75% Grass cover, Good, HSG B
18,921	55	Woods, Good, HSG B
763	85	Gravel roads, HSG B
2,854	98	Roofs, HSG B
106,567	67	Weighted Average
86,320		81.00% Pervious Area
20,247		19.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.18"
6.1	365	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.4	415	Total			

Subcatchment 3A: EX-3A



Summary for Subcatchment 4A: EX-4A

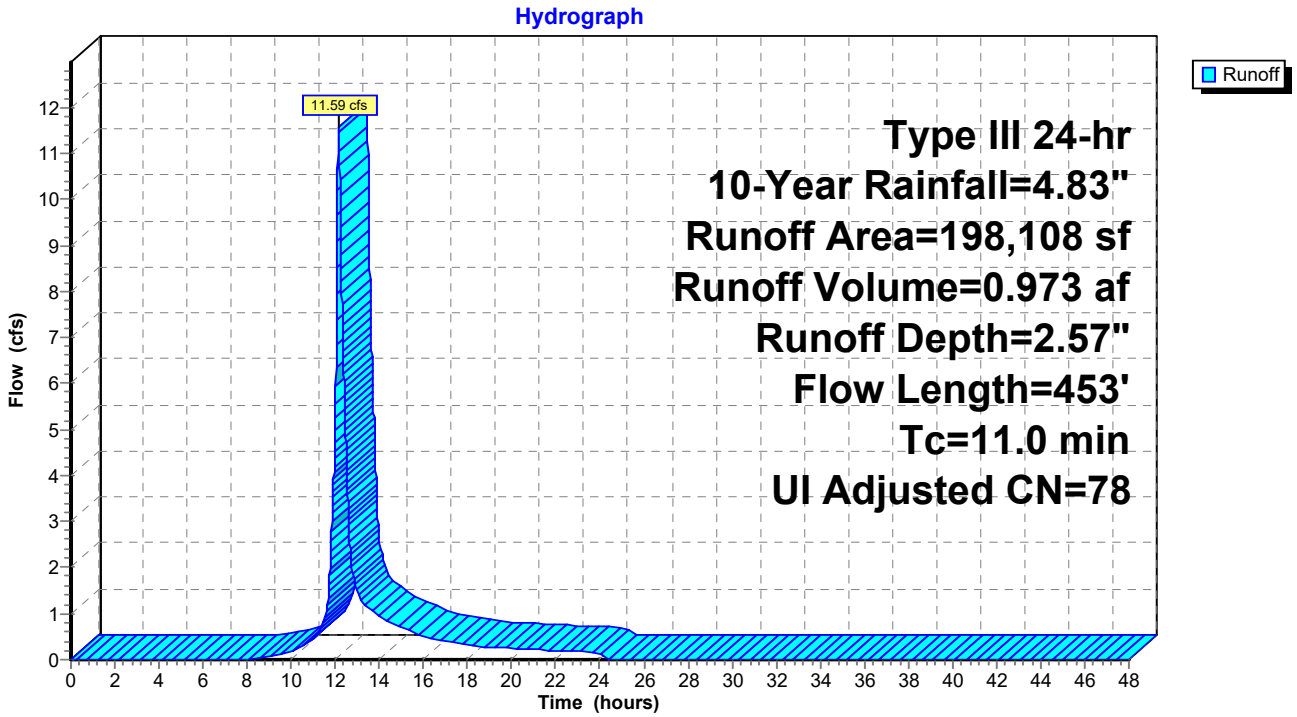
Runoff = 11.59 cfs @ 12.16 hrs, Volume= 0.973 af, Depth= 2.57"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Adj	Description
12,500	98		Unconnected pavement, HSG D
176,670	77		Woods, Good, HSG D
8,938	91		Gravel roads, HSG D
198,108	79	78	Weighted Average, UI Adjusted
185,608			93.69% Pervious Area
12,500			6.31% Impervious Area
12,500			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.9	50	0.2000	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.18"
0.8	88	0.1250	1.77		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.2	315	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.0	453	Total			

Subcatchment 4A: EX-4A



Summary for Subcatchment 4B: EX-4B

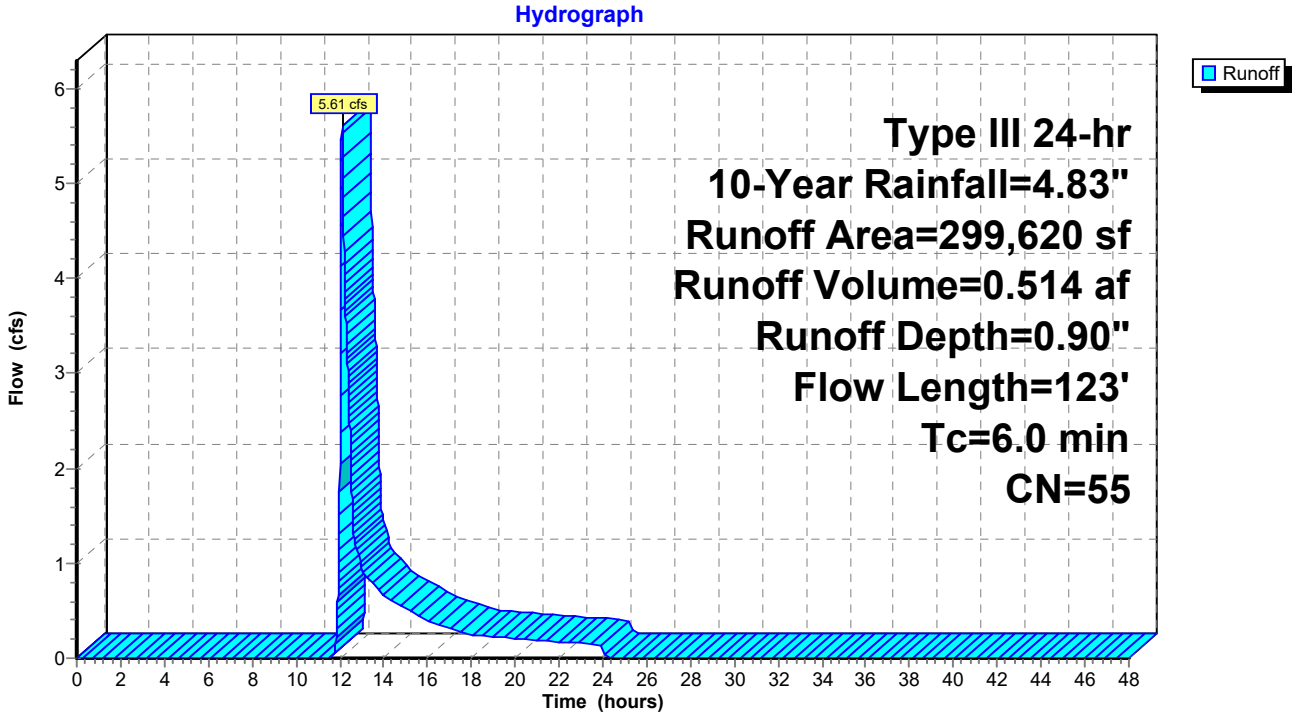
Runoff = 5.61 cfs @ 12.11 hrs, Volume= 0.514 af, Depth= 0.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
774	98	Paved parking, HSG B
296,991	55	Woods, Good, HSG B
1,855	85	Gravel roads, HSG B
299,620	55	Weighted Average
298,846		99.74% Pervious Area
774		0.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	123		0.34		**Direct Entry,**

Subcatchment 4B: EX-4B



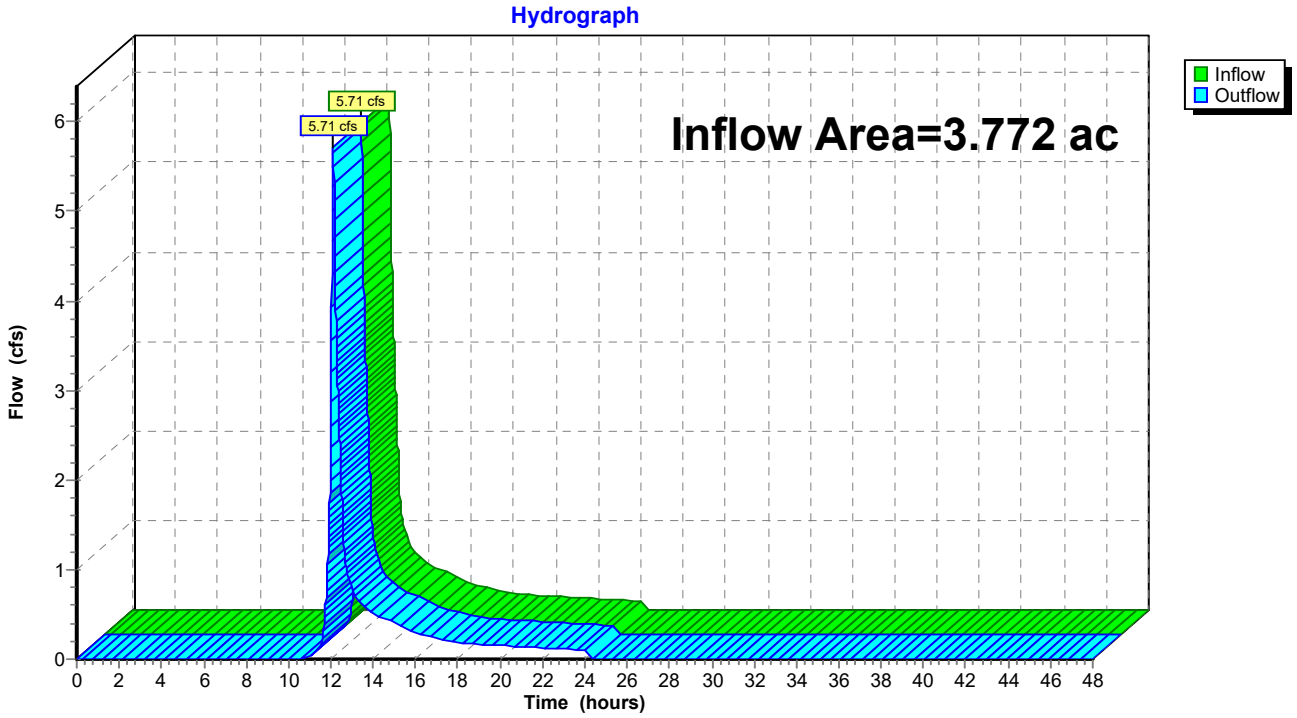
Summary for Reach DP1: DP-1 (BVW)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 3.772 ac, 15.22% Impervious, Inflow Depth = 1.47" for 10-Year event
Inflow = 5.71 cfs @ 12.11 hrs, Volume= 0.462 af
Outflow = 5.71 cfs @ 12.11 hrs, Volume= 0.462 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach DP1: DP-1 (BVW)



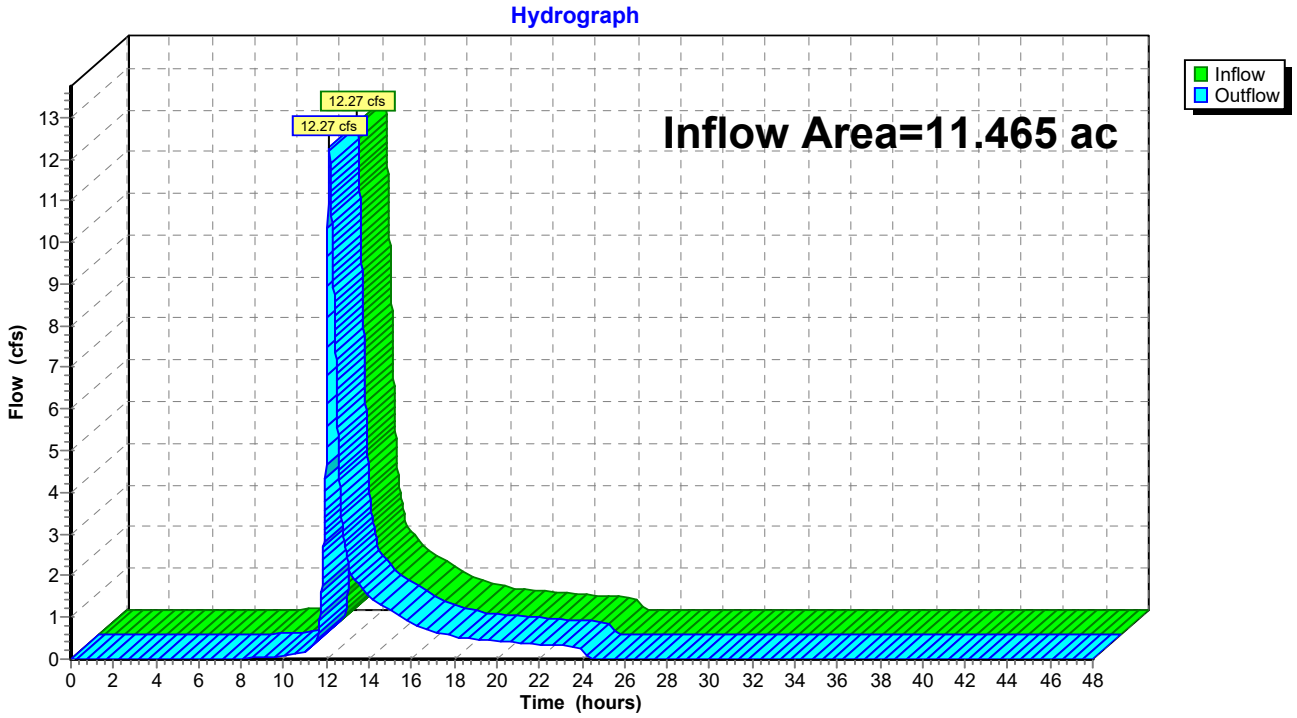
Summary for Reach DP2: DP-2 (SOUTH BEACH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11.465 ac, 11.05% Impervious, Inflow Depth = 1.36" for 10-Year event
Inflow = 12.27 cfs @ 12.13 hrs, Volume= 1.299 af
Outflow = 12.27 cfs @ 12.13 hrs, Volume= 1.299 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach DP2: DP-2 (SOUTH BEACH)



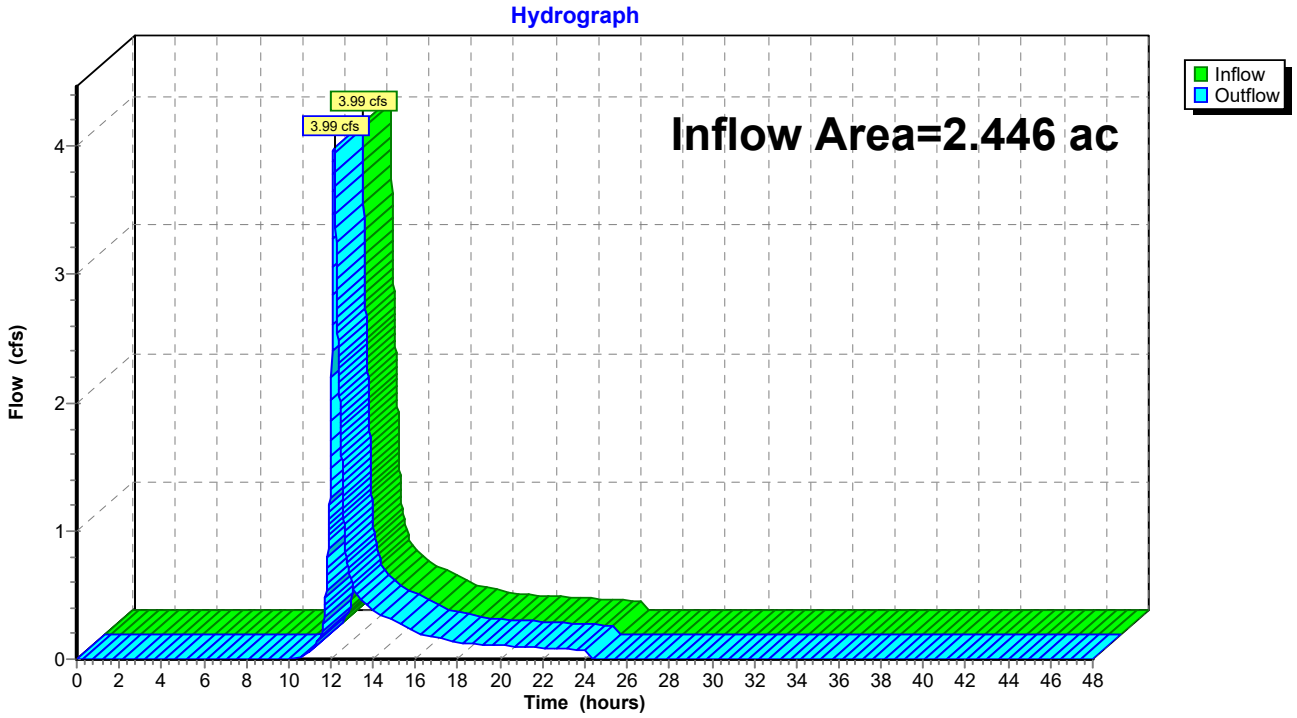
Summary for Reach DP3: DP-3 (EX PIPE TO NORTH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 2.446 ac, 19.00% Impervious, Inflow Depth = 1.69" for 10-Year event
Inflow = 3.99 cfs @ 12.15 hrs, Volume= 0.344 af
Outflow = 3.99 cfs @ 12.15 hrs, Volume= 0.344 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach DP3: DP-3 (EX PIPE TO NORTH)



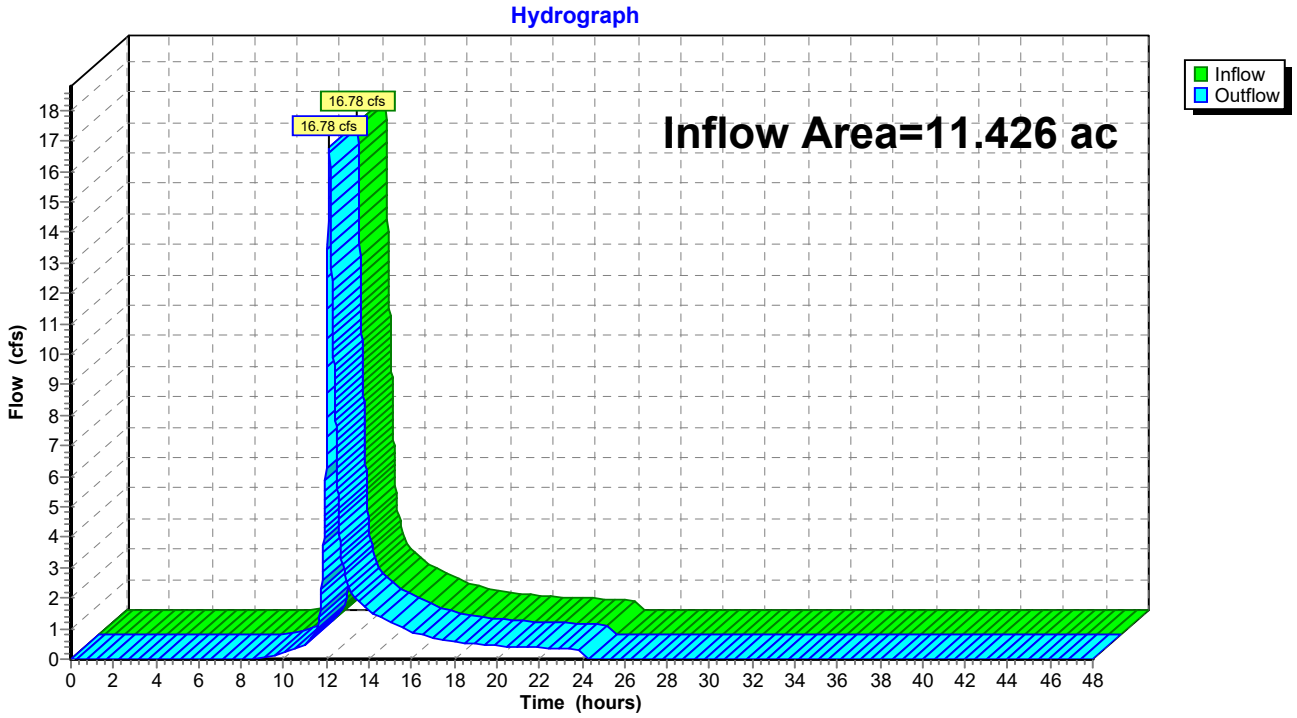
Summary for Reach DP4: DP-4 (EAST BEACH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11.426 ac, 2.67% Impervious, Inflow Depth = 1.56" for 10-Year event
Inflow = 16.78 cfs @ 12.14 hrs, Volume= 1.487 af
Outflow = 16.78 cfs @ 12.14 hrs, Volume= 1.487 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach DP4: DP-4 (EAST BEACH)



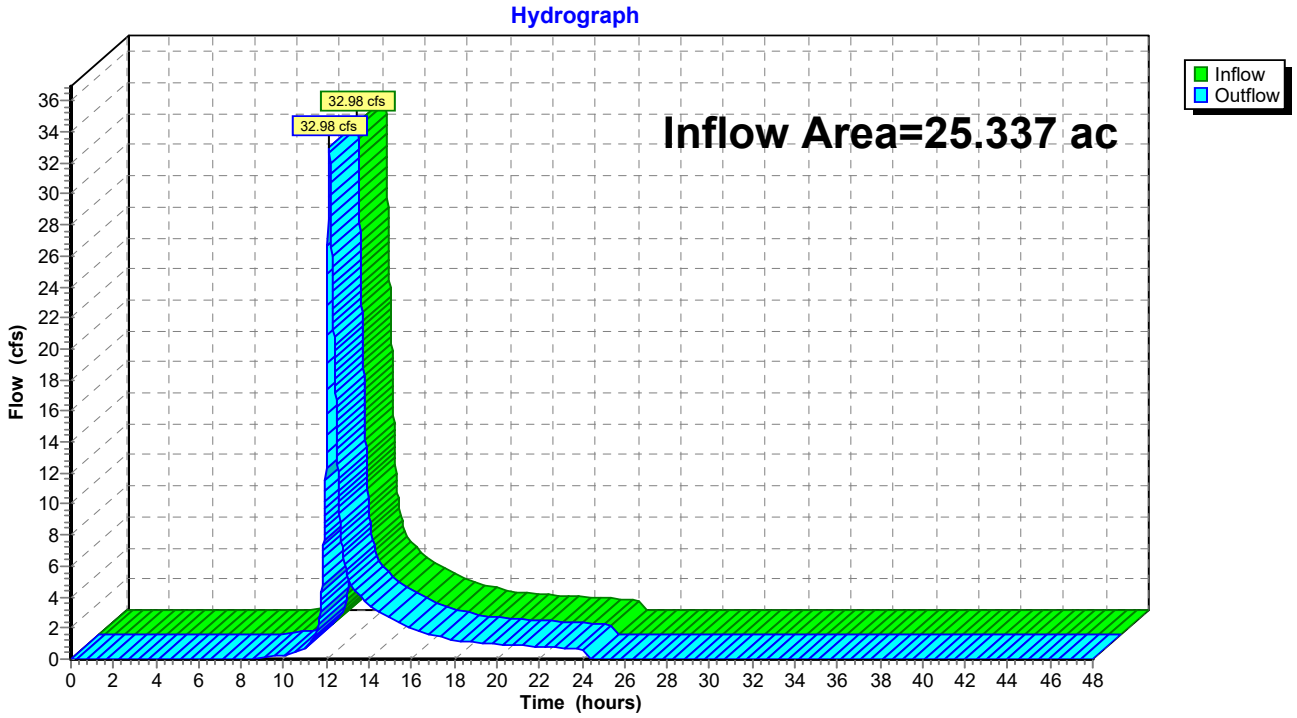
Summary for Reach TS: OCEAN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 25.337 ac, 8.04% Impervious, Inflow Depth = 1.48" for 10-Year event
Inflow = 32.98 cfs @ 12.14 hrs, Volume= 3.130 af
Outflow = 32.98 cfs @ 12.14 hrs, Volume= 3.130 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach TS: OCEAN



Time span=0.00-48.00 hrs, dt=0.01 hrs, 4801 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1A: EX-1A Runoff Area=83,747 sf 11.43% Impervious Runoff Depth=4.30"
Flow Length=187' Tc=8.4 min CN=62 Runoff=8.88 cfs 0.689 af

Subcatchment1B: EX-1B Runoff Area=80,571 sf 19.16% Impervious Runoff Depth=4.79"
Flow Length=303' Tc=6.5 min CN=66 Runoff=10.21 cfs 0.738 af

Subcatchment2A: EX-2A Runoff Area=293,625 sf 4.21% Impervious Runoff Depth=3.81"
Flow Length=347' Tc=15.3 min CN=58 Runoff=22.23 cfs 2.140 af

Subcatchment2B: EX-2B Runoff Area=41,460 sf 42.97% Impervious Runoff Depth=6.76"
Flow Length=153' Tc=6.2 min CN=82 Runoff=7.27 cfs 0.536 af

Subcatchment3A: EX-3A Runoff Area=106,567 sf 19.00% Impervious Runoff Depth=4.91"
Flow Length=415' Tc=10.4 min CN=67 Runoff=12.16 cfs 1.002 af

Subcatchment4A: EX-4A Runoff Area=198,108 sf 6.31% Impervious Runoff Depth=6.27"
Flow Length=453' Tc=11.0 min UI Adjusted CN=78 Runoff=27.91 cfs 2.375 af

Subcatchment4B: EX-4B Runoff Area=299,620 sf 0.26% Impervious Runoff Depth=3.44"
Flow Length=123' Tc=6.0 min CN=55 Runoff=27.11 cfs 1.974 af

Reach DP1: DP-1 (BVW) Inflow=18.89 cfs 1.427 af
Outflow=18.89 cfs 1.427 af

Reach DP2: DP-2 (SOUTH BEACH) Inflow=42.80 cfs 4.103 af
Outflow=42.80 cfs 4.103 af

Reach DP3: DP-3 (EX PIPE TO NORTH) Inflow=12.16 cfs 1.002 af
Outflow=12.16 cfs 1.002 af

Reach DP4: DP-4 (EAST BEACH) Inflow=52.72 cfs 4.349 af
Outflow=52.72 cfs 4.349 af

Reach TS: OCEAN Inflow=107.13 cfs 9.454 af
Outflow=107.13 cfs 9.454 af

Total Runoff Area = 25.337 ac Runoff Volume = 9.454 af Average Runoff Depth = 4.48"
91.96% Pervious = 23.301 ac 8.04% Impervious = 2.036 ac

Summary for Subcatchment 1A: EX-1A

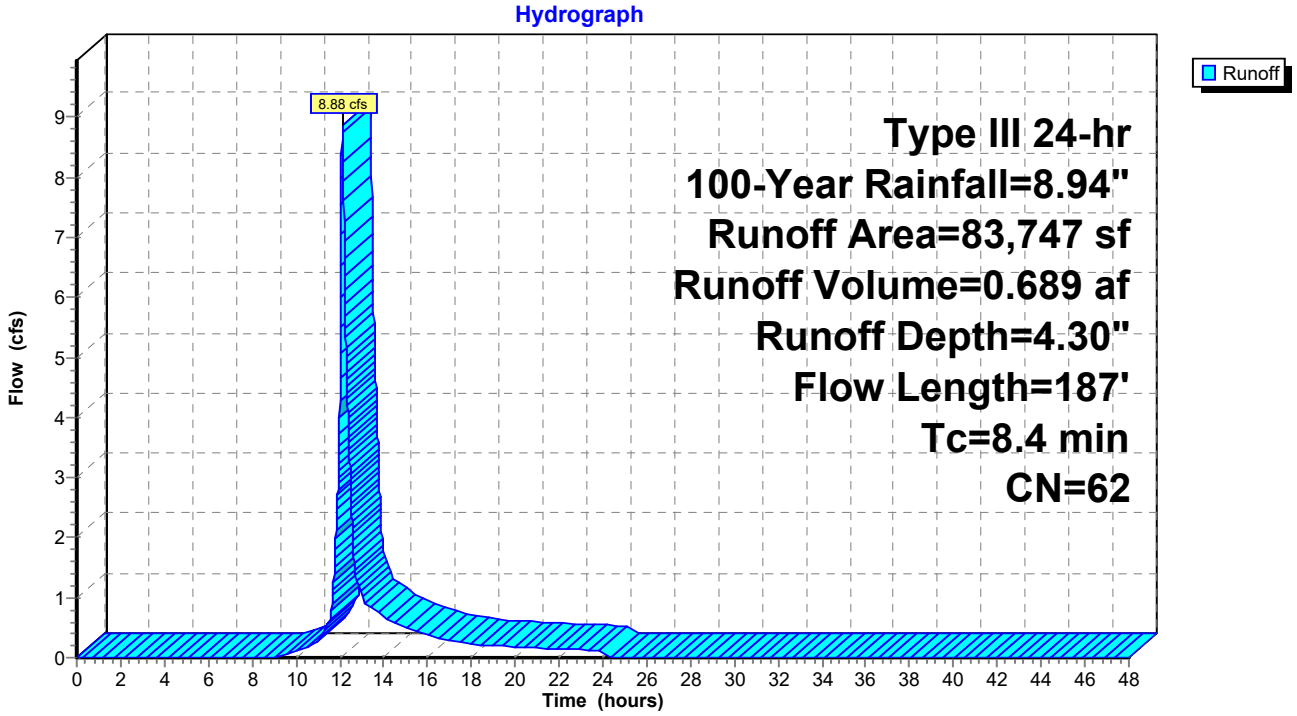
Runoff = 8.88 cfs @ 12.12 hrs, Volume= 0.689 af, Depth= 4.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
9,572	98	Paved parking, HSG B
61,186	55	Woods, Good, HSG B
4,818	85	Gravel roads, HSG B
8,171	58	Woods/grass comb., Good, HSG B
83,747	62	Weighted Average
74,175		88.57% Pervious Area
9,572		11.43% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.3	50	0.1100	0.13		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.18"
2.1	137	0.0470	1.08		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
8.4	187	Total			

Subcatchment 1A: EX-1A



Summary for Subcatchment 1B: EX-1B

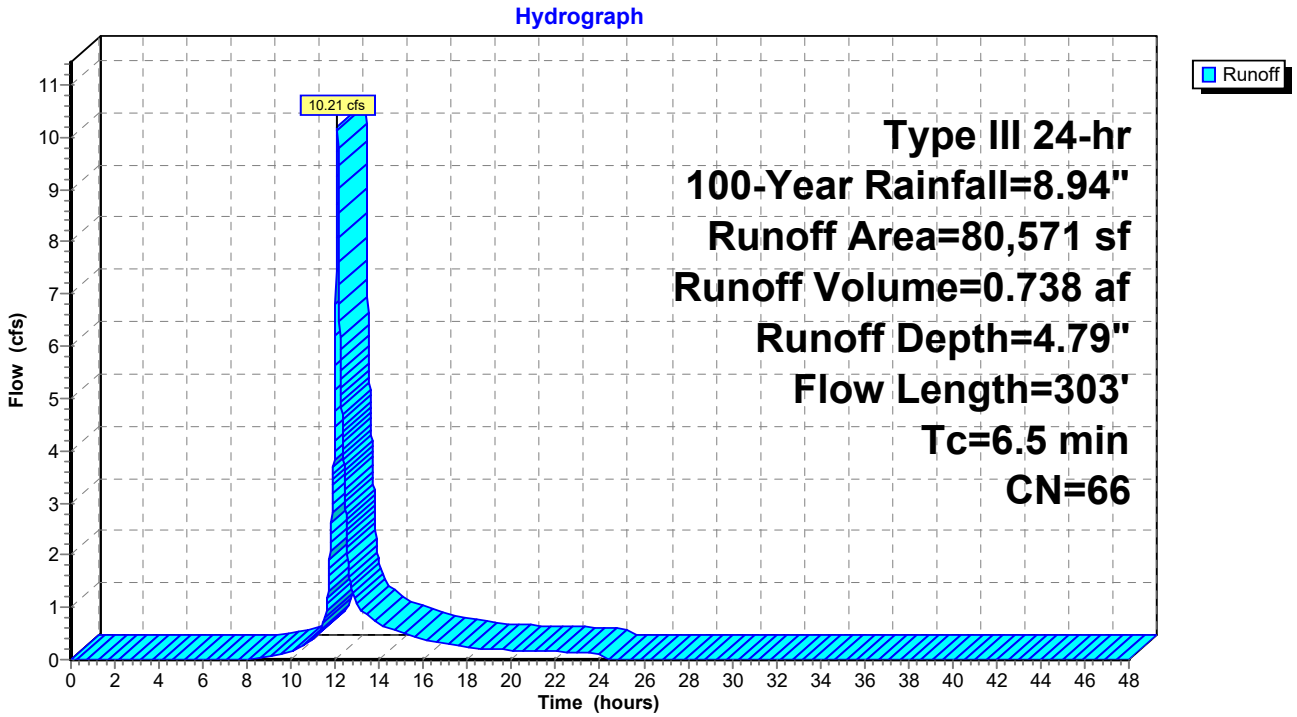
Runoff = 10.21 cfs @ 12.10 hrs, Volume= 0.738 af, Depth= 4.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
15,441	98	Paved parking, HSG B
36,095	55	Woods, Good, HSG B
27,884	61	>75% Grass cover, Good, HSG B
1,151	85	Gravel roads, HSG B
80,571	66	Weighted Average
65,130		80.84% Pervious Area
15,441		19.16% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.5	50	0.4800	0.24		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.18"
0.2	89	0.1800	6.83		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
2.8	164	0.0190	0.96		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
6.5	303	Total			

Subcatchment 1B: EX-1B



Summary for Subcatchment 2A: EX-2A

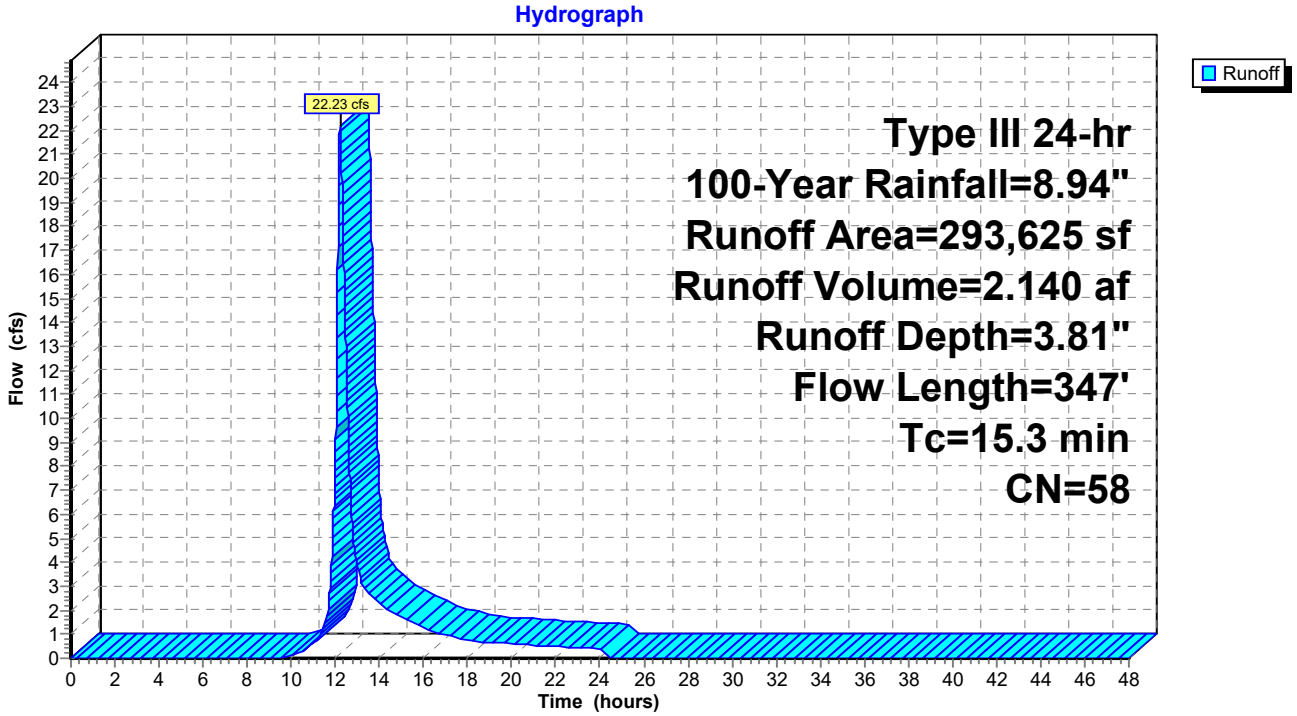
Runoff = 22.23 cfs @ 12.22 hrs, Volume= 2.140 af, Depth= 3.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
12,348	98	Paved parking, HSG B
273,466	55	Woods, Good, HSG B
7,811	85	Gravel roads, HSG B
293,625	58	Weighted Average
281,277		95.79% Pervious Area
12,348		4.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.4	50	0.0800	0.07		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 3.18"
2.9	297	0.1200	1.73		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	347	Total			

Subcatchment 2A: EX-2A



Summary for Subcatchment 2B: EX-2B

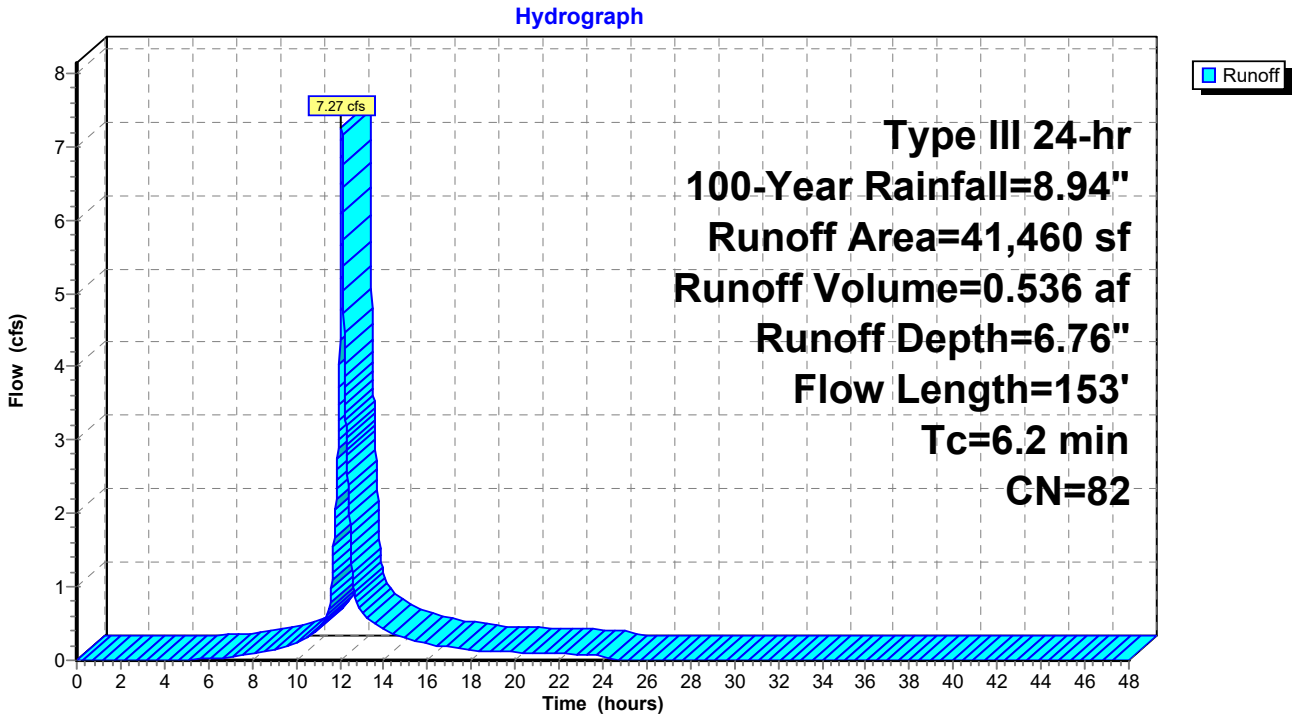
Runoff = 7.27 cfs @ 12.09 hrs, Volume= 0.536 af, Depth= 6.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
17,814	98	Roofs, HSG B
14,033	61	>75% Grass cover, Good, HSG B
9,613	85	Gravel roads, HSG B
41,460	82	Weighted Average
23,646		57.03% Pervious Area
17,814		42.97% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	50	0.1200	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.18"
0.2	103	0.2900	8.67		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.2	153	Total			

Subcatchment 2B: EX-2B



Summary for Subcatchment 3A: EX-3A

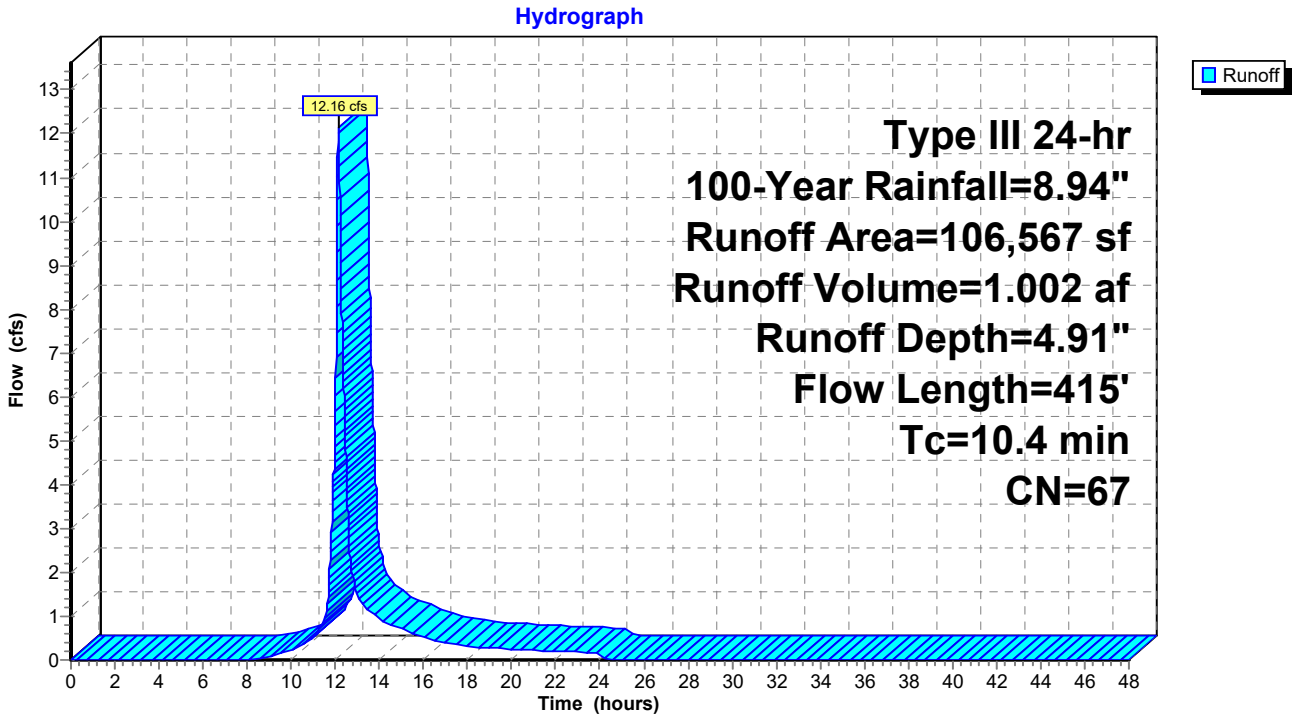
Runoff = 12.16 cfs @ 12.15 hrs, Volume= 1.002 af, Depth= 4.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
17,393	98	Paved parking, HSG B
66,636	61	>75% Grass cover, Good, HSG B
18,921	55	Woods, Good, HSG B
763	85	Gravel roads, HSG B
2,854	98	Roofs, HSG B
106,567	67	Weighted Average
86,320		81.00% Pervious Area
20,247		19.00% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.3	50	0.0400	0.19		**Sheet Flow,** Grass: Short n= 0.150 P2= 3.18"
6.1	365	0.0200	0.99		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
10.4	415	Total			

Subcatchment 3A: EX-3A



Summary for Subcatchment 4A: EX-4A

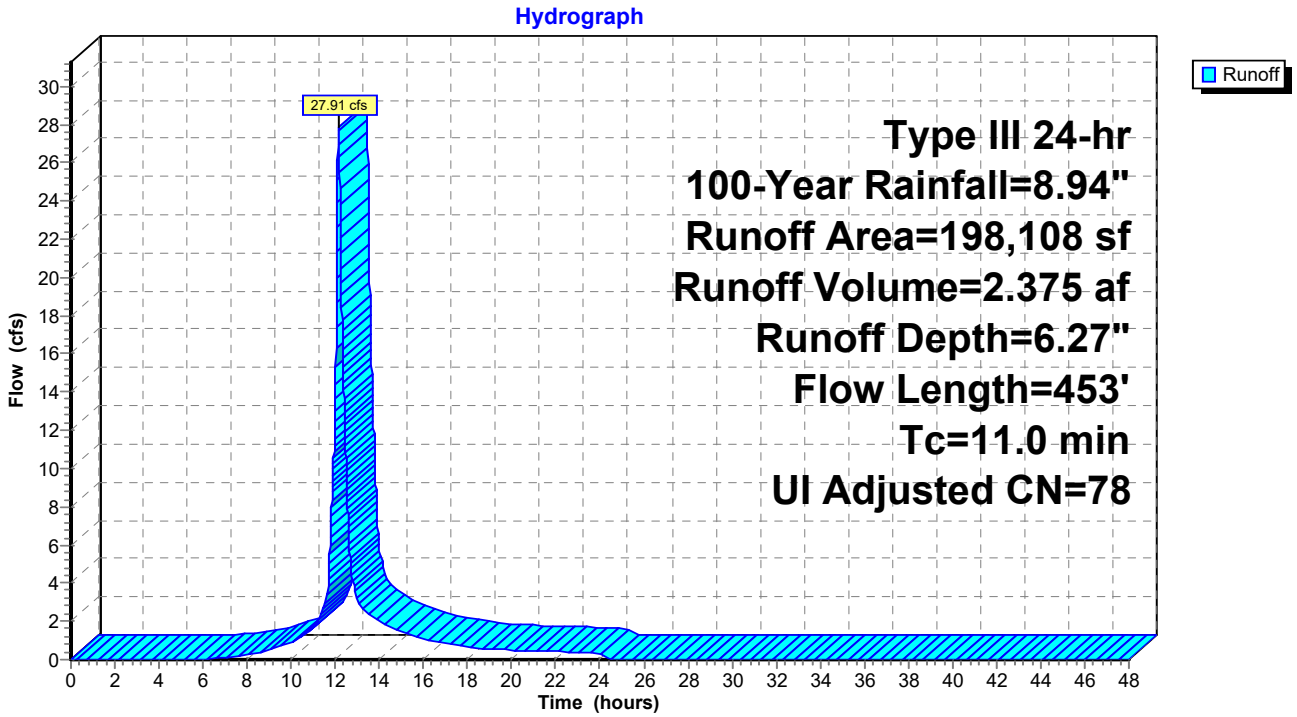
Runoff = 27.91 cfs @ 12.15 hrs, Volume= 2.375 af, Depth= 6.27"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Adj	Description
12,500	98		Unconnected pavement, HSG D
176,670	77		Woods, Good, HSG D
8,938	91		Gravel roads, HSG D
198,108	79	78	Weighted Average, UI Adjusted
185,608			93.69% Pervious Area
12,500			6.31% Impervious Area
12,500			100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
4.9	50	0.2000	0.17		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.18"
0.8	88	0.1250	1.77		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
5.2	315	0.0400	1.00		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
11.0	453	Total			

Subcatchment 4A: EX-4A



Summary for Subcatchment 4B: EX-4B

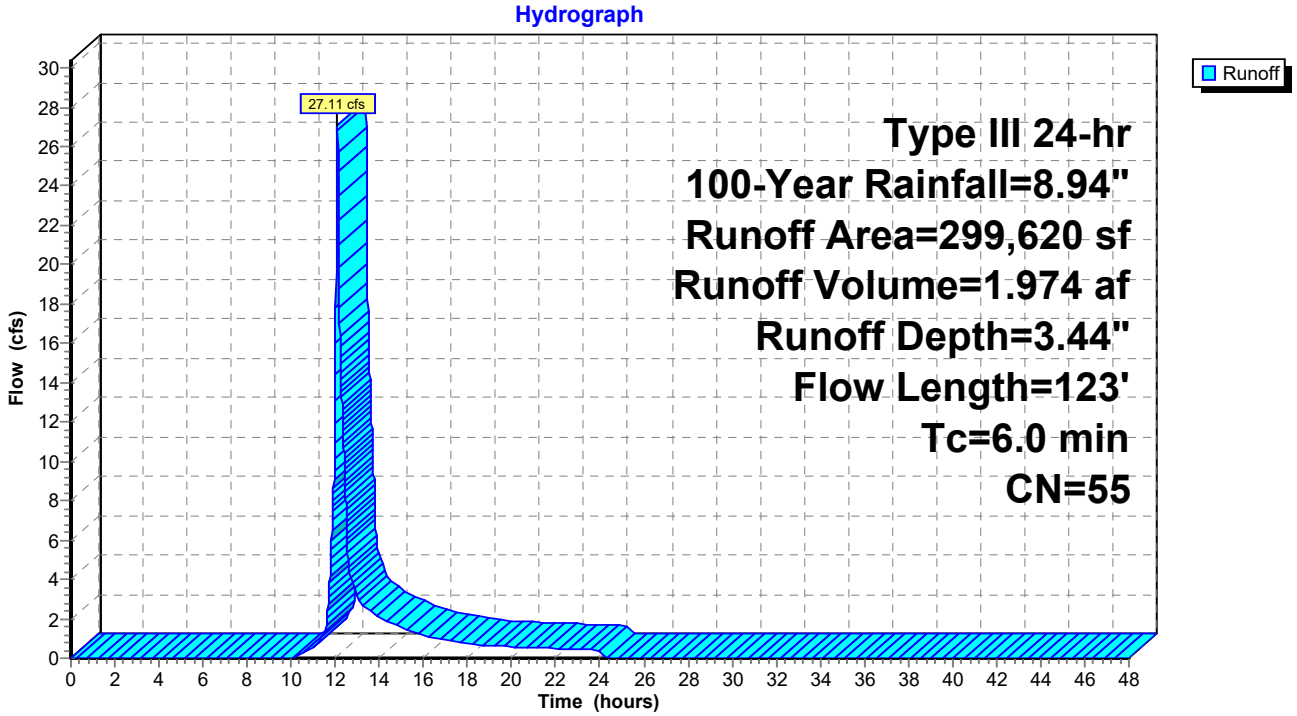
Runoff = 27.11 cfs @ 12.09 hrs, Volume= 1.974 af, Depth= 3.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
774	98	Paved parking, HSG B
296,991	55	Woods, Good, HSG B
1,855	85	Gravel roads, HSG B
299,620	55	Weighted Average
298,846		99.74% Pervious Area
774		0.26% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.0	123		0.34		**Direct Entry,**

Subcatchment 4B: EX-4B



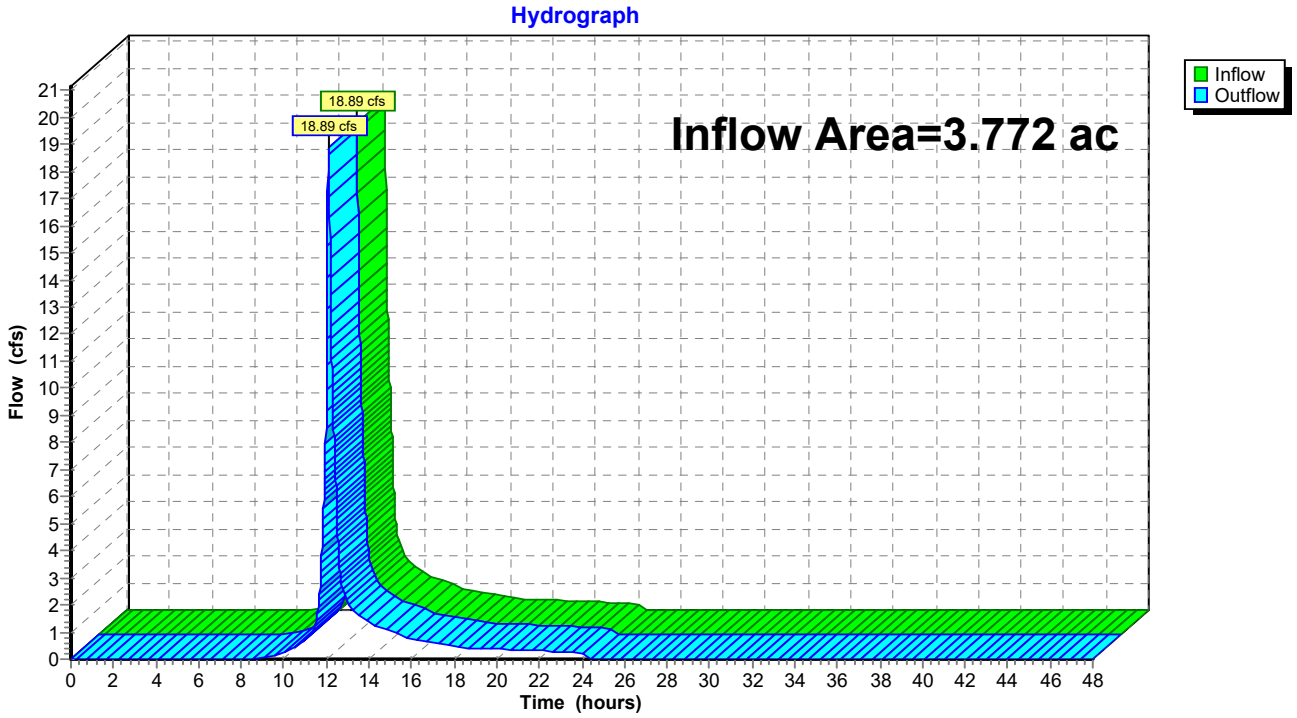
Summary for Reach DP1: DP-1 (BVW)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 3.772 ac, 15.22% Impervious, Inflow Depth = 4.54" for 100-Year event
Inflow = 18.89 cfs @ 12.11 hrs, Volume= 1.427 af
Outflow = 18.89 cfs @ 12.11 hrs, Volume= 1.427 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach DP1: DP-1 (BVW)



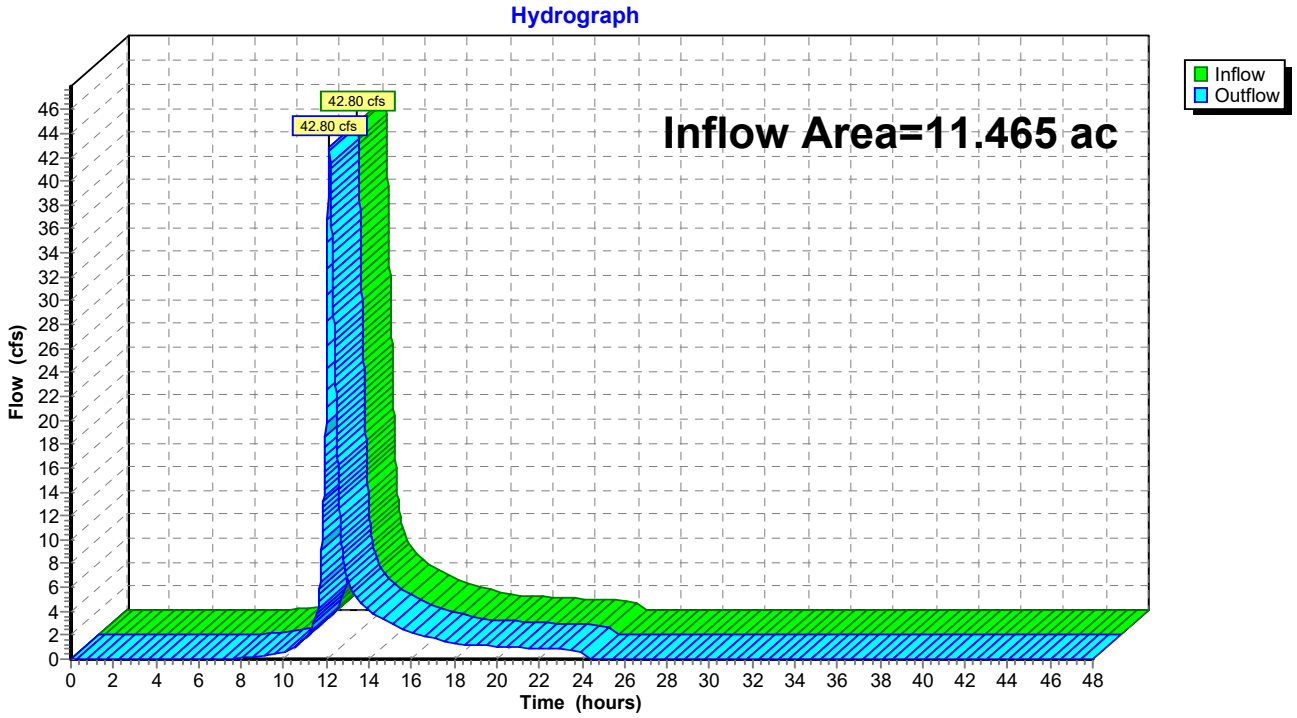
Summary for Reach DP2: DP-2 (SOUTH BEACH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11.465 ac, 11.05% Impervious, Inflow Depth = 4.29" for 100-Year event
Inflow = 42.80 cfs @ 12.13 hrs, Volume= 4.103 af
Outflow = 42.80 cfs @ 12.13 hrs, Volume= 4.103 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach DP2: DP-2 (SOUTH BEACH)



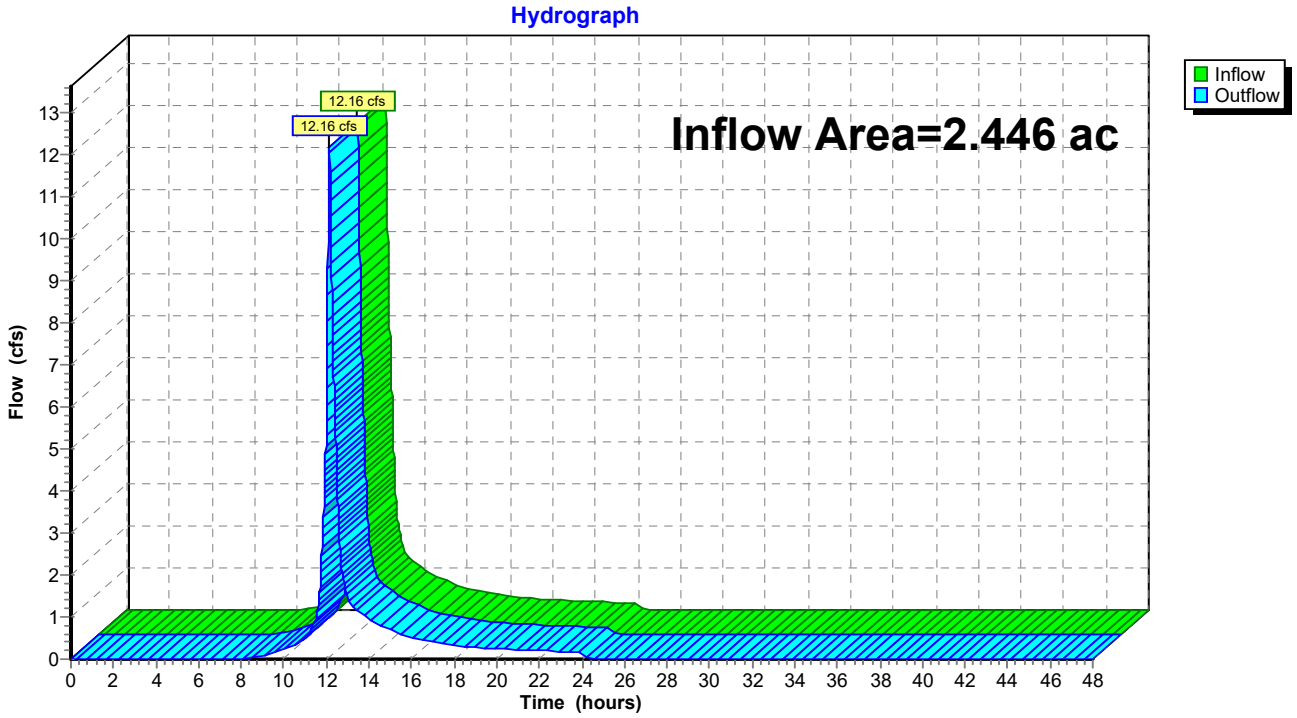
Summary for Reach DP3: DP-3 (EX PIPE TO NORTH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 2.446 ac, 19.00% Impervious, Inflow Depth = 4.91" for 100-Year event
Inflow = 12.16 cfs @ 12.15 hrs, Volume= 1.002 af
Outflow = 12.16 cfs @ 12.15 hrs, Volume= 1.002 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach DP3: DP-3 (EX PIPE TO NORTH)



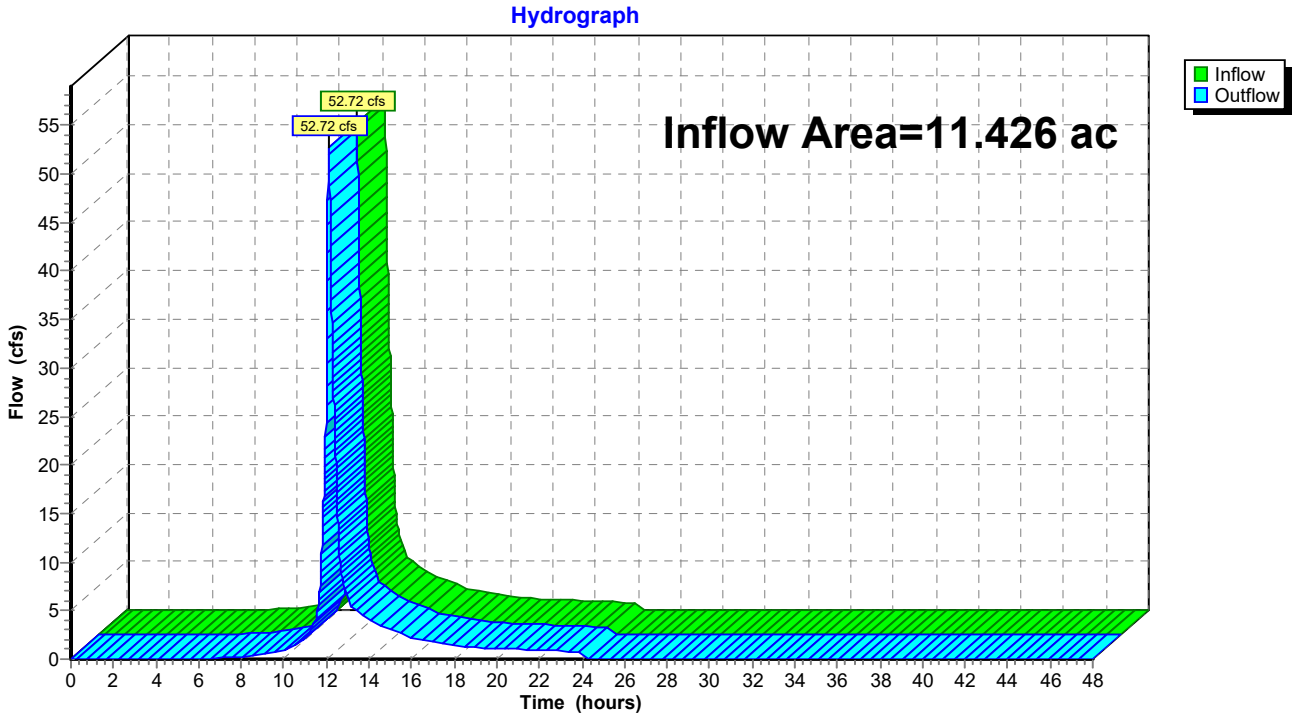
Summary for Reach DP4: DP-4 (EAST BEACH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 11.426 ac, 2.67% Impervious, Inflow Depth = 4.57" for 100-Year event
Inflow = 52.72 cfs @ 12.11 hrs, Volume= 4.349 af
Outflow = 52.72 cfs @ 12.11 hrs, Volume= 4.349 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

Reach DP4: DP-4 (EAST BEACH)



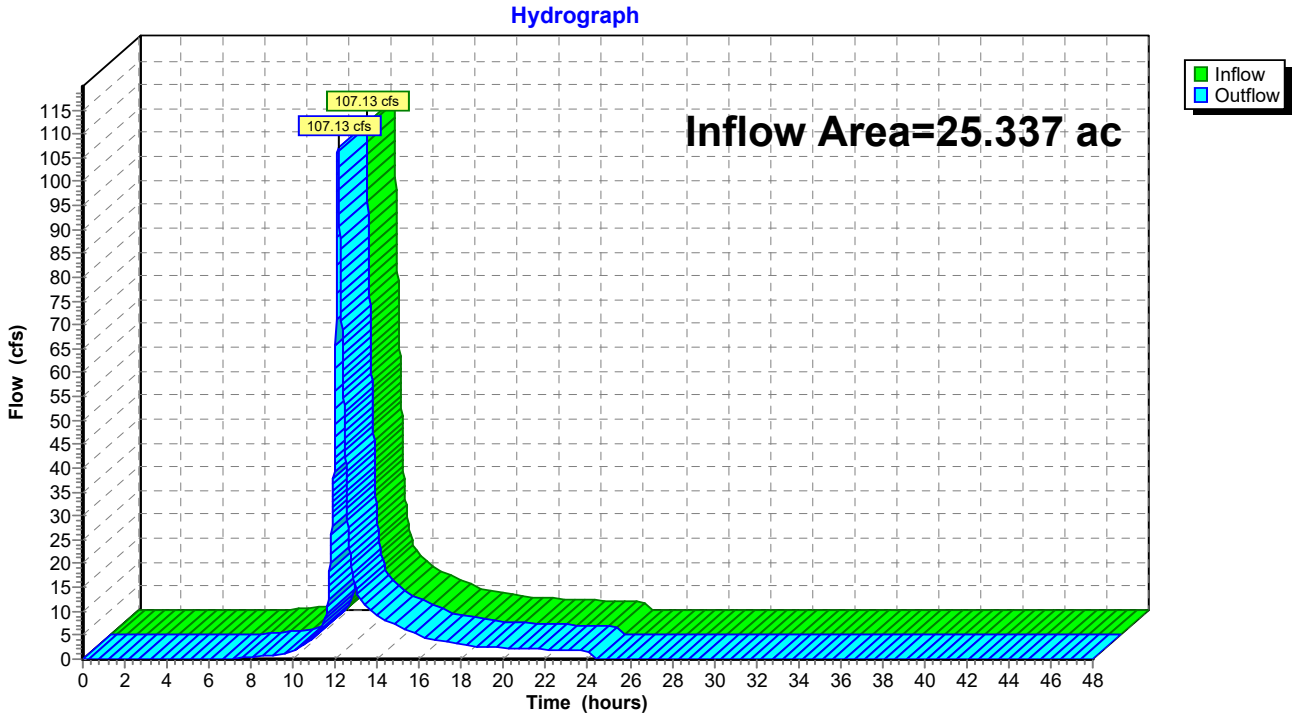
Summary for Reach TS: OCEAN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 25.337 ac, 8.04% Impervious, Inflow Depth = 4.48" for 100-Year event
Inflow = 107.13 cfs @ 12.12 hrs, Volume= 9.454 af
Outflow = 107.13 cfs @ 12.12 hrs, Volume= 9.454 af, Atten= 0%, Lag= 0.0 min

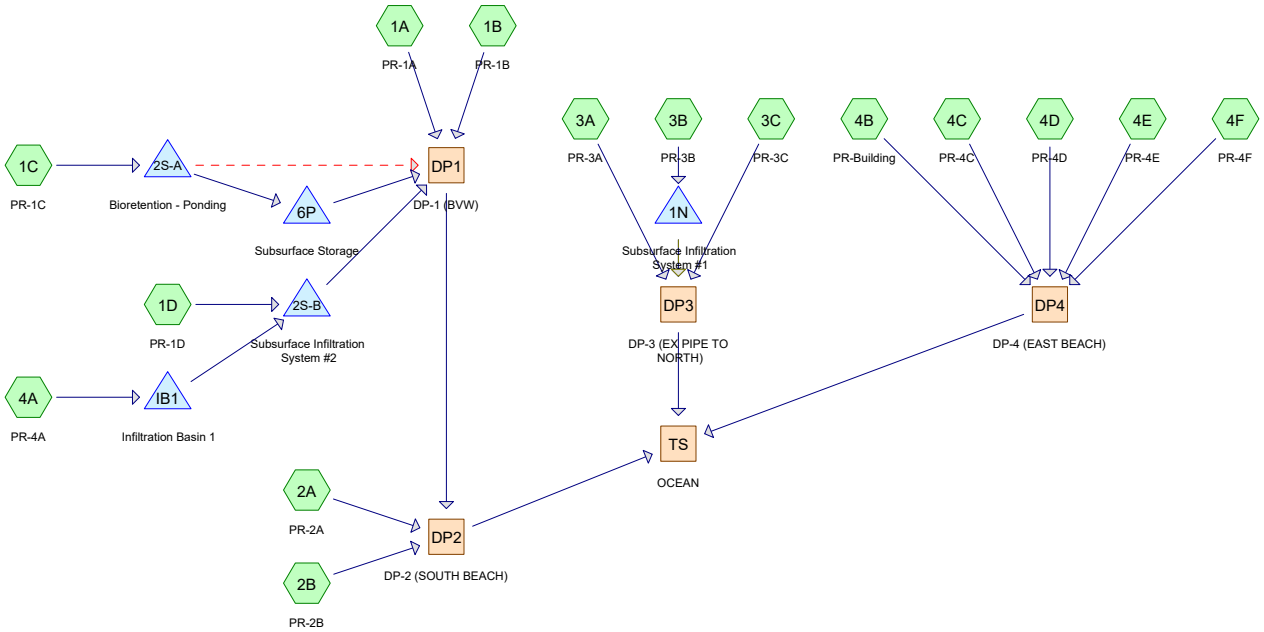
Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.01 hrs

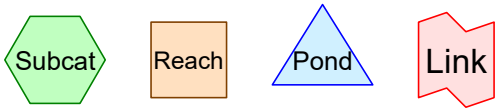
Reach TS: OCEAN



APPENDIX C

Post-Development Conditions – HydroCAD Calculations





Routing Diagram for SW Calc - Proposed
Prepared by Nitsch Engineering, Printed 4/11/2019
HydroCAD® 10.00-20 s/n 00546 © 2017 HydroCAD Software Solutions LLC

Area Listing (all nodes)

Area (acres)	CN	Description (subcatchment-numbers)
5.820	61	>75% Grass cover, Good, HSG B (1A, 1B, 1C, 1D, 2B, 3A, 3B, 3C, 4D, 4E)
0.827	80	>75% Grass cover, Good, HSG D (4A, 4F)
0.771	85	Gravel roads, HSG B (1A, 2A, 2B, 4A, 4C, 4D, 4E)
0.768	61	Pasture/grassland/range, Good, HSG B (3A)
1.611	98	Paved parking, HSG B (1A, 1C, 1D, 2A, 3A, 3B)
0.056	98	Paved parking, HSG D (4A)
0.190	98	Pavement (1B)
0.239	98	Unconnected pavement, HSG B (3C, 4C)
1.334	98	Unconnected roofs, HSG B (2B, 4B)
13.722	55	Woods, Good, HSG B (1A, 2A, 4C)
25.337	**64**	**TOTAL AREA**

Soil Listing (all nodes)

Area (acres)	Soil Group	Subcatchment Numbers
0.000	HSG A	
24.265	HSG B	1A, 1B, 1C, 1D, 2A, 2B, 3A, 3B, 3C, 4A, 4B, 4C, 4D, 4E
0.000	HSG C	
0.883	HSG D	4A, 4F
0.190	Other	1B
25.337		**TOTAL AREA**

Ground Covers (all nodes)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	5.820	0.000	0.827	0.000	6.647	>75% Grass cover, Good	1A, 1B, 1C, 1D, 2B, 3A, 3B, 3C, 4A, 4D, 4E, 4F
0.000	0.771	0.000	0.000	0.000	0.771	Gravel roads	1A, 2A, 2B, 4A, 4C, 4D, 4E
0.000	0.768	0.000	0.000	0.000	0.768	Pasture/grassland/range, Good	3A
0.000	1.611	0.000	0.056	0.000	1.667	Paved parking	1A, 1C, 1D, 2A, 3A

Ground Covers (all nodes) (continued)

HSG-A (acres)	HSG-B (acres)	HSG-C (acres)	HSG-D (acres)	Other (acres)	Total (acres)	Ground Cover	Subcatchment Numbers
0.000	0.000	0.000	0.000	0.190	0.190	Pavement	1B
0.000	0.239	0.000	0.000	0.000	0.239	Unconnected pavement	3C, 4C
0.000	1.334	0.000	0.000	0.000	1.334	Unconnected roofs	2B, 4B
0.000	13.722	0.000	0.000	0.000	13.722	Woods, Good	1A, 2A, 4C
0.000	**24.265**	**0.000**	**0.883**	**0.190**	**25.337**	**TOTAL AREA**	

Pipe Listing (all nodes)

Line#	Node Number	In-Invert (feet)	Out-Invert (feet)	Length (feet)	Slope (ft/ft)	n	Diam/Width (inches)	Height (inches)	Inside-Fill (inches)
1	1N	13.00	12.75	50.0	0.0050	0.020	15.0	0.0	0.0
2	2S-B	13.50	13.10	50.0	0.0080	0.020	15.0	0.0	0.0

Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1A: PR-1A Runoff Area=61,199 sf 9.62% Impervious Runoff Depth=0.54"
Flow Length=135' Tc=6.6 min CN=64 Runoff=0.63 cfs 0.063 af

Subcatchment1B: PR-1B Runoff Area=47,277 sf 17.48% Impervious Runoff Depth=0.66"
Flow Length=1,689' Tc=23.3 min CN=67 Runoff=0.44 cfs 0.060 af

Subcatchment1C: PR-1C Runoff Area=22,519 sf 53.05% Impervious Runoff Depth=1.43"
Tc=6.0 min CN=81 Runoff=0.84 cfs 0.062 af

Subcatchment1D: PR-1D Runoff Area=38,129 sf 35.02% Impervious Runoff Depth=1.00"
Tc=6.0 min CN=74 Runoff=0.96 cfs 0.073 af

Subcatchment2A: PR-2A Runoff Area=293,625 sf 4.21% Impervious Runoff Depth=0.32"
Flow Length=347' Tc=15.3 min CN=58 Runoff=0.99 cfs 0.182 af

Subcatchment2B: PR-2B Runoff Area=41,460 sf 42.97% Impervious Runoff Depth=1.50"
Flow Length=153' Tc=6.3 min CN=82 Runoff=1.62 cfs 0.119 af

Subcatchment3A: PR-3A Runoff Area=59,328 sf 23.32% Impervious Runoff Depth=0.80"
Flow Length=140' Tc=13.0 min CN=70 Runoff=0.89 cfs 0.091 af

Subcatchment3B: PR-3B Runoff Area=31,260 sf 41.03% Impervious Runoff Depth=1.12"
Tc=6.0 min CN=76 Runoff=0.89 cfs 0.067 af

Subcatchment3C: PR-3C Runoff Area=13,432 sf 71.85% Impervious Runoff Depth=1.95"
Tc=6.0 min CN=88 Runoff=0.69 cfs 0.050 af

Subcatchment4A: PR-4A Runoff Area=33,278 sf 7.29% Impervious Runoff Depth=1.43"
Tc=6.0 min CN=81 Runoff=1.25 cfs 0.091 af

Subcatchment4B: PR-Building Runoff Area=40,287 sf 100.00% Impervious Runoff Depth=2.92"
Tc=6.0 min CN=98 Runoff=2.76 cfs 0.225 af

Subcatchment4C: PR-4C Runoff Area=293,843 sf 0.26% Impervious Runoff Depth=0.24"
Tc=6.0 min CN=55 Runoff=0.64 cfs 0.133 af

Subcatchment4D: PR-4D Runoff Area=13,538 sf 0.00% Impervious Runoff Depth=0.46"
Tc=6.0 min CN=62 Runoff=0.11 cfs 0.012 af

Subcatchment4E: PR-4E Runoff Area=108,777 sf 0.00% Impervious Runoff Depth=0.50"
Flow Length=377' Tc=9.2 min CN=63 Runoff=0.90 cfs 0.103 af

Subcatchment4F: PR-4F Runoff Area=5,747 sf 0.00% Impervious Runoff Depth=1.36"
Tc=6.0 min CN=80 Runoff=0.20 cfs 0.015 af

Reach DP1: DP-1 (BVW) Inflow=1.10 cfs 0.190 af
Outflow=1.10 cfs 0.190 af

Reach DP2: DP-2 (SOUTH BEACH) Inflow=2.72 cfs 0.490 af
Outflow=2.72 cfs 0.490 af

Reach DP3: DP-3 (EX PIPE TO NORTH) Inflow=1.37 cfs 0.142 af
Outflow=1.37 cfs 0.142 af

Reach DP4: DP-4 (EAST BEACH) Inflow=3.92 cfs 0.488 af
Outflow=3.92 cfs 0.488 af

Reach TS: OCEAN Inflow=7.81 cfs 1.120 af
Outflow=7.81 cfs 1.120 af

Pond 1N: Subsurface Infiltration System #1 Peak Elev=13.75' Storage=0.027 af Inflow=0.89 cfs 0.067 af
Discarded=0.07 cfs 0.066 af Primary=0.01 cfs 0.001 af Outflow=0.08 cfs 0.067 af

Pond 2S-A: Bioretention - Ponding Peak Elev=17.74' Storage=1,026 cf Inflow=0.84 cfs 0.062 af
Primary=0.09 cfs 0.062 af Secondary=0.00 cfs 0.000 af Outflow=0.09 cfs 0.062 af

Pond 2S-B: Subsurface Infiltration System #2 Peak Elev=14.13' Storage=2,376 cf Inflow=1.94 cfs 0.158 af
Discarded=0.08 cfs 0.095 af Primary=0.40 cfs 0.062 af Outflow=0.48 cfs 0.158 af

Pond 6P: Subsurface Storage Peak Elev=13.57' Storage=530 cf Inflow=0.09 cfs 0.062 af
Discarded=0.06 cfs 0.057 af Primary=0.02 cfs 0.005 af Outflow=0.08 cfs 0.062 af

Pond IB1: Infiltration Basin 1 Peak Elev=31.61' Storage=630 cf Inflow=1.25 cfs 0.091 af
Outflow=1.05 cfs 0.084 af

Total Runoff Area = 25.337 ac Runoff Volume = 1.345 af Average Runoff Depth = 0.64"
86.46% Pervious = 21.907 ac 13.54% Impervious = 3.430 ac

Summary for Subcatchment 1A: PR-1A

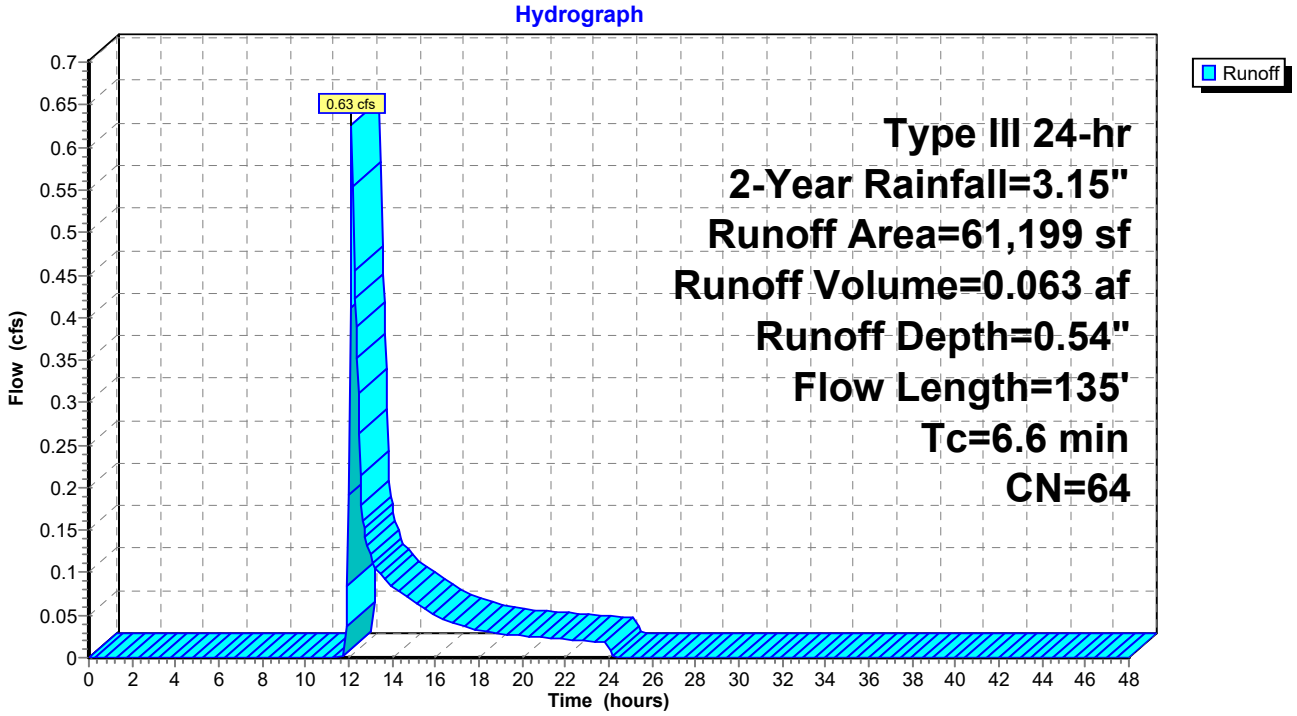
Runoff = 0.63 cfs @ 12.12 hrs, Volume= 0.063 af, Depth= 0.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
5,888	98	Paved parking, HSG B
5,753	85	Gravel roads, HSG B
16,513	61	>75% Grass cover, Good, HSG B
33,045	55	Woods, Good, HSG B
61,199	64	Weighted Average
55,311		90.38% Pervious Area
5,888		9.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	50	0.1300	0.21		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.17"
2.7	85	0.0110	0.52		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
6.6	135	Total			

Subcatchment 1A: PR-1A



Summary for Subcatchment 1B: PR-1B

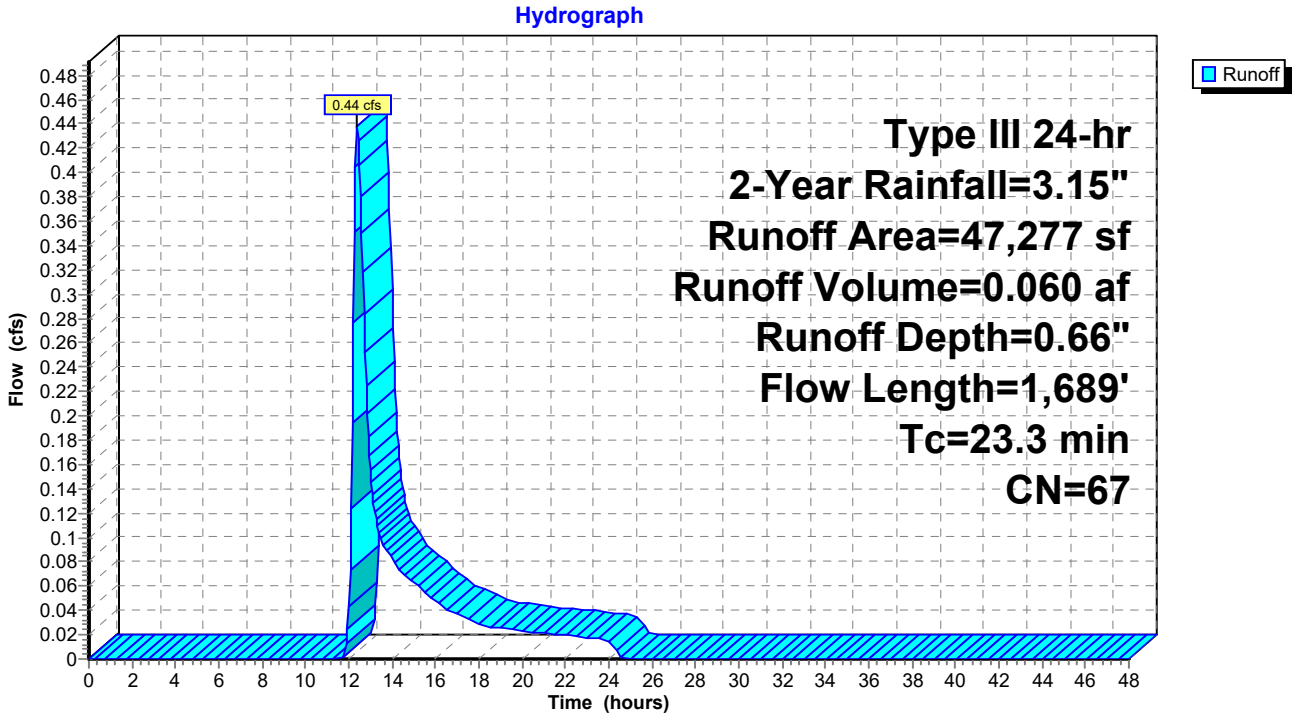
Runoff = 0.44 cfs @ 12.39 hrs, Volume= 0.060 af, Depth= 0.66"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

	Area (sf)	CN	Description
*	8,263	98	Pavement
	0	55	Woods, Good, HSG B
	39,014	61	>75% Grass cover, Good, HSG B
	47,277	67	Weighted Average
	39,014		82.52% Pervious Area
	8,263		17.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.4000	0.22		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.17"
0.1	16	0.2500	2.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.1	38	0.1300	7.32		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
19.4	1,585	0.0380	1.36		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
23.3	1,689	Total			

Subcatchment 1B: PR-1B



Summary for Subcatchment 1C: PR-1C

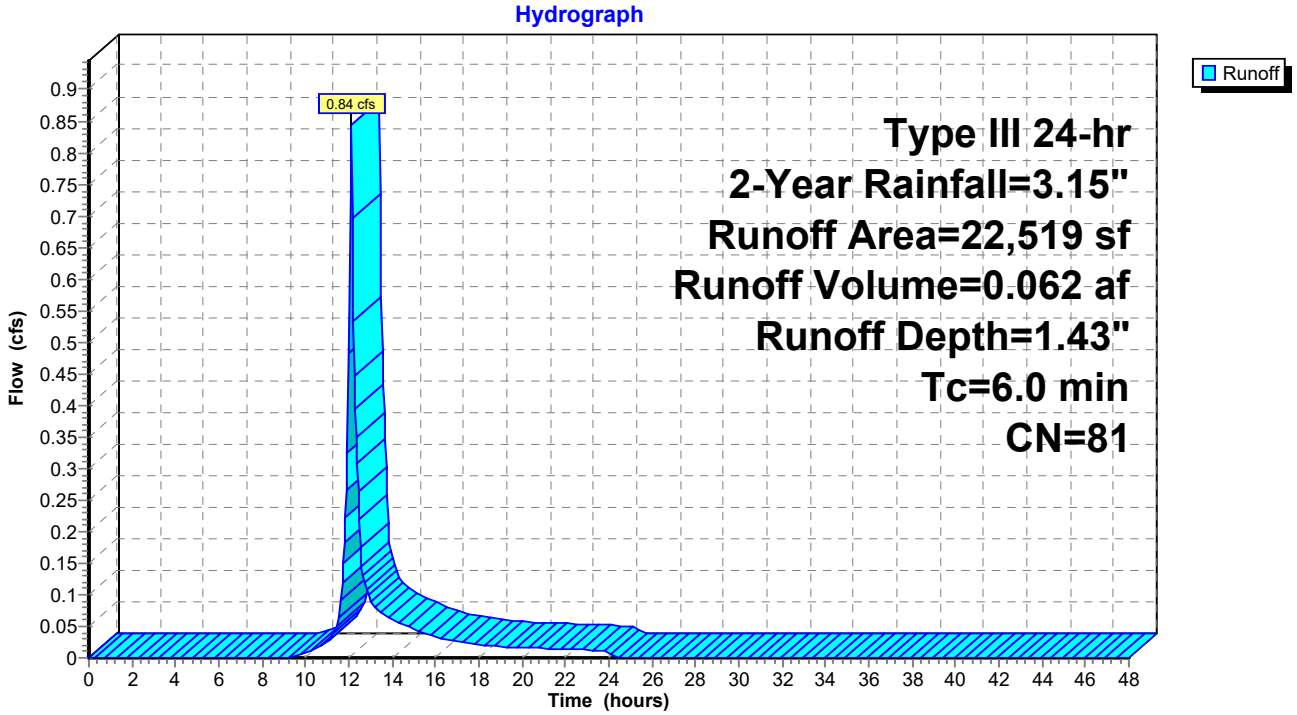
Runoff = 0.84 cfs @ 12.10 hrs, Volume= 0.062 af, Depth= 1.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
0	98	Unconnected roofs, HSG B
11,947	98	Paved parking, HSG B
10,572	61	>75% Grass cover, Good, HSG B
0	85	Gravel roads, HSG B
0	58	Meadow, non-grazed, HSG B
22,519	81	Weighted Average
10,572		46.95% Pervious Area
11,947		53.05% Impervious Area

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

Subcatchment 1C: PR-1C



Summary for Subcatchment 1D: PR-1D

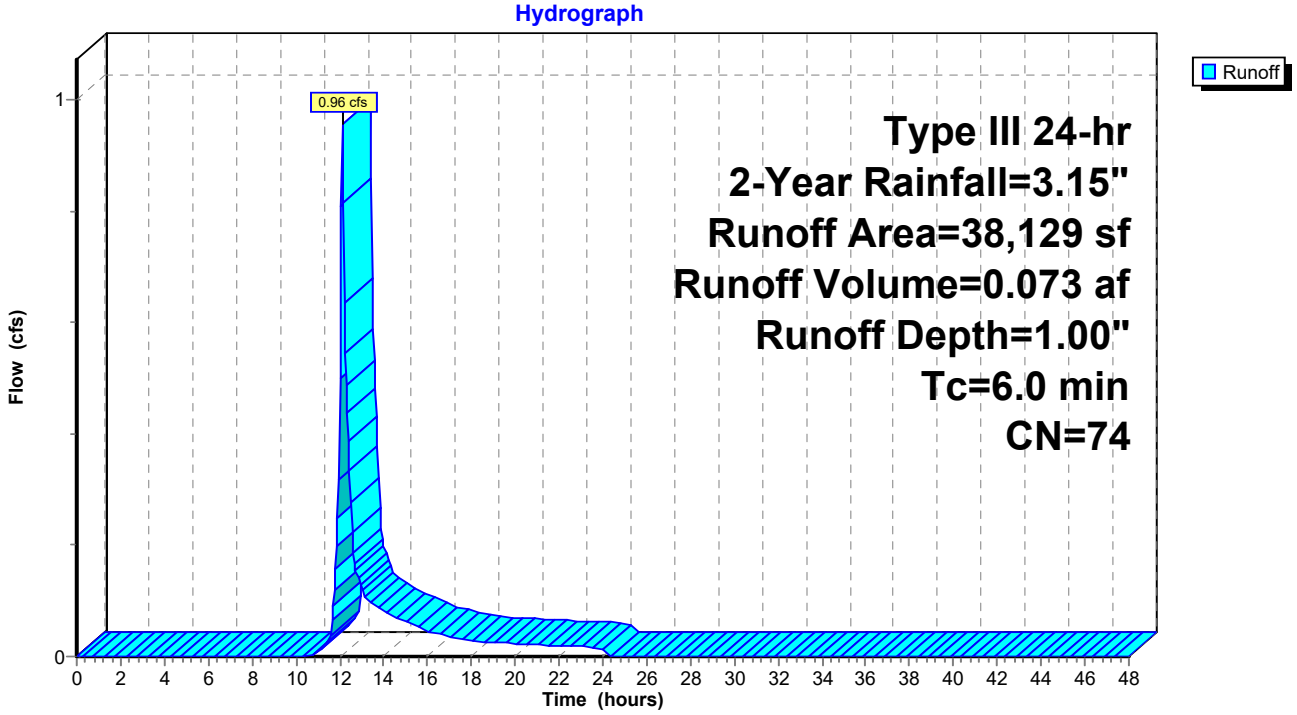
Runoff = 0.96 cfs @ 12.10 hrs, Volume= 0.073 af, Depth= 1.00"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
13,353	98	Paved parking, HSG B
24,776	61	>75% Grass cover, Good, HSG B
38,129	74	Weighted Average
24,776		64.98% Pervious Area
13,353		35.02% Impervious Area

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

Subcatchment 1D: PR-1D



Summary for Subcatchment 2A: PR-2A

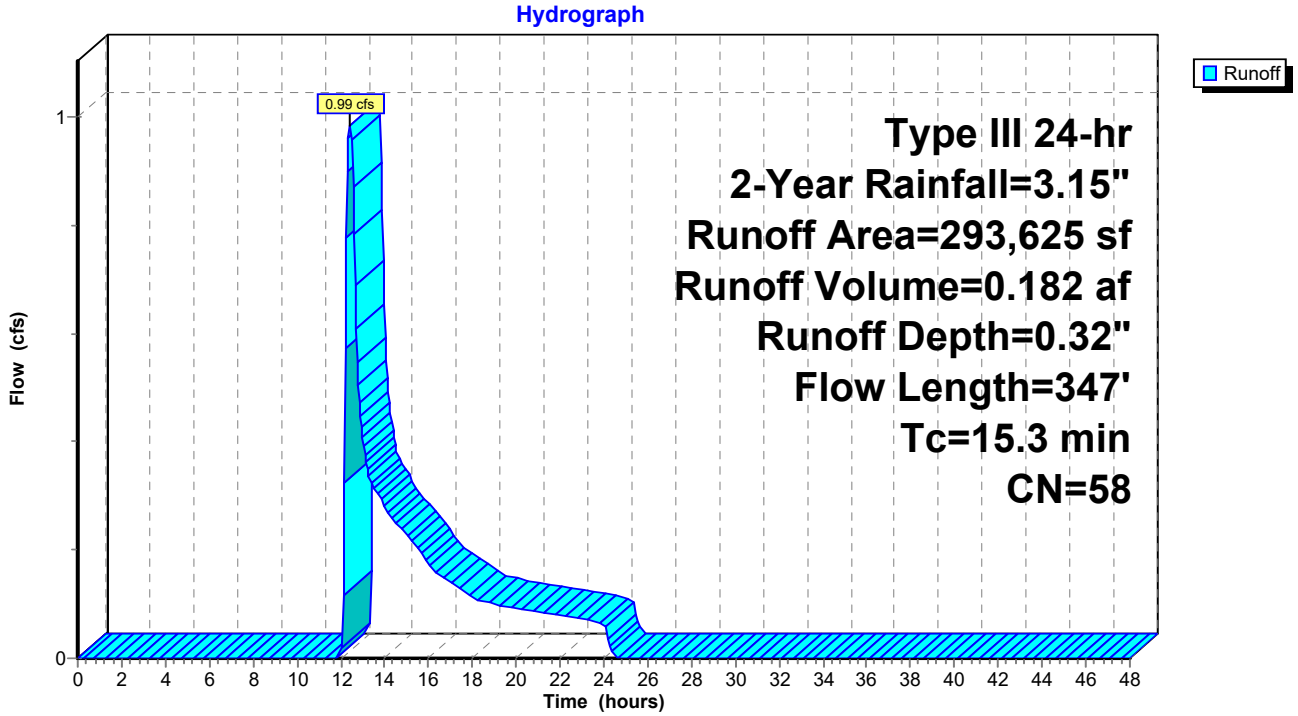
Runoff = 0.99 cfs @ 12.41 hrs, Volume= 0.182 af, Depth= 0.32"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
273,466	55	Woods, Good, HSG B
12,348	98	Paved parking, HSG B
7,811	85	Gravel roads, HSG B
293,625	58	Weighted Average
281,277		95.79% Pervious Area
12,348		4.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.4	50	0.0800	0.07		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 3.17"
2.9	297	0.1200	1.73		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	347	Total			

Subcatchment 2A: PR-2A



Summary for Subcatchment 2B: PR-2B

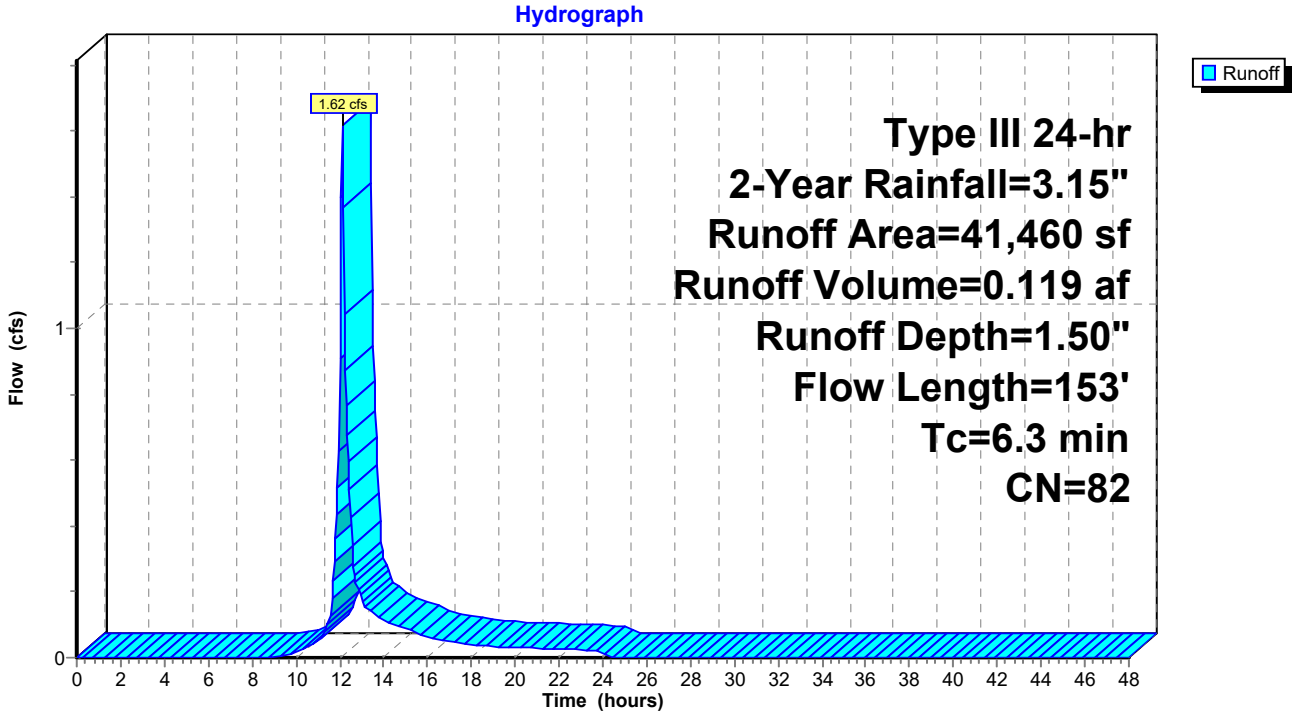
Runoff = 1.62 cfs @ 12.10 hrs, Volume= 0.119 af, Depth= 1.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
17,814	98	Unconnected roofs, HSG B
14,033	61	>75% Grass cover, Good, HSG B
9,613	85	Gravel roads, HSG B
41,460	82	Weighted Average
23,646		57.03% Pervious Area
17,814		42.97% Impervious Area
17,814		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	50	0.1200	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.17"
0.2	103	0.2900	8.67		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.3	153	Total			

Subcatchment 2B: PR-2B



Summary for Subcatchment 3A: PR-3A

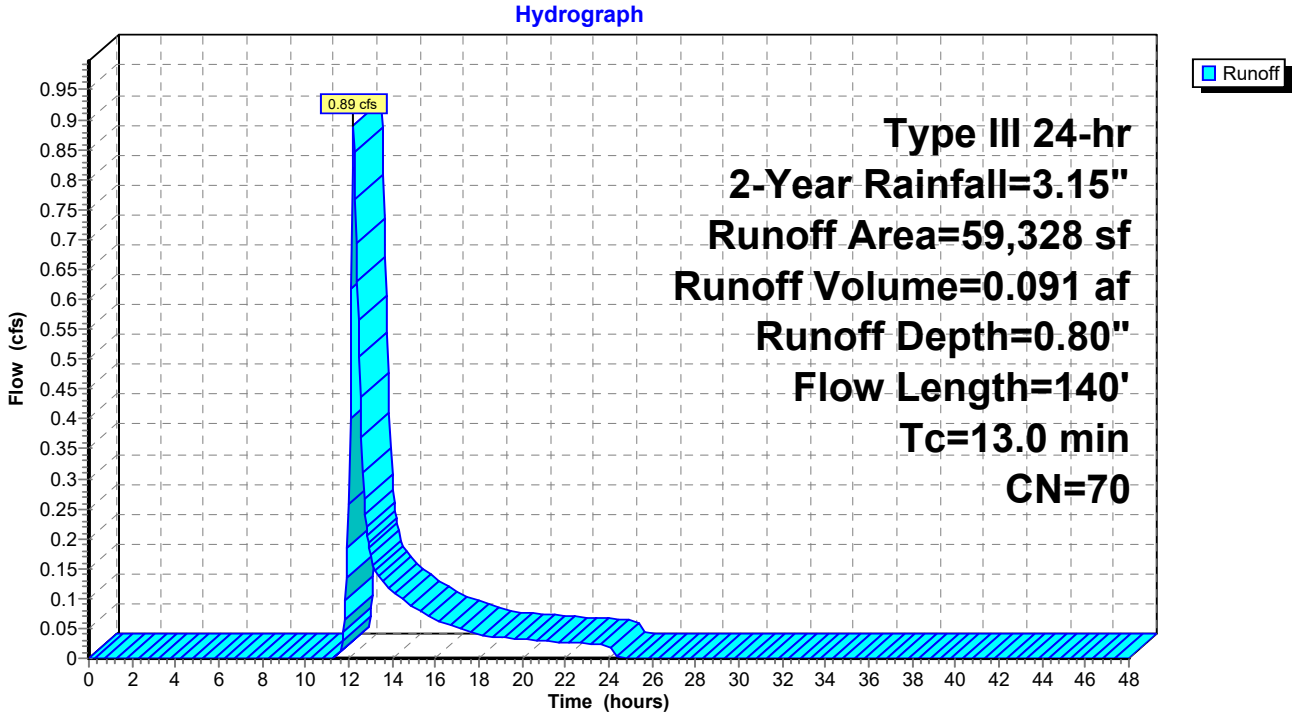
Runoff = 0.89 cfs @ 12.21 hrs, Volume= 0.091 af, Depth= 0.80"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
13,833	98	Paved parking, HSG B
12,046	61	>75% Grass cover, Good, HSG B
33,449	61	Pasture/grassland/range, Good, HSG B
59,328	70	Weighted Average
45,495		76.68% Pervious Area
13,833		23.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	50	0.0400	0.13		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.17"
6.8	90	0.0010	0.22		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.0	140	Total			

Subcatchment 3A: PR-3A



Summary for Subcatchment 3B: PR-3B

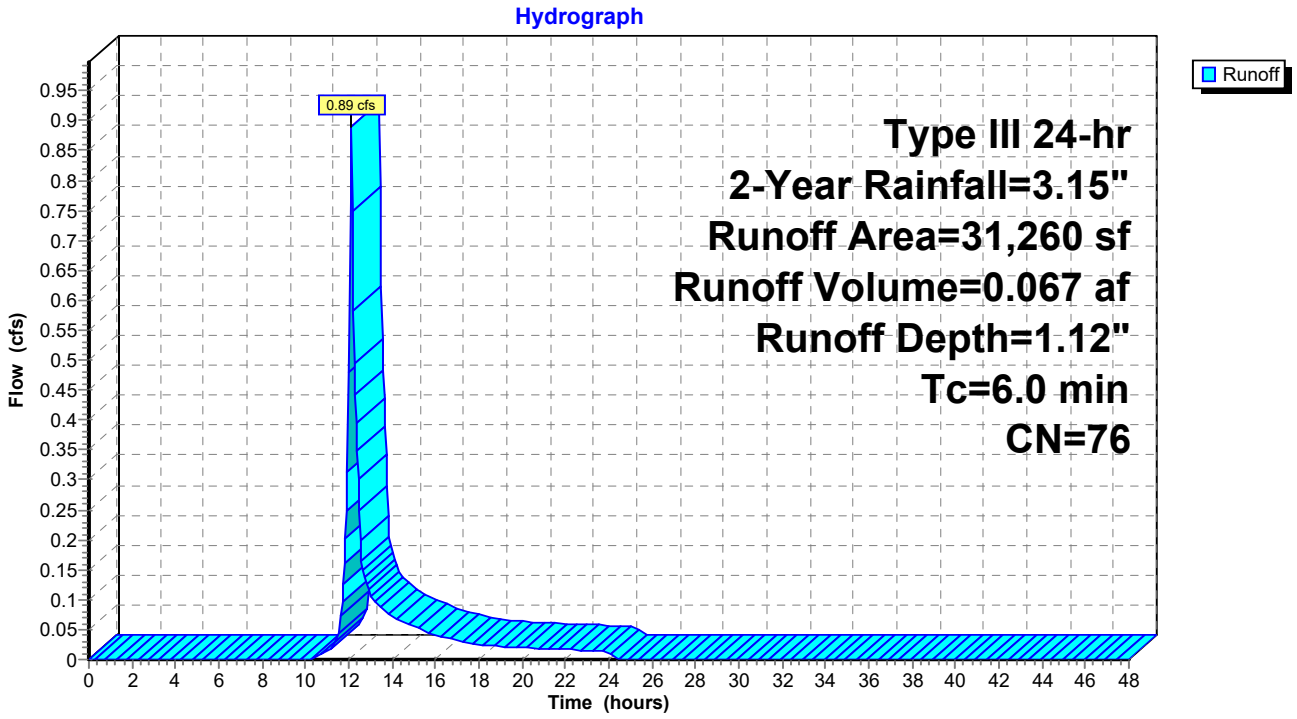
Runoff = 0.89 cfs @ 12.10 hrs, Volume= 0.067 af, Depth= 1.12"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
0	98	Unconnected roofs, HSG B
12,826	98	Paved parking, HSG B
18,434	61	>75% Grass cover, Good, HSG B
0	85	Gravel roads, HSG B
0	58	Meadow, non-grazed, HSG B
0	39	>75% Grass cover, Good, HSG A
31,260	76	Weighted Average
18,434		58.97% Pervious Area
12,826		41.03% Impervious Area

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

Subcatchment 3B: PR-3B



Summary for Subcatchment 3C: PR-3C

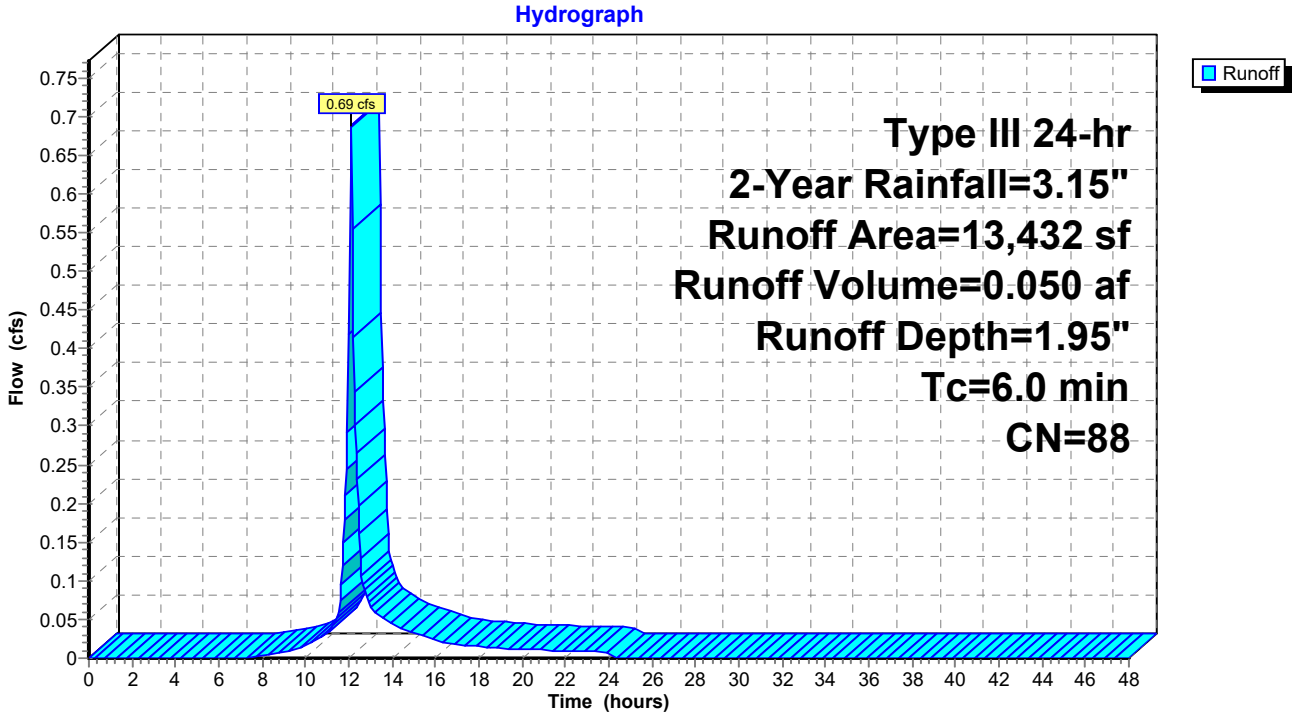
Runoff = 0.69 cfs @ 12.09 hrs, Volume= 0.050 af, Depth= 1.95"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
9,651	98	Unconnected pavement, HSG B
3,781	61	>75% Grass cover, Good, HSG B
13,432	88	Weighted Average
3,781		28.15% Pervious Area
9,651		71.85% Impervious Area
9,651		100.00% Unconnected

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

Subcatchment 3C: PR-3C



Summary for Subcatchment 4A: PR-4A

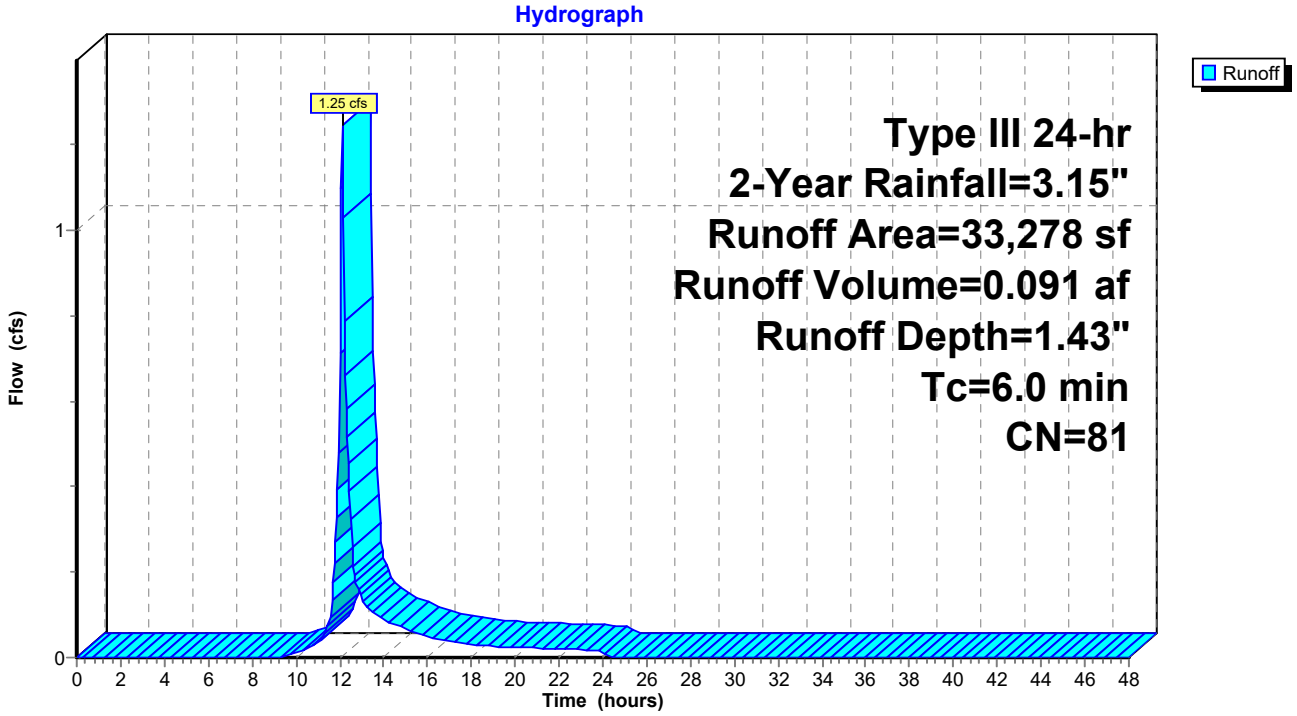
Runoff = 1.25 cfs @ 12.10 hrs, Volume= 0.091 af, Depth= 1.43"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

	Area (sf)	CN	Description
	0	98	Roofs, HSG D
*	2,426	98	Paved parking, HSG D
	30,281	80	>75% Grass cover, Good, HSG D
	571	85	Gravel roads, HSG B
	33,278	81	Weighted Average
	30,852		92.71% Pervious Area
	2,426		7.29% Impervious Area

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

Subcatchment 4A: PR-4A



Summary for Subcatchment 4B: PR-Building

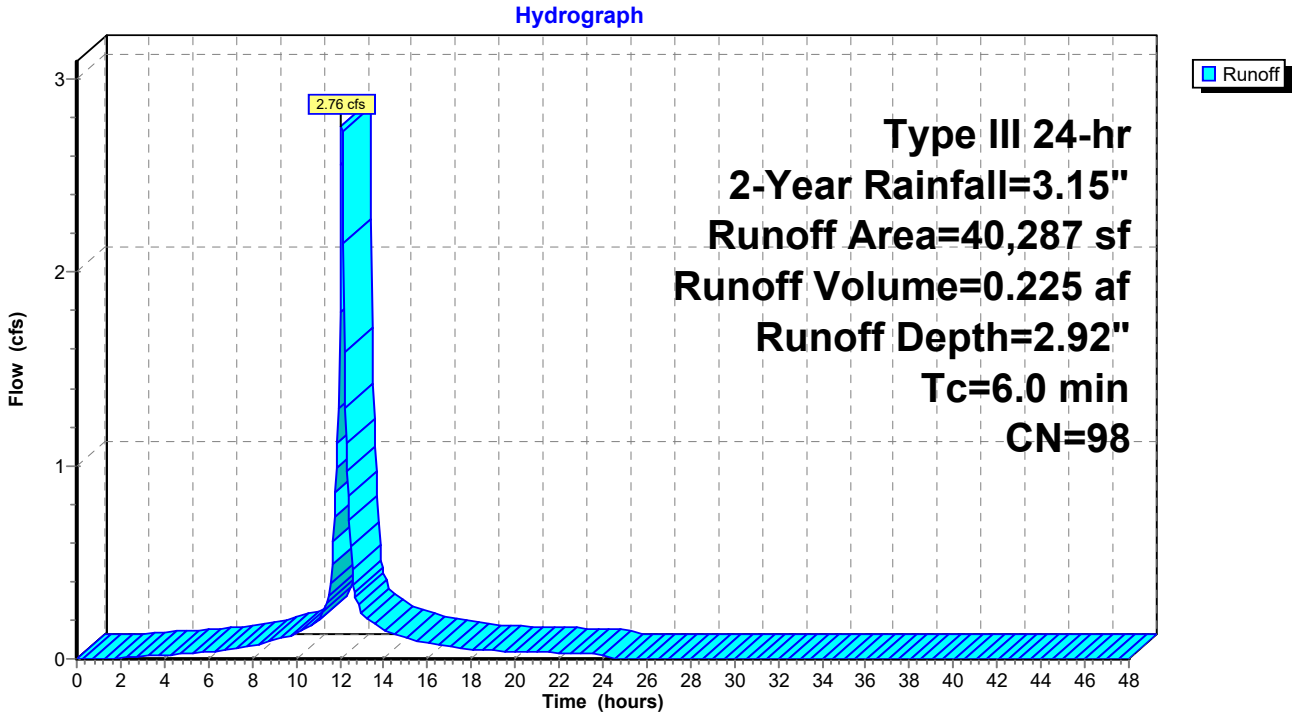
Runoff = 2.76 cfs @ 12.09 hrs, Volume= 0.225 af, Depth= 2.92"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
40,287	98	Unconnected roofs, HSG B
40,287		100.00% Impervious Area
40,287		100.00% Unconnected

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

Subcatchment 4B: PR-Building



Summary for Subcatchment 4C: PR-4C

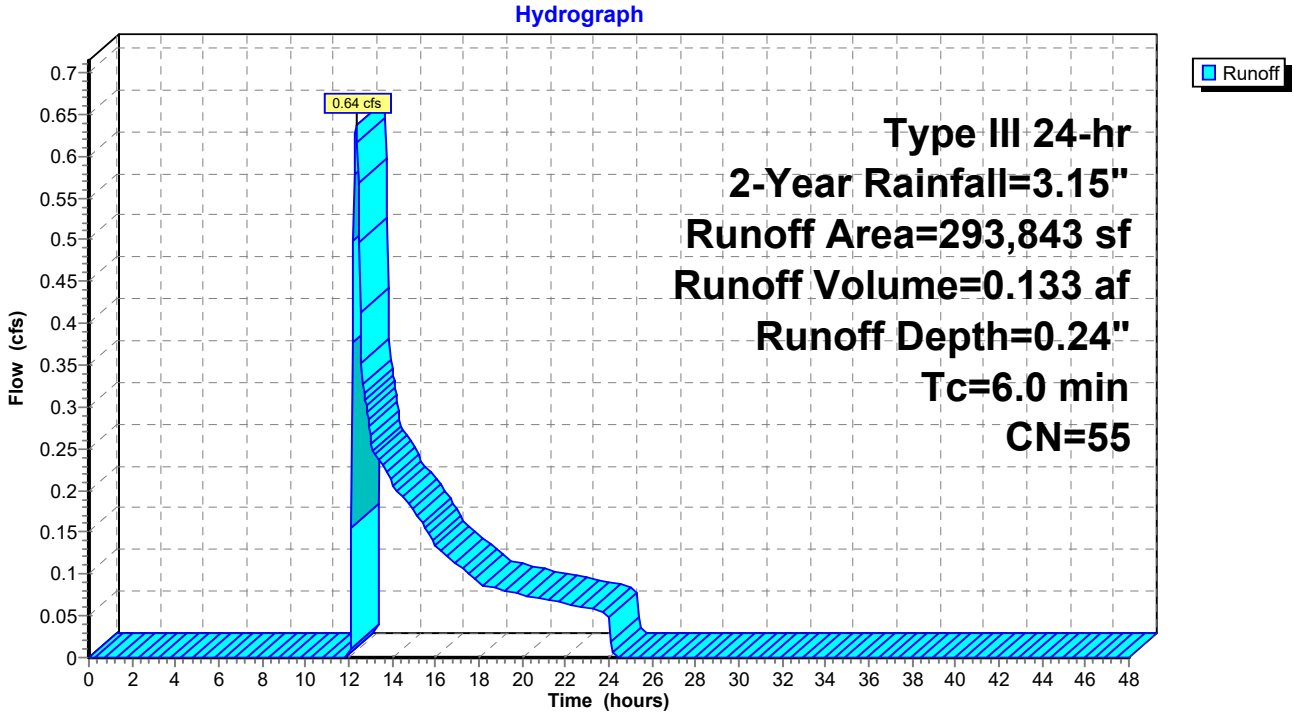
Runoff = 0.64 cfs @ 12.34 hrs, Volume= 0.133 af, Depth= 0.24"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
774	98	Unconnected pavement, HSG B
291,213	55	Woods, Good, HSG B
1,856	85	Gravel roads, HSG B
293,843	55	Weighted Average
293,069		99.74% Pervious Area
774		0.26% Impervious Area
774		100.00% Unconnected

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

Subcatchment 4C: PR-4C



Summary for Subcatchment 4D: PR-4D

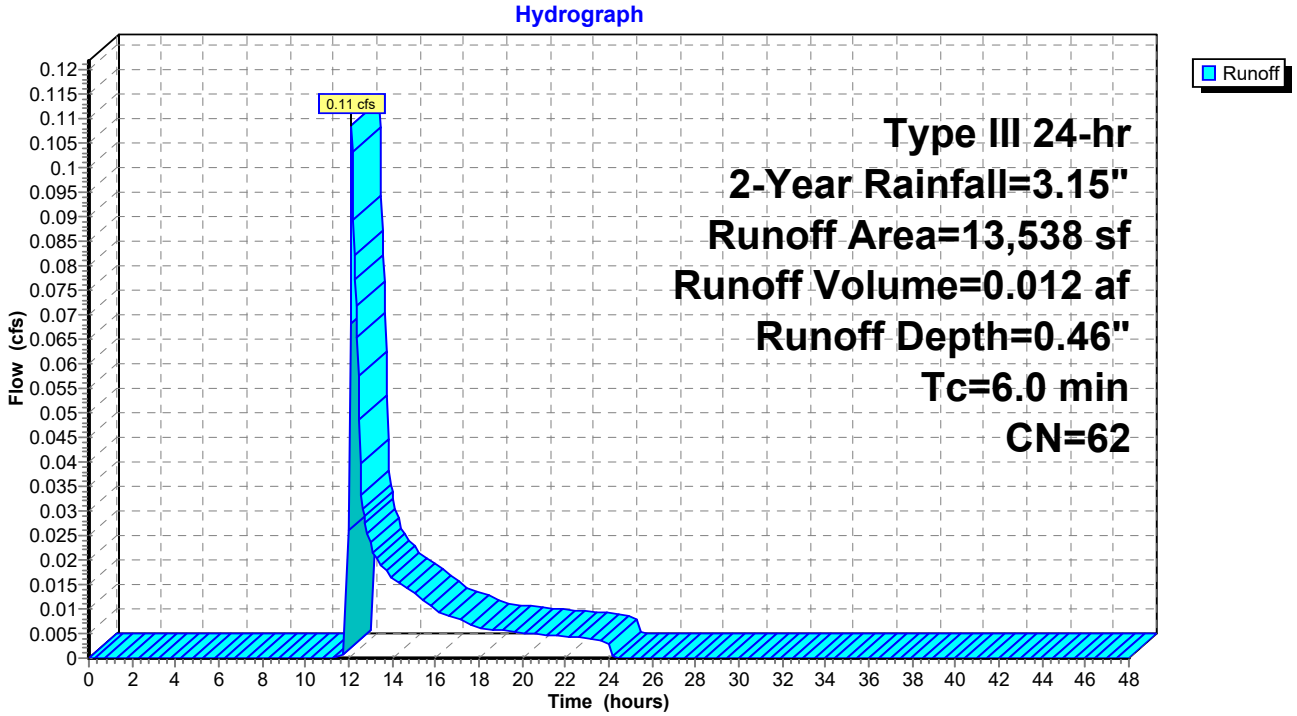
Runoff = 0.11 cfs @ 12.12 hrs, Volume= 0.012 af, Depth= 0.46"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
12,699	61	>75% Grass cover, Good, HSG B
839	85	Gravel roads, HSG B
13,538	62	Weighted Average
13,538		100.00% Pervious Area

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

Subcatchment 4D: PR-4D



Summary for Subcatchment 4E: PR-4E

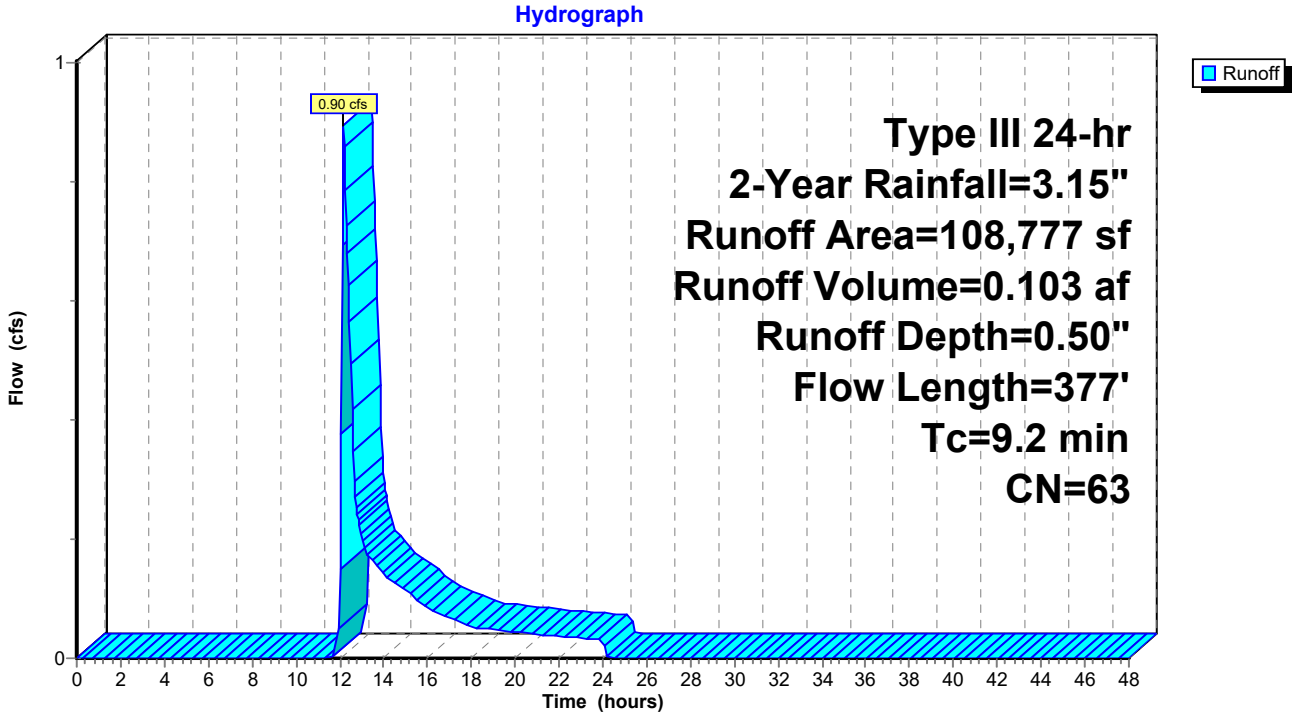
Runoff = 0.90 cfs @ 12.17 hrs, Volume= 0.103 af, Depth= 0.50"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
101,639	61	>75% Grass cover, Good, HSG B
7,138	85	Gravel roads, HSG B
108,777	63	Weighted Average
108,777		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	50	0.0600	0.16		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.17"
3.9	327	0.0390	1.38		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.2	377	Total			

Subcatchment 4E: PR-4E



Summary for Subcatchment 4F: PR-4F

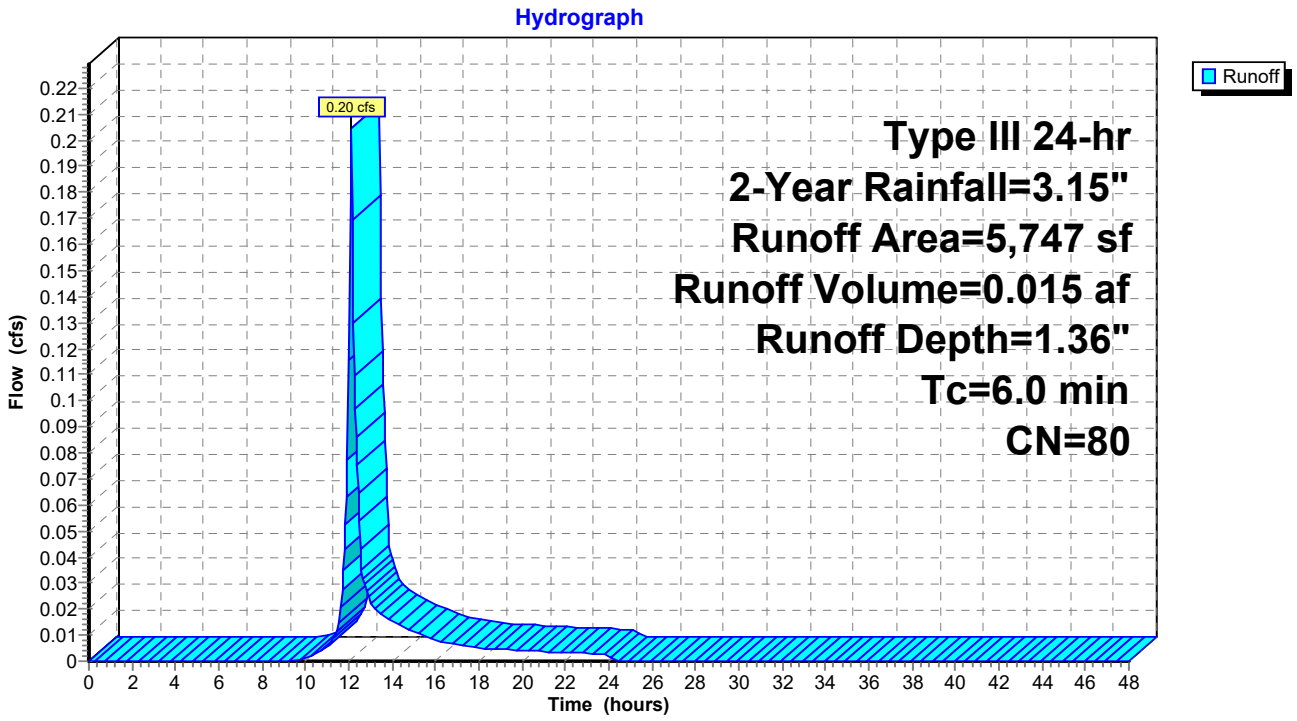
Runoff = 0.20 cfs @ 12.10 hrs, Volume= 0.015 af, Depth= 1.36"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 2-Year Rainfall=3.15"

Area (sf)	CN	Description
5,747	80	>75% Grass cover, Good, HSG D
5,747		100.00% Pervious Area

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

Subcatchment 4F: PR-4F



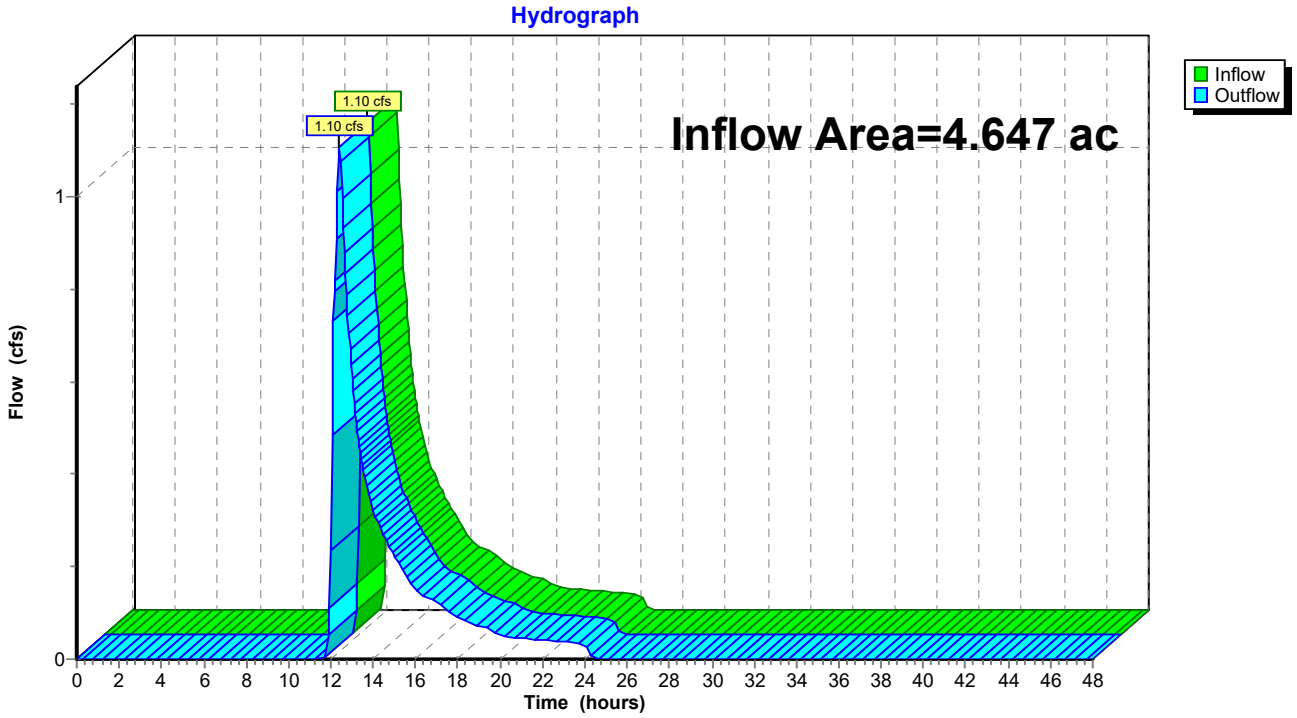
Summary for Reach DP1: DP-1 (BVW)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.647 ac, 20.69% Impervious, Inflow Depth = 0.49" for 2-Year event
Inflow = 1.10 cfs @ 12.41 hrs, Volume= 0.190 af
Outflow = 1.10 cfs @ 12.41 hrs, Volume= 0.190 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DP1: DP-1 (BVW)



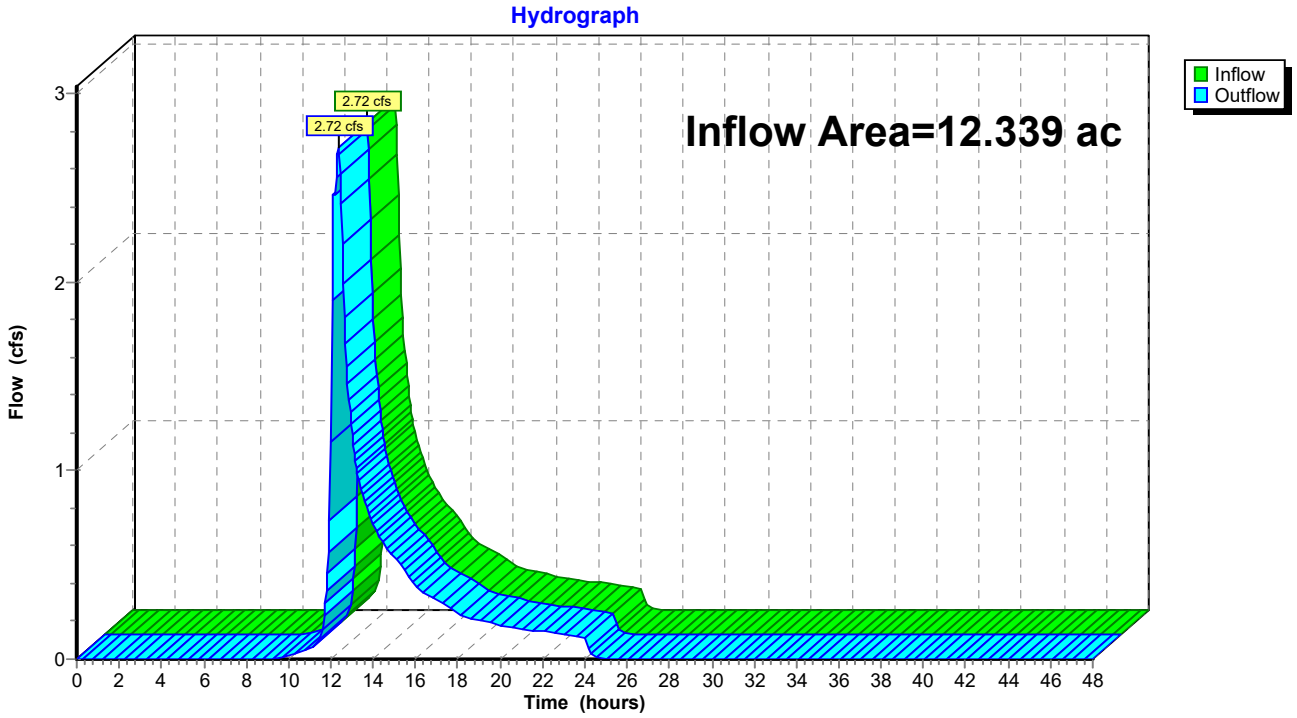
Summary for Reach DP2: DP-2 (SOUTH BEACH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 12.339 ac, 13.40% Impervious, Inflow Depth = 0.48" for 2-Year event
Inflow = 2.72 cfs @ 12.35 hrs, Volume= 0.490 af
Outflow = 2.72 cfs @ 12.35 hrs, Volume= 0.490 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DP2: DP-2 (SOUTH BEACH)



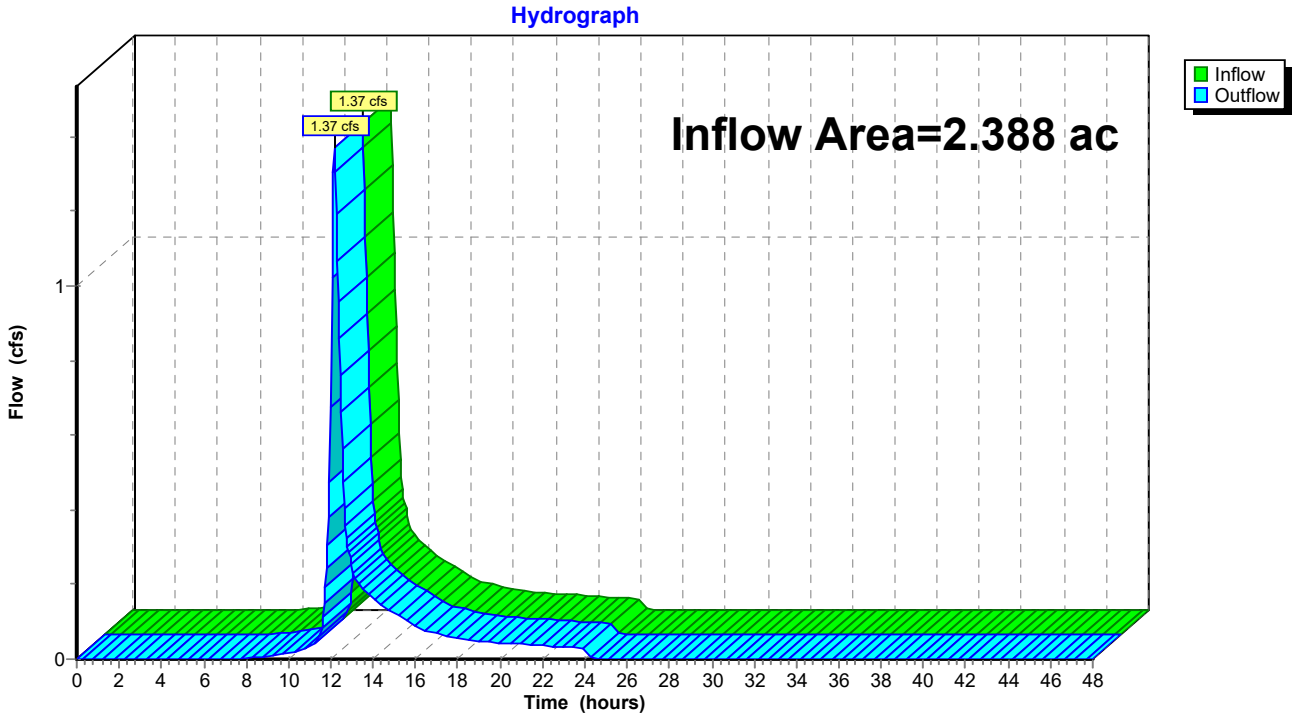
Summary for Reach DP3: DP-3 (EX PIPE TO NORTH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 2.388 ac, 34.91% Impervious, Inflow Depth = 0.71" for 2-Year event
Inflow = 1.37 cfs @ 12.15 hrs, Volume= 0.142 af
Outflow = 1.37 cfs @ 12.15 hrs, Volume= 0.142 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DP3: DP-3 (EX PIPE TO NORTH)



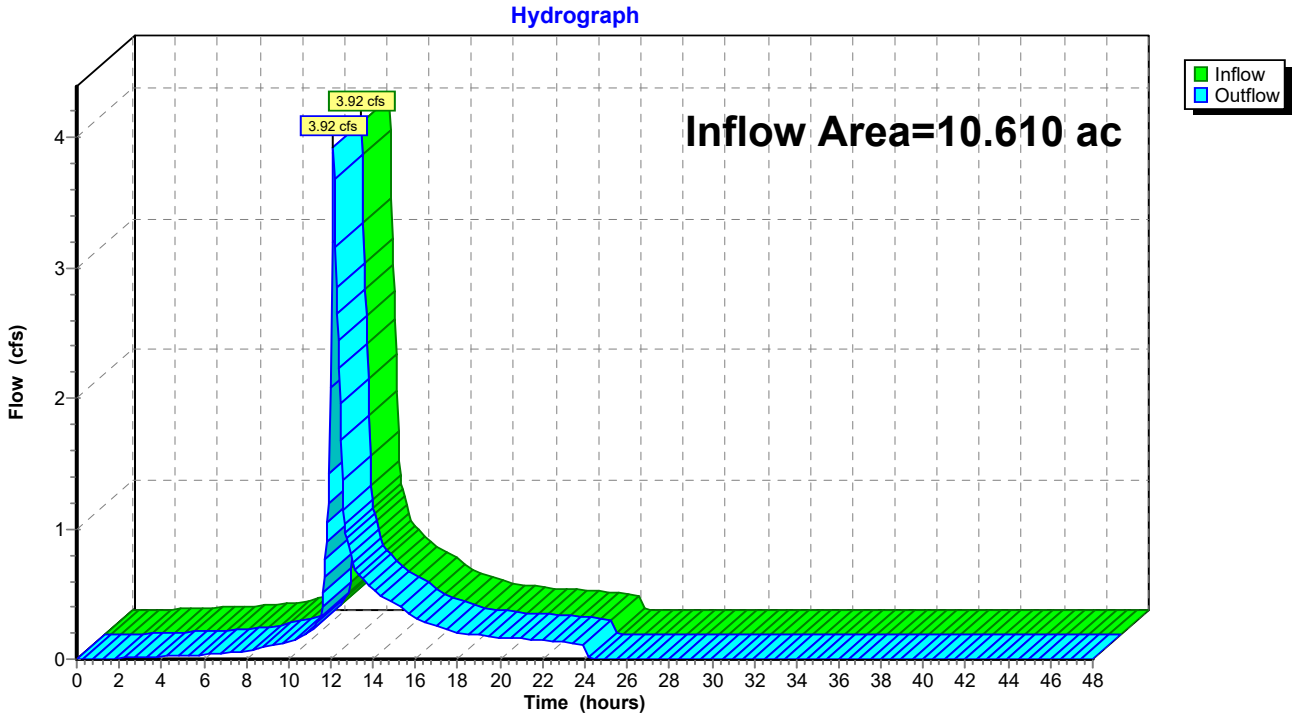
Summary for Reach DP4: DP-4 (EAST BEACH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 10.610 ac, 8.88% Impervious, Inflow Depth = 0.55" for 2-Year event
Inflow = 3.92 cfs @ 12.11 hrs, Volume= 0.488 af
Outflow = 3.92 cfs @ 12.11 hrs, Volume= 0.488 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DP4: DP-4 (EAST BEACH)



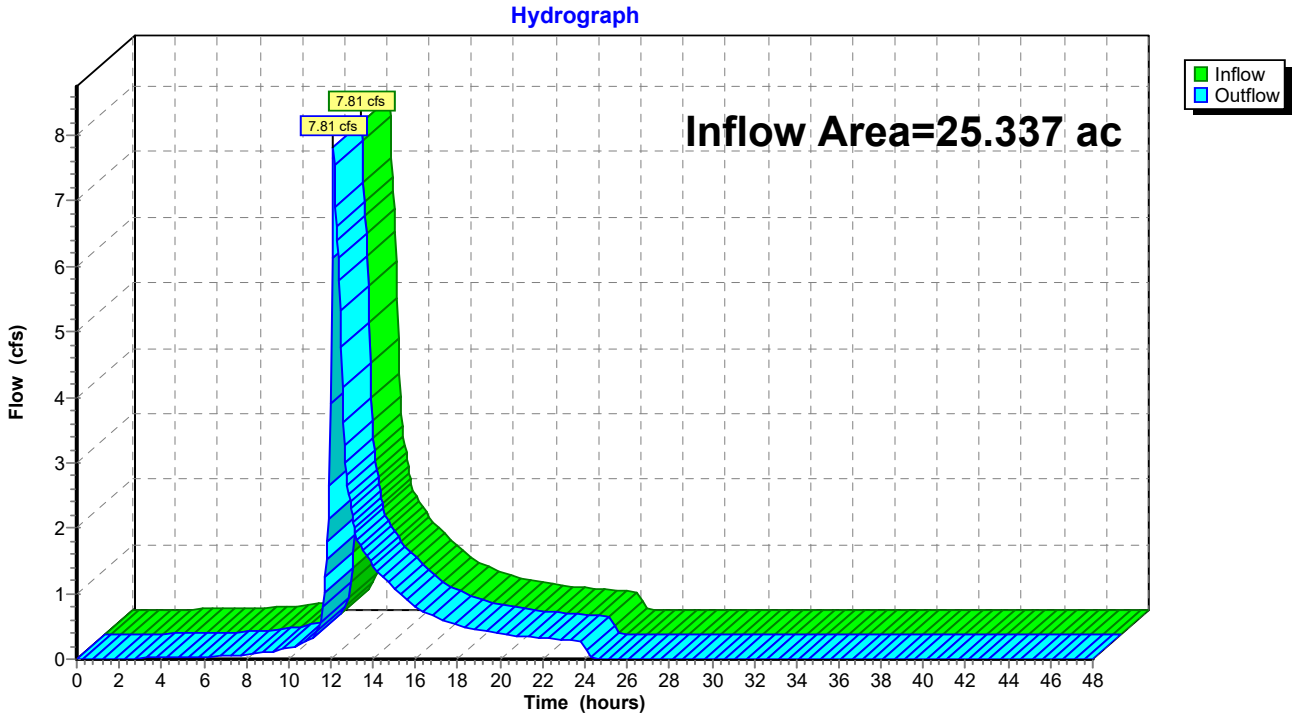
Summary for Reach TS: OCEAN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 25.337 ac, 13.54% Impervious, Inflow Depth = 0.53" for 2-Year event
Inflow = 7.81 cfs @ 12.12 hrs, Volume= 1.120 af
Outflow = 7.81 cfs @ 12.12 hrs, Volume= 1.120 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach TS: OCEAN



Summary for Pond 1N: Subsurface Infiltration System #1

Inflow Area =	0.718 ac, 41.03% Impervious, Inflow Depth = 1.12" for 2-Year event				
Inflow =	0.89 cfs @	12.10 hrs,	Volume=	0.067 af	
Outflow =	0.08 cfs @	13.79 hrs,	Volume=	0.067 af,	Atten= 91%, Lag= 101.5 min
Discarded =	0.07 cfs @	11.75 hrs,	Volume=	0.066 af	
Primary =	0.01 cfs @	13.79 hrs,	Volume=	0.001 af	

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 13.75' @ 13.79 hrs Surf.Area= 0.069 ac Storage= 0.027 af

Plug-Flow detention time= 162.9 min calculated for 0.067 af (100% of inflow)
Center-of-Mass det. time= 162.7 min (1,019.2 - 856.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	13.00'	0.049 af	**44.83'W x 67.28'L x 2.33'H Field A** 0.162 af Overall - 0.040 af Embedded = 0.122 af x 40.0% Voids
#2A	13.50'	0.040 af	**ADS_StormTech SC-310 +Cap** x 117 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 13 Rows of 9 Chambers
		0.088 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	13.70'	**6.0" Vert. Orifice/Grate** C= 0.600
#2	Discarded	13.00'	**1.020 in/hr Exfiltration over Surface area**
#3	Device 4	15.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Primary	13.00'	**15.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 13.00' / 12.75' S= 0.0050 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 1.23 sf

Discarded OutFlow Max=0.07 cfs @ 11.75 hrs HW=13.03' (Free Discharge)
└─**2=Exfiltration** (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=0.01 cfs @ 13.79 hrs HW=13.75' (Free Discharge)
└─**4=Culvert** (Passes 0.01 cfs of 1.32 cfs potential flow)
  ├─**1=Orifice/Grate** (Orifice Controls 0.01 cfs @ 0.72 fps)
  └─**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1N: Subsurface Infiltration System #1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-310 +Cap (ADS StormTech®SC-310 with cap length)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

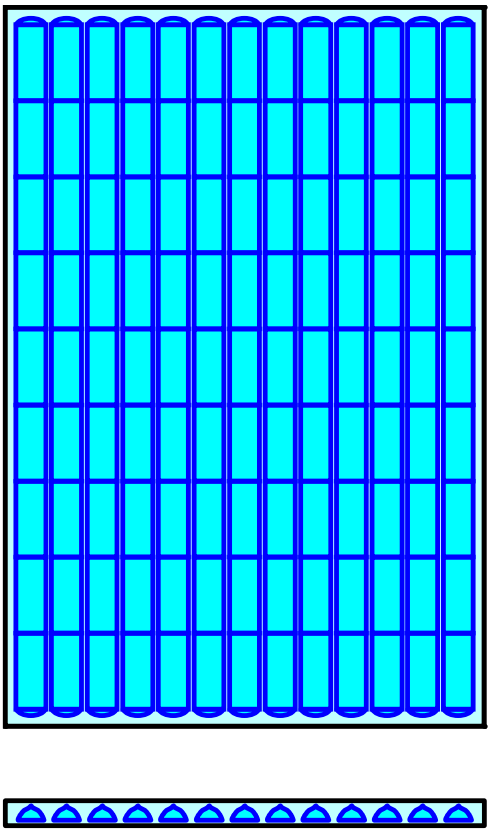
9 Chambers/Row x 7.12' Long +0.60' Cap Length x 2 = 65.28' Row Length +12.0" End Stone x 2 = 67.28' Base Length
13 Rows x 34.0" Wide + 6.0" Spacing x 12 + 12.0" Side Stone x 2 = 44.83' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

117 Chambers x 14.7 cf = 1,724.8 cf Chamber Storage

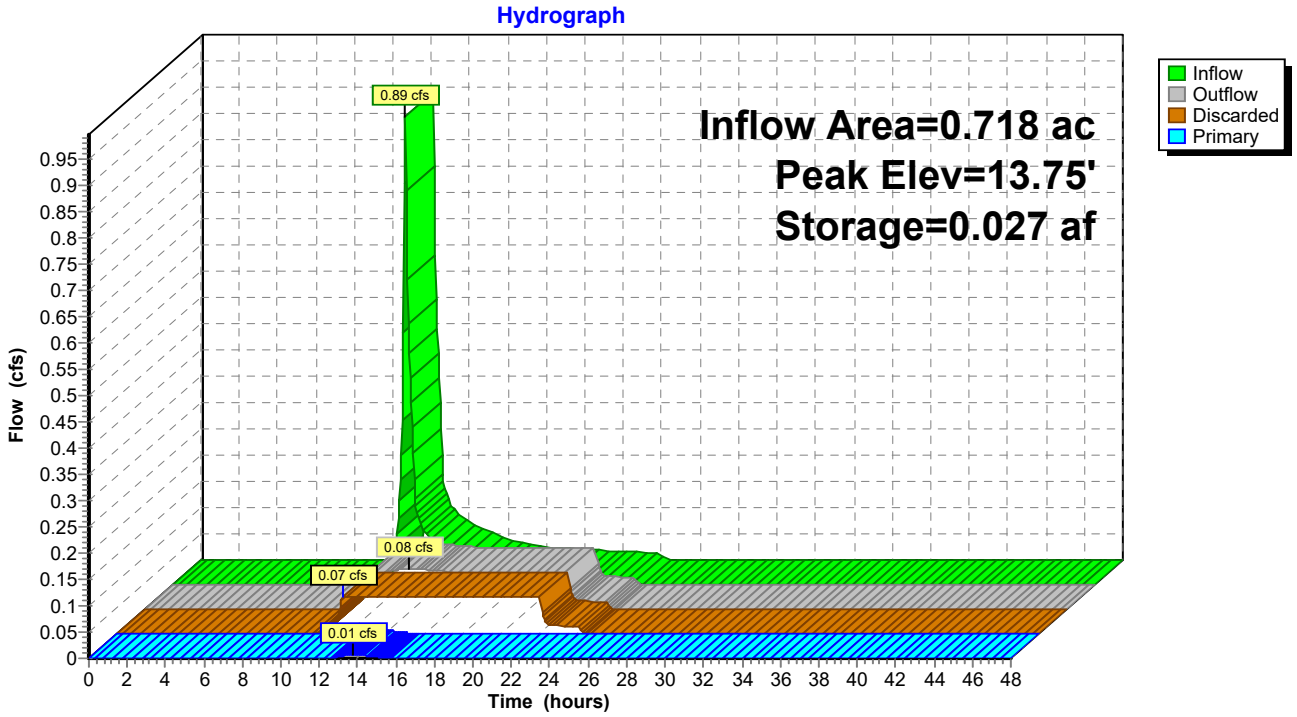
7,038.2 cf Field - 1,724.8 cf Chambers = 5,313.4 cf Stone x 40.0% Voids = 2,125.4 cf Stone Storage

Chamber Storage + Stone Storage = 3,850.2 cf = 0.088 af
Overall Storage Efficiency = 54.7%
Overall System Size = 67.28' x 44.83' x 2.33'

117 Chambers
260.7 cy Field
196.8 cy Stone



Pond 1N: Subsurface Infiltration System #1



Summary for Pond 2S-A: Bioretention - Ponding

Inflow Area = 0.517 ac, 53.05% Impervious, Inflow Depth = 1.43" for 2-Year event
Inflow = 0.84 cfs @ 12.10 hrs, Volume= 0.062 af
Outflow = 0.09 cfs @ 13.04 hrs, Volume= 0.062 af, Atten= 89%, Lag= 56.7 min
Primary = 0.09 cfs @ 13.04 hrs, Volume= 0.062 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 17.74' @ 13.04 hrs Surf.Area= 1,592 sf Storage= 1,026 cf

Plug-Flow detention time= 110.1 min calculated for 0.062 af (100% of inflow)
Center-of-Mass det. time= 110.0 min (950.3 - 840.3)

Volume	Invert	Avail.Storage	Storage Description
#1	17.00'	3,490 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

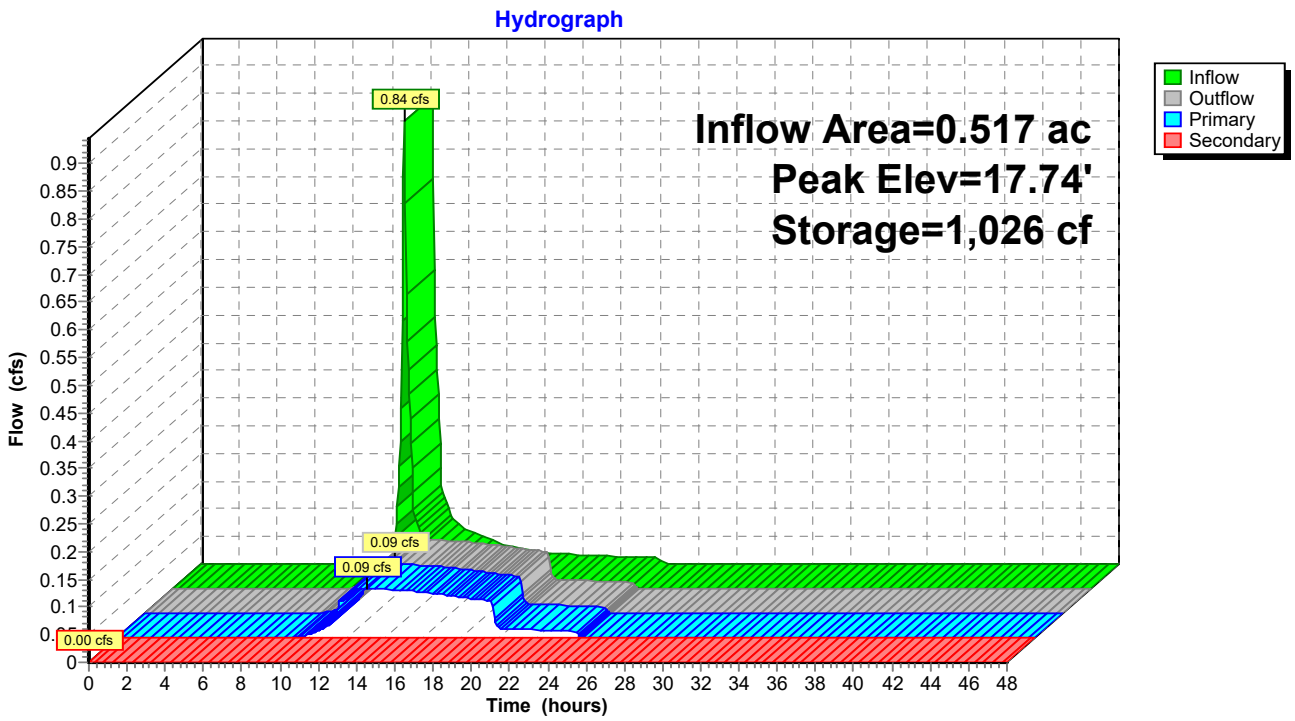
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
17.00	1,166	0	0
18.00	1,738	1,452	1,452
19.00	2,338	2,038	3,490

Device	Routing	Invert	Outlet Devices
#1	Primary	17.00'	**2.410 in/hr Flow Through Filter over Horizontal area**
#2	Secondary	18.50'	**10.0' 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
#3	Primary	17.75'	**12.0" Horiz. Infiltration Riser X 0.60** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.09 cfs @ 13.04 hrs HW=17.74' (Free Discharge)
└─**1=Flow Through Filter** (Exfiltration Controls 0.09 cfs)
└─**3=Infiltration Riser** (Controls 0.00 cfs)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=17.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2S-A: Bioretention - Ponding



Summary for Pond 2S-B: Subsurface Infiltration System #2

Inflow Area =	1.639 ac, 22.10% Impervious, Inflow Depth = 1.15" for 2-Year event				
Inflow =	1.94 cfs @	12.12 hrs,	Volume=	0.158 af	
Outflow =	0.48 cfs @	12.61 hrs,	Volume=	0.158 af,	Atten= 75%, Lag= 29.4 min
Discarded =	0.08 cfs @	11.80 hrs,	Volume=	0.095 af	
Primary =	0.40 cfs @	12.61 hrs,	Volume=	0.062 af	

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 14.13' @ 12.61 hrs Surf.Area= 3,311 sf Storage= 2,376 cf

Plug-Flow detention time= 151.6 min calculated for 0.158 af (100% of inflow)
Center-of-Mass det. time= 151.7 min (1,015.1 - 863.5)

Volume	Invert	Avail.Storage	Storage Description
#1A	13.00'	2,981 cf	**44.25'W x 74.82'L x 3.50'H Field A** 11,587 cf Overall - 4,135 cf Embedded = 7,453 cf x 40.0% Voids
#2A	13.50'	4,135 cf	**ADS_StormTech SC-740 +Cap** x 90 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 9 Rows of 10 Chambers
		7,116 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	13.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Device 5	16.00'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Device 5	13.70'	**6.0" Vert. Orifice/Grate** C= 0.600
#4	Device 5	14.50'	**8.0" Vert. Orifice/Grate** C= 0.600
#5	Primary	13.50'	**15.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 13.50' / 13.10' S= 0.0080 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 1.23 sf

Discarded OutFlow Max=0.08 cfs @ 11.80 hrs HW=13.04' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=0.40 cfs @ 12.61 hrs HW=14.13' (Free Discharge)
└─**5=Culvert** (Passes 0.40 cfs of 1.13 cfs potential flow)
  ├─**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
  ├─**3=Orifice/Grate** (Orifice Controls 0.40 cfs @ 2.24 fps)
  └─**4=Orifice/Grate** (Controls 0.00 cfs)

Pond 2S-B: Subsurface Infiltration System #2 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

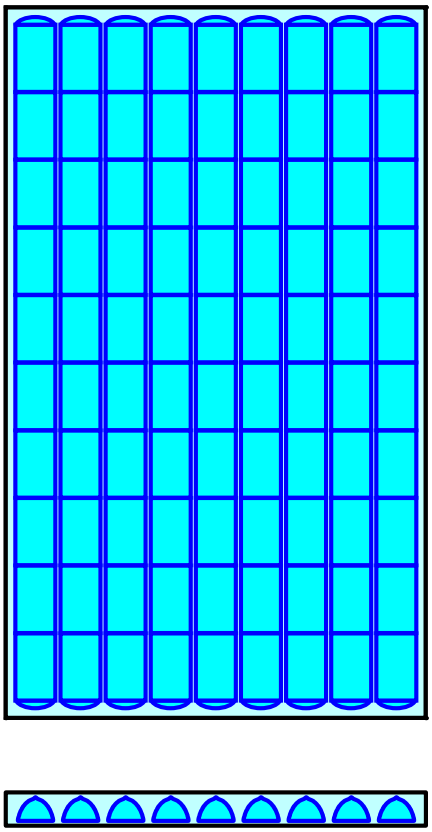
10 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 72.82' Row Length +12.0" End Stone x 2 = 74.82' Base Length
9 Rows x 51.0" Wide + 6.0" Spacing x 8 + 12.0" Side Stone x 2 = 44.25' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

90 Chambers x 45.9 cf = 4,134.6 cf Chamber Storage

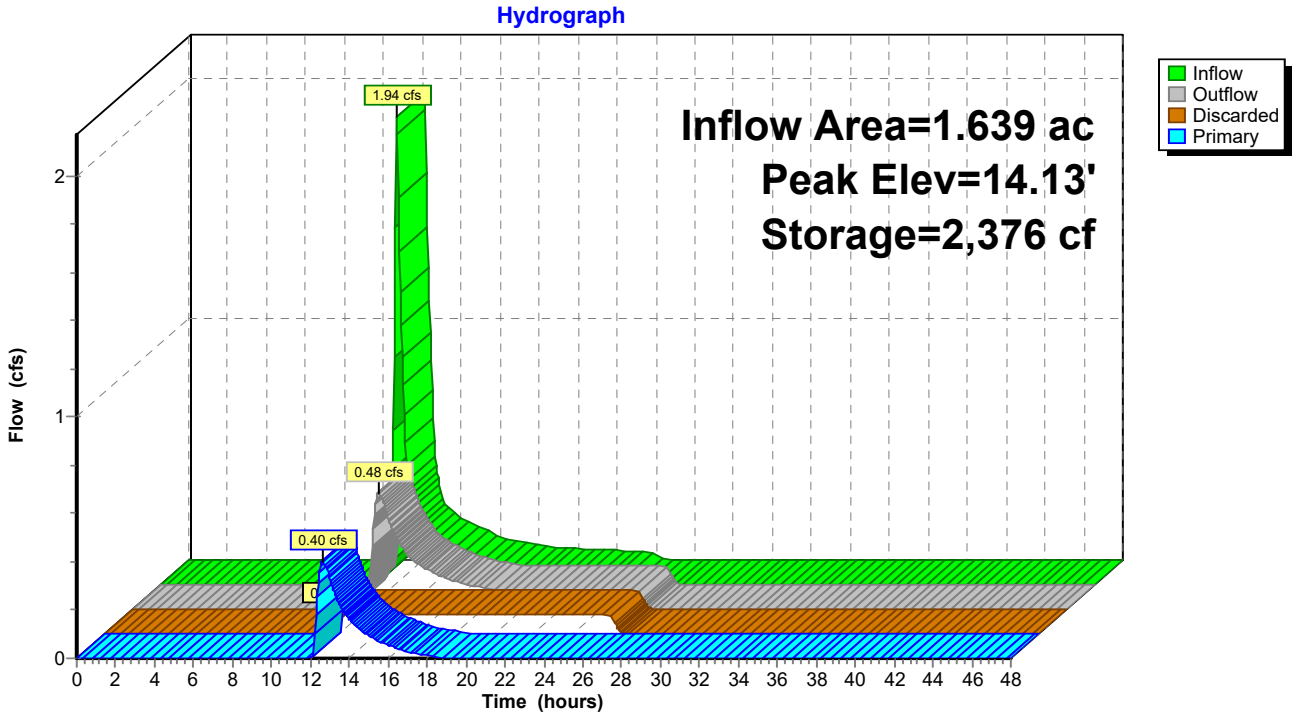
11,587.2 cf Field - 4,134.6 cf Chambers = 7,452.6 cf Stone x 40.0% Voids = 2,981.1 cf Stone Storage

Chamber Storage + Stone Storage = 7,115.7 cf = 0.163 af
Overall Storage Efficiency = 61.4%
Overall System Size = 74.82' x 44.25' x 3.50'

90 Chambers
429.2 cy Field
276.0 cy Stone



Pond 2S-B: Subsurface Infiltration System #2



Summary for Pond 6P: Subsurface Storage

Inflow Area = 0.517 ac, 53.05% Impervious, Inflow Depth = 1.43" for 2-Year event
Inflow = 0.09 cfs @ 13.04 hrs, Volume= 0.062 af
Outflow = 0.08 cfs @ 17.55 hrs, Volume= 0.062 af, Atten= 15%, Lag= 270.7 min
Discarded = 0.06 cfs @ 11.70 hrs, Volume= 0.057 af
Primary = 0.02 cfs @ 17.55 hrs, Volume= 0.005 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 13.57' @ 17.55 hrs Surf.Area= 2,338 sf Storage= 530 cf

Plug-Flow detention time= 87.3 min calculated for 0.062 af (100% of inflow)
Center-of-Mass det. time= 87.2 min (1,037.4 - 950.3)

Volume	Invert	Avail.Storage	Storage Description
#1	13.00'	1,403 cf	**Stone Under Basin (Prismatic)** Listed below (Recalc) 3,507 cf Overall x 40.0% Voids

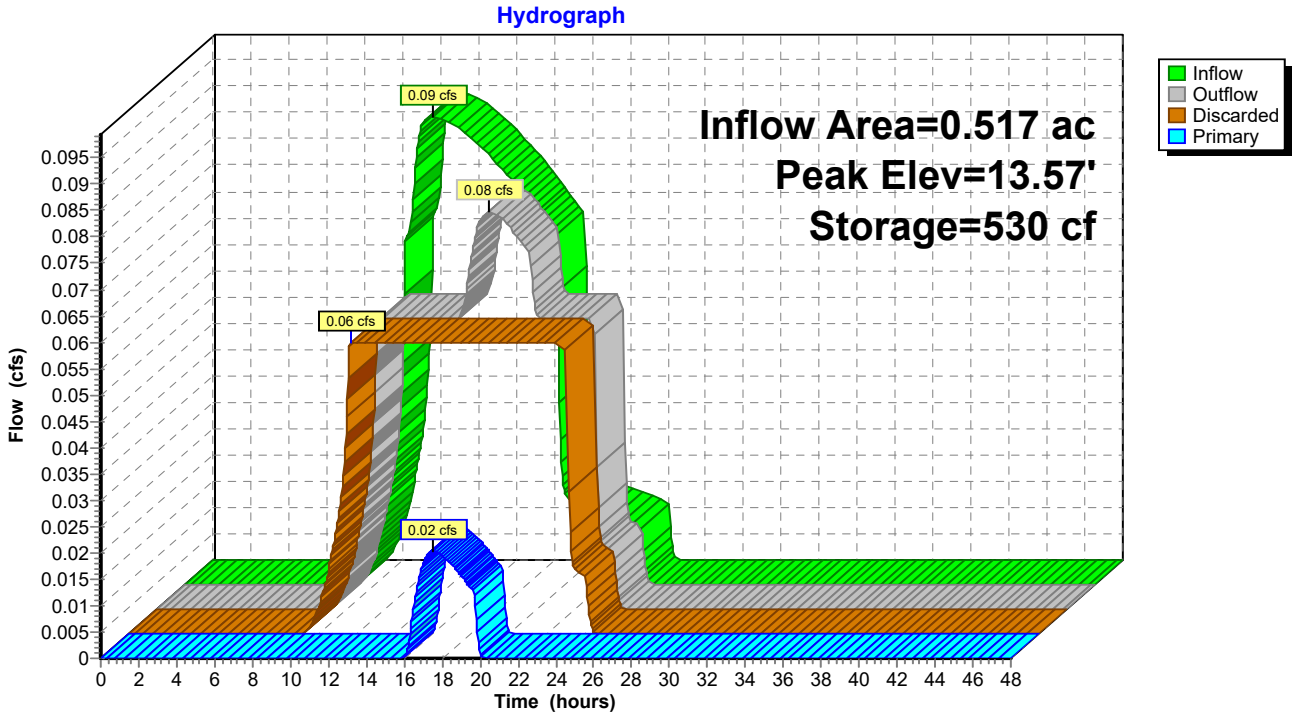
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
13.00	2,338	0	0
14.50	2,338	3,507	3,507

Device	Routing	Invert	Outlet Devices
#1	Discarded	13.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	13.50'	**12.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.06 cfs @ 11.70 hrs HW=13.02' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.06 cfs)

Primary OutFlow Max=0.02 cfs @ 17.55 hrs HW=13.57' (Free Discharge)
└─**2=Orifice/Grate** (Orifice Controls 0.02 cfs @ 0.88 fps)

Pond 6P: Subsurface Storage



Summary for Pond IB1: Infiltration Basin 1

Inflow Area = 0.764 ac, 7.29% Impervious, Inflow Depth = 1.43" for 2-Year event
Inflow = 1.25 cfs @ 12.10 hrs, Volume= 0.091 af
Outflow = 1.05 cfs @ 12.15 hrs, Volume= 0.084 af, Atten= 16%, Lag= 3.5 min
Primary = 1.05 cfs @ 12.15 hrs, Volume= 0.084 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 31.61' @ 12.15 hrs Surf.Area= 1,179 sf Storage= 630 cf

Plug-Flow detention time= 61.3 min calculated for 0.084 af (93% of inflow)
Center-of-Mass det. time= 23.5 min (863.8 - 840.3)

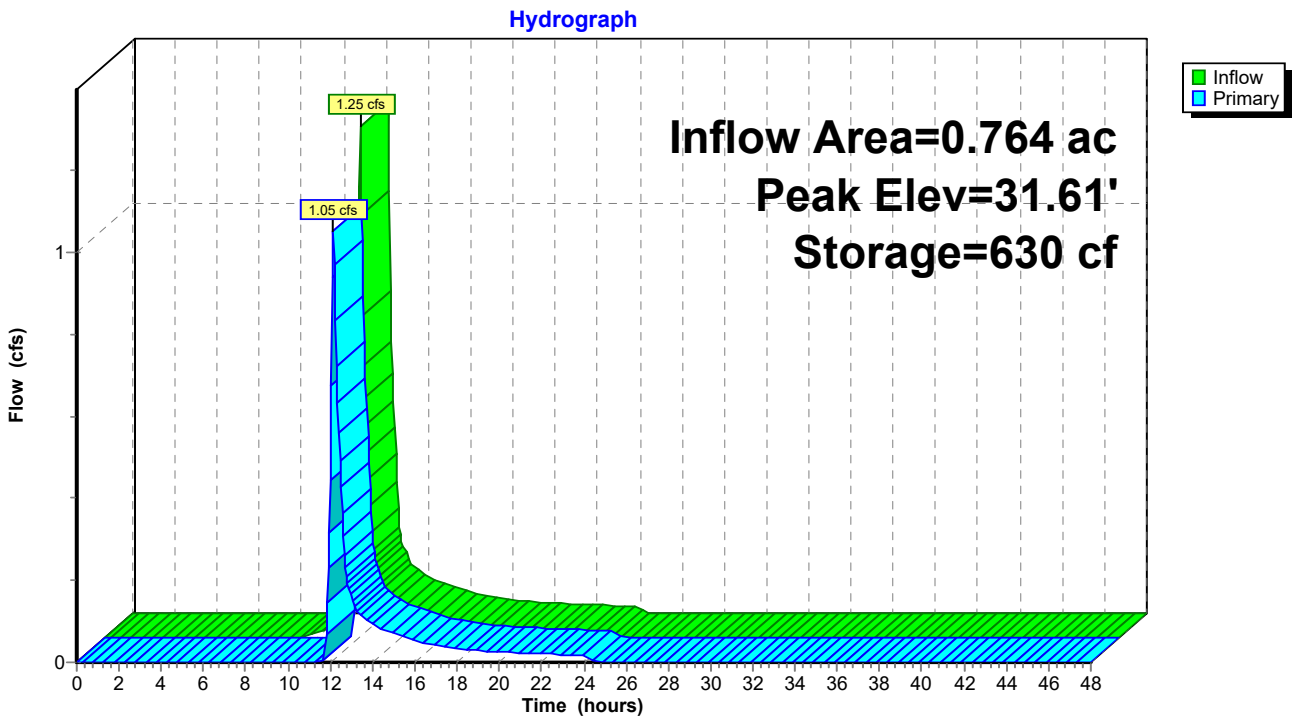
Volume	Invert	Avail.Storage	Storage Description
#1	31.00'	4,992 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
31.00	902	133.0	0	0	902
32.00	1,377	157.0	1,131	1,131	1,475
33.00	1,908	178.0	1,635	2,766	2,059
34.00	2,558	199.0	2,225	4,992	2,716

Device	Routing	Invert	Outlet Devices
#1	Primary	31.30'	**12.0" Horiz. Orifice/Grate X 0.60** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.04 cfs @ 12.15 hrs HW=31.61' (Free Discharge)
└**1=Orifice/Grate** (Weir Controls 1.04 cfs @ 1.09 fps)

Pond IB1: Infiltration Basin 1



Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1A: PR-1A Runoff Area=61,199 sf 9.62% Impervious Runoff Depth=1.47"
Flow Length=135' Tc=6.6 min CN=64 Runoff=2.19 cfs 0.172 af

Subcatchment1B: PR-1B Runoff Area=47,277 sf 17.48% Impervious Runoff Depth=1.69"
Flow Length=1,689' Tc=23.3 min CN=67 Runoff=1.29 cfs 0.152 af

Subcatchment1C: PR-1C Runoff Area=22,519 sf 53.05% Impervious Runoff Depth=2.84"
Tc=6.0 min CN=81 Runoff=1.68 cfs 0.122 af

Subcatchment1D: PR-1D Runoff Area=38,129 sf 35.02% Impervious Runoff Depth=2.23"
Tc=6.0 min CN=74 Runoff=2.23 cfs 0.163 af

Subcatchment2A: PR-2A Runoff Area=293,625 sf 4.21% Impervious Runoff Depth=1.08"
Flow Length=347' Tc=15.3 min CN=58 Runoff=5.32 cfs 0.605 af

Subcatchment2B: PR-2B Runoff Area=41,460 sf 42.97% Impervious Runoff Depth=2.93"
Flow Length=153' Tc=6.3 min CN=82 Runoff=3.17 cfs 0.232 af

Subcatchment3A: PR-3A Runoff Area=59,328 sf 23.32% Impervious Runoff Depth=1.91"
Flow Length=140' Tc=13.0 min CN=70 Runoff=2.35 cfs 0.217 af

Subcatchment3B: PR-3B Runoff Area=31,260 sf 41.03% Impervious Runoff Depth=2.40"
Tc=6.0 min CN=76 Runoff=1.97 cfs 0.143 af

Subcatchment3C: PR-3C Runoff Area=13,432 sf 71.85% Impervious Runoff Depth=3.51"
Tc=6.0 min CN=88 Runoff=1.21 cfs 0.090 af

Subcatchment4A: PR-4A Runoff Area=33,278 sf 7.29% Impervious Runoff Depth=2.84"
Tc=6.0 min CN=81 Runoff=2.49 cfs 0.181 af

Subcatchment4B: PR-Building Runoff Area=40,287 sf 100.00% Impervious Runoff Depth=4.59"
Tc=6.0 min CN=98 Runoff=4.27 cfs 0.354 af

Subcatchment4C: PR-4C Runoff Area=293,843 sf 0.26% Impervious Runoff Depth=0.90"
Tc=6.0 min CN=55 Runoff=5.44 cfs 0.504 af

Subcatchment4D: PR-4D Runoff Area=13,538 sf 0.00% Impervious Runoff Depth=1.33"
Tc=6.0 min CN=62 Runoff=0.44 cfs 0.035 af

Subcatchment4E: PR-4E Runoff Area=108,777 sf 0.00% Impervious Runoff Depth=1.40"
Flow Length=377' Tc=9.2 min CN=63 Runoff=3.34 cfs 0.292 af

Subcatchment4F: PR-4F Runoff Area=5,747 sf 0.00% Impervious Runoff Depth=2.75"
Tc=6.0 min CN=80 Runoff=0.42 cfs 0.030 af

Reach DP1: DP-1 (BVW) Inflow=4.30 cfs 0.593 af
Outflow=4.30 cfs 0.593 af

Reach DP2: DP-2 (SOUTH BEACH) Inflow=10.69 cfs 1.430 af
Outflow=10.69 cfs 1.430 af

Reach DP3: DP-3 (EX PIPE TO NORTH) Inflow=3.37 cfs 0.362 af
Outflow=3.37 cfs 0.362 af

Reach DP4: DP-4 (EAST BEACH) Inflow=13.58 cfs 1.215 af
Outflow=13.58 cfs 1.215 af

Reach TS: OCEAN Inflow=26.68 cfs 3.007 af
Outflow=26.68 cfs 3.007 af

Pond 1N: Subsurface Infiltration System #1 Peak Elev=14.18' Storage=0.050 af Inflow=1.97 cfs 0.143 af
Discarded=0.07 cfs 0.089 af Primary=0.46 cfs 0.055 af Outflow=0.53 cfs 0.143 af

Pond 2S-A: Bioretention - Ponding Peak Elev=18.00' Storage=1,450 cf Inflow=1.68 cfs 0.122 af
Primary=0.86 cfs 0.122 af Secondary=0.00 cfs 0.000 af Outflow=0.86 cfs 0.122 af

Pond 2S-B: Subsurface Infiltration System #2 Peak Elev=15.05' Storage=4,656 cf Inflow=3.87 cfs 0.336 af
Discarded=0.08 cfs 0.117 af Primary=1.76 cfs 0.219 af Outflow=1.84 cfs 0.336 af

Pond 6P: Subsurface Storage Peak Elev=13.85' Storage=798 cf Inflow=0.86 cfs 0.122 af
Discarded=0.06 cfs 0.073 af Primary=0.50 cfs 0.050 af Outflow=0.56 cfs 0.122 af

Pond IB1: Infiltration Basin 1 Peak Elev=31.90' Storage=999 cf Inflow=2.49 cfs 0.181 af
Outflow=1.76 cfs 0.174 af

Total Runoff Area = 25.337 ac Runoff Volume = 3.292 af Average Runoff Depth = 1.56"
86.46% Pervious = 21.907 ac 13.54% Impervious = 3.430 ac

Summary for Subcatchment 1A: PR-1A

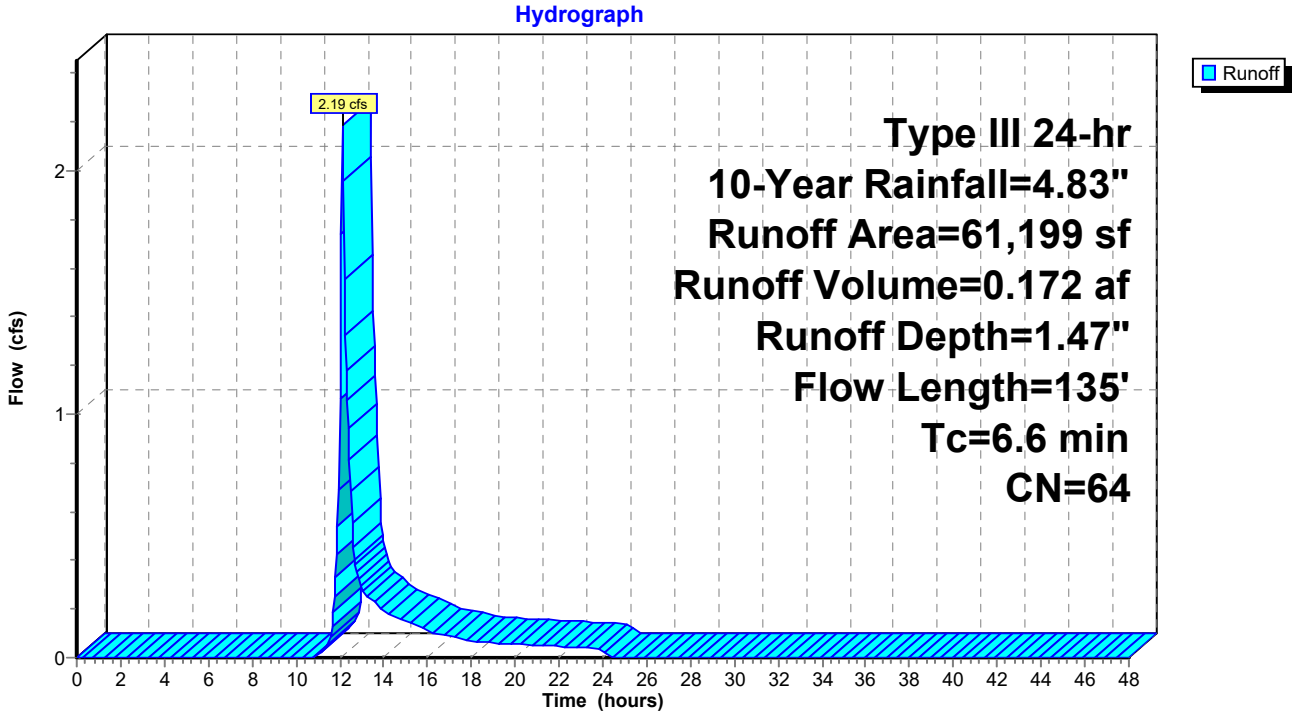
Runoff = 2.19 cfs @ 12.11 hrs, Volume= 0.172 af, Depth= 1.47"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
5,888	98	Paved parking, HSG B
5,753	85	Gravel roads, HSG B
16,513	61	>75% Grass cover, Good, HSG B
33,045	55	Woods, Good, HSG B
61,199	64	Weighted Average
55,311		90.38% Pervious Area
5,888		9.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	50	0.1300	0.21		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.17"
2.7	85	0.0110	0.52		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
6.6	135	Total			

Subcatchment 1A: PR-1A



Summary for Subcatchment 1B: PR-1B

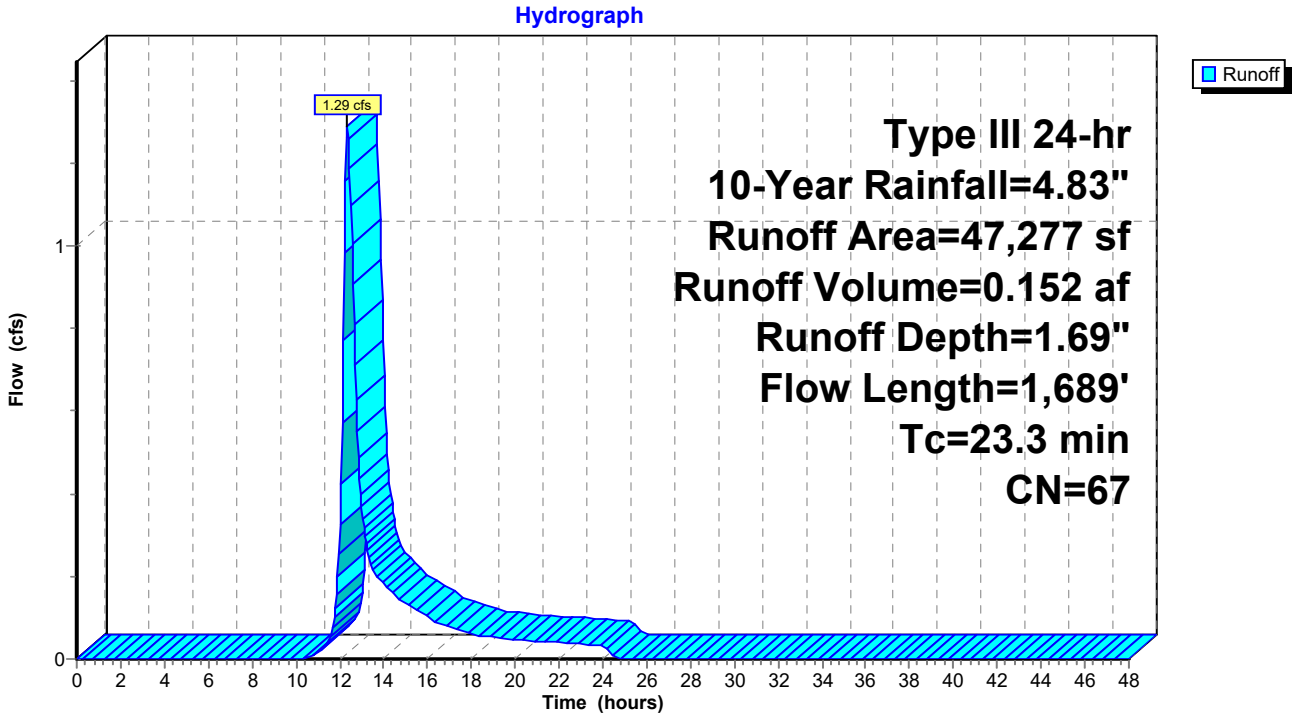
Runoff = 1.29 cfs @ 12.35 hrs, Volume= 0.152 af, Depth= 1.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

	Area (sf)	CN	Description
*	8,263	98	Pavement
	0	55	Woods, Good, HSG B
	39,014	61	>75% Grass cover, Good, HSG B
	47,277	67	Weighted Average
	39,014		82.52% Pervious Area
	8,263		17.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.4000	0.22		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.17"
0.1	16	0.2500	2.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.1	38	0.1300	7.32		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
19.4	1,585	0.0380	1.36		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
23.3	1,689	Total			

Subcatchment 1B: PR-1B



Summary for Subcatchment 1C: PR-1C

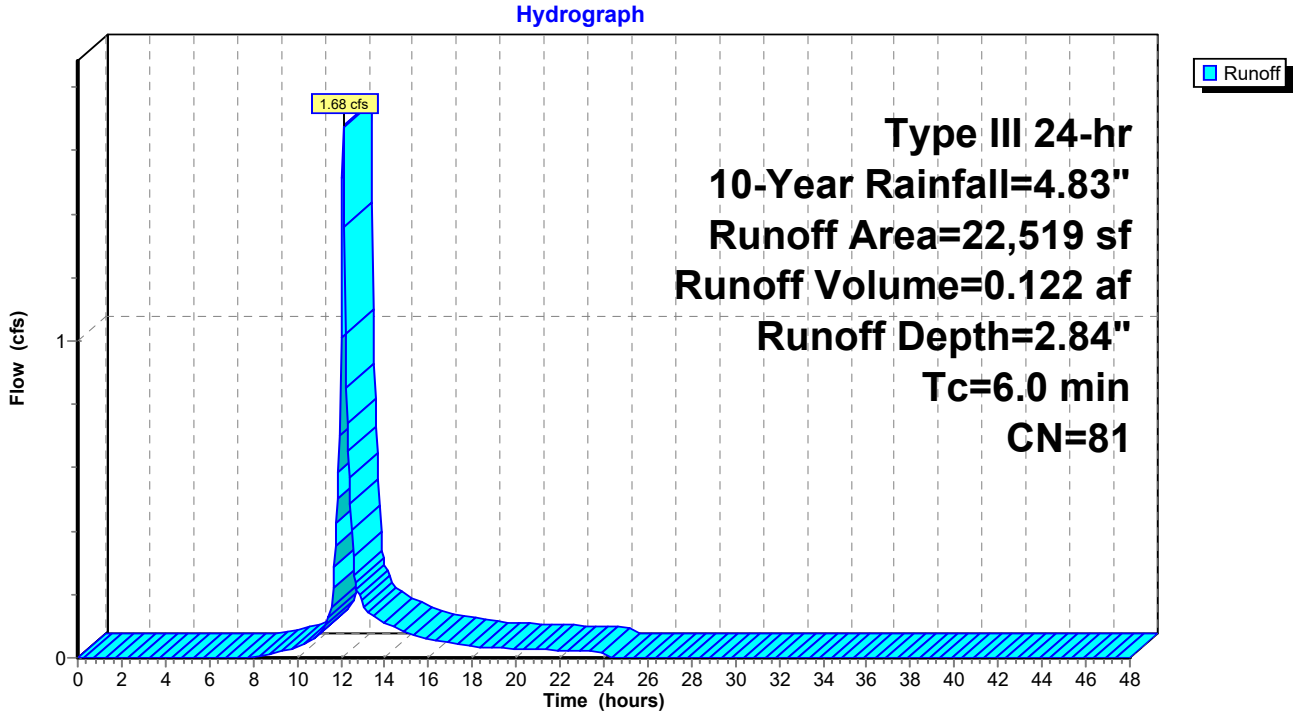
Runoff = 1.68 cfs @ 12.09 hrs, Volume= 0.122 af, Depth= 2.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
0	98	Unconnected roofs, HSG B
11,947	98	Paved parking, HSG B
10,572	61	>75% Grass cover, Good, HSG B
0	85	Gravel roads, HSG B
0	58	Meadow, non-grazed, HSG B
22,519	81	Weighted Average
10,572		46.95% Pervious Area
11,947		53.05% Impervious Area

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

Subcatchment 1C: PR-1C



Summary for Subcatchment 1D: PR-1D

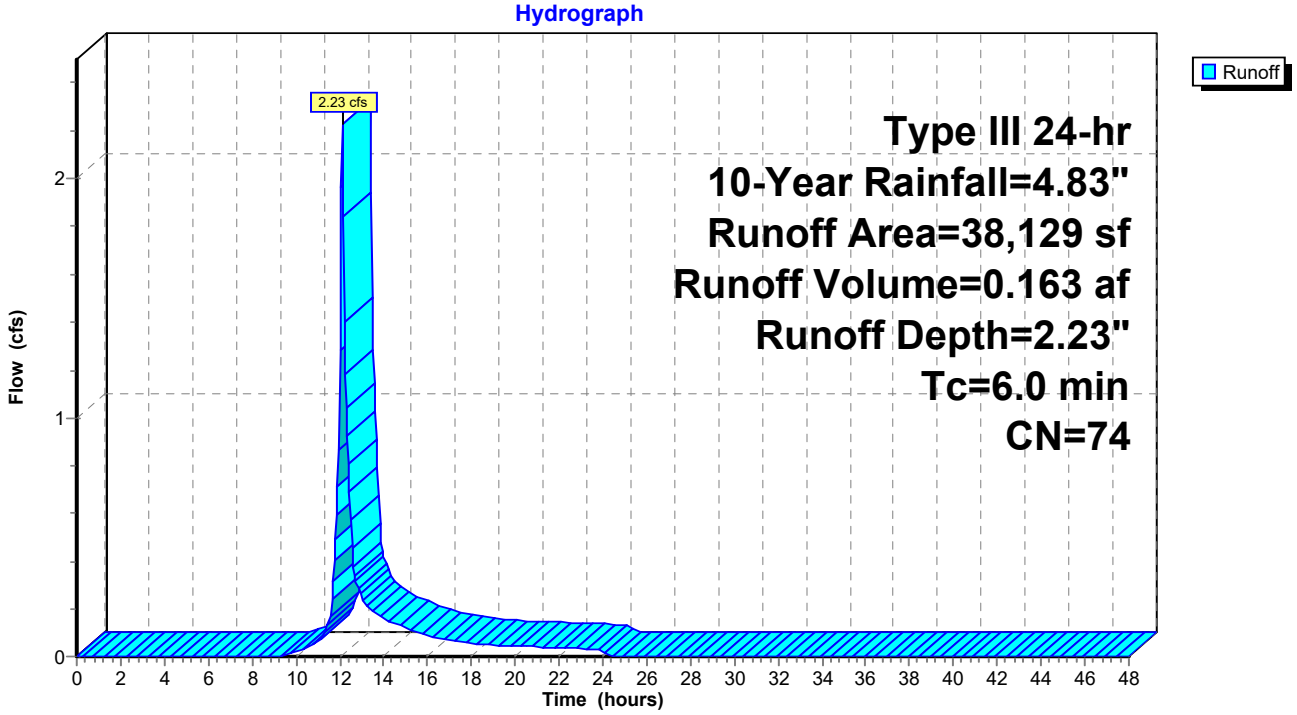
Runoff = 2.23 cfs @ 12.10 hrs, Volume= 0.163 af, Depth= 2.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
13,353	98	Paved parking, HSG B
24,776	61	>75% Grass cover, Good, HSG B
38,129	74	Weighted Average
24,776		64.98% Pervious Area
13,353		35.02% Impervious Area

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

Subcatchment 1D: PR-1D



Summary for Subcatchment 2A: PR-2A

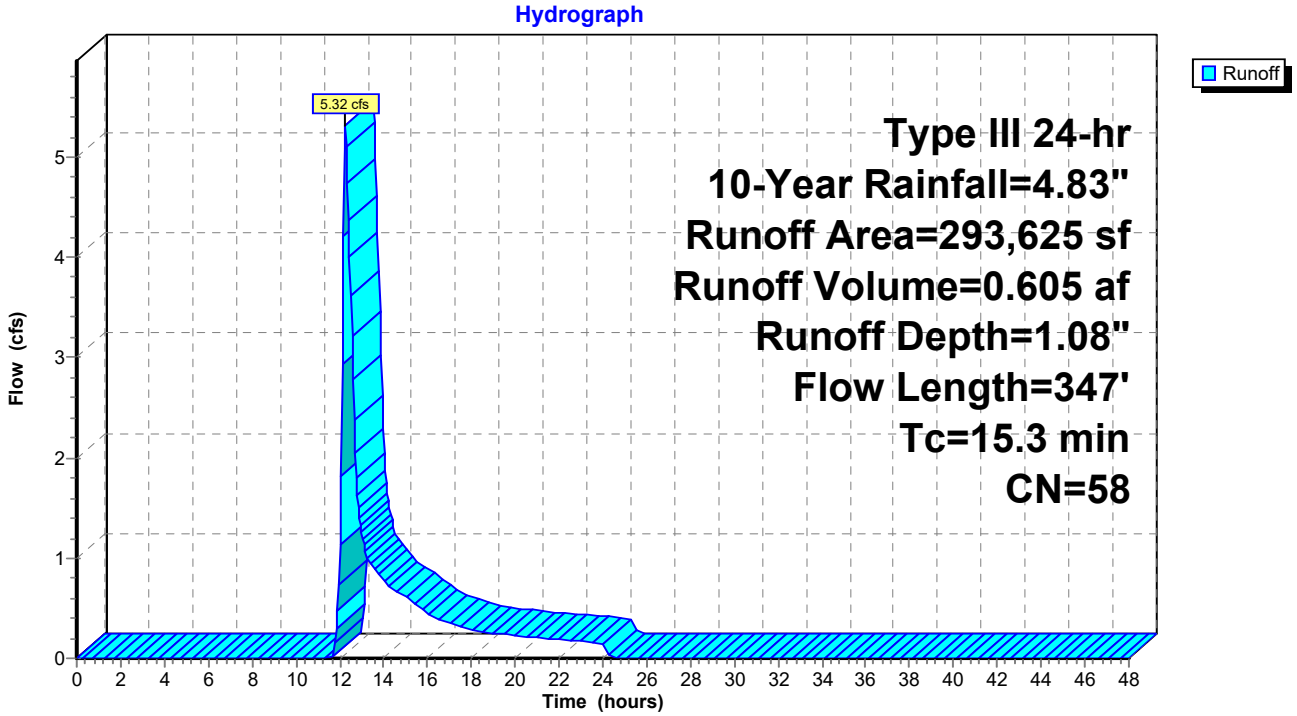
Runoff = 5.32 cfs @ 12.25 hrs, Volume= 0.605 af, Depth= 1.08"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
273,466	55	Woods, Good, HSG B
12,348	98	Paved parking, HSG B
7,811	85	Gravel roads, HSG B
293,625	58	Weighted Average
281,277		95.79% Pervious Area
12,348		4.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.4	50	0.0800	0.07		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 3.17"
2.9	297	0.1200	1.73		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	347	Total			

Subcatchment 2A: PR-2A



Summary for Subcatchment 2B: PR-2B

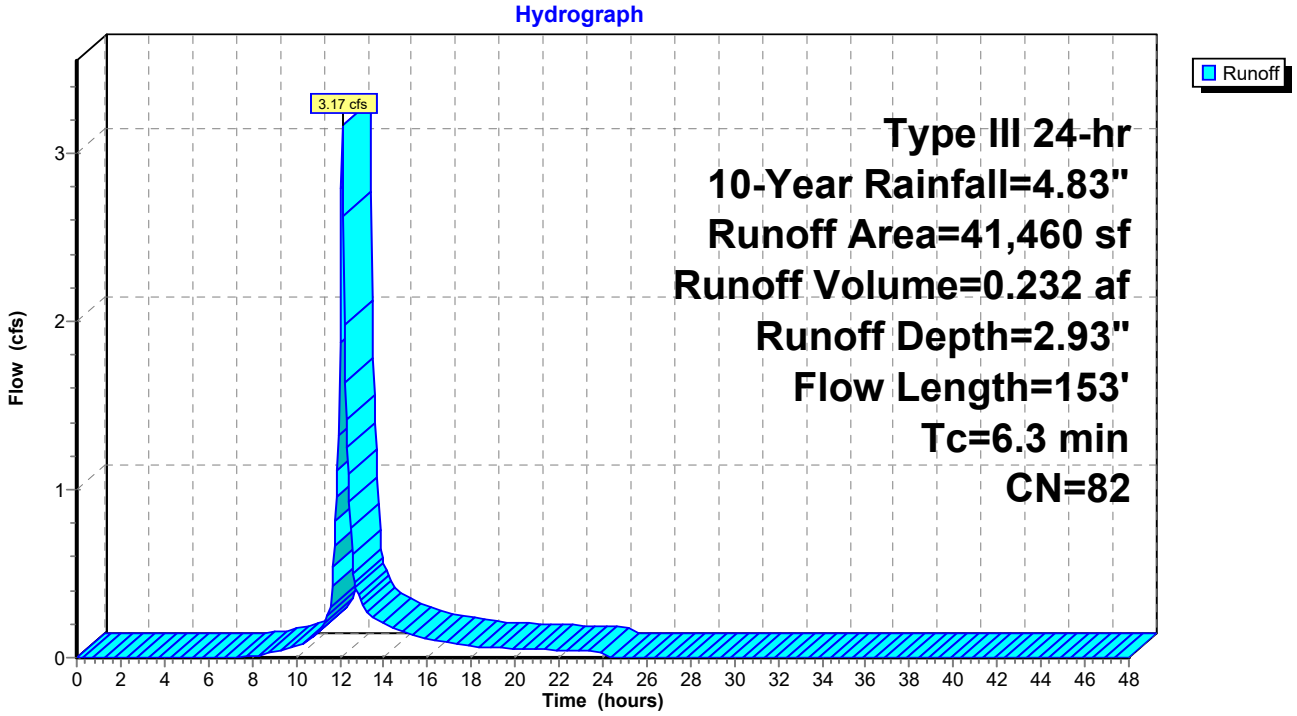
Runoff = 3.17 cfs @ 12.10 hrs, Volume= 0.232 af, Depth= 2.93"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
17,814	98	Unconnected roofs, HSG B
14,033	61	>75% Grass cover, Good, HSG B
9,613	85	Gravel roads, HSG B
41,460	82	Weighted Average
23,646		57.03% Pervious Area
17,814		42.97% Impervious Area
17,814		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	50	0.1200	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.17"
0.2	103	0.2900	8.67		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.3	153	Total			

Subcatchment 2B: PR-2B



Summary for Subcatchment 3A: PR-3A

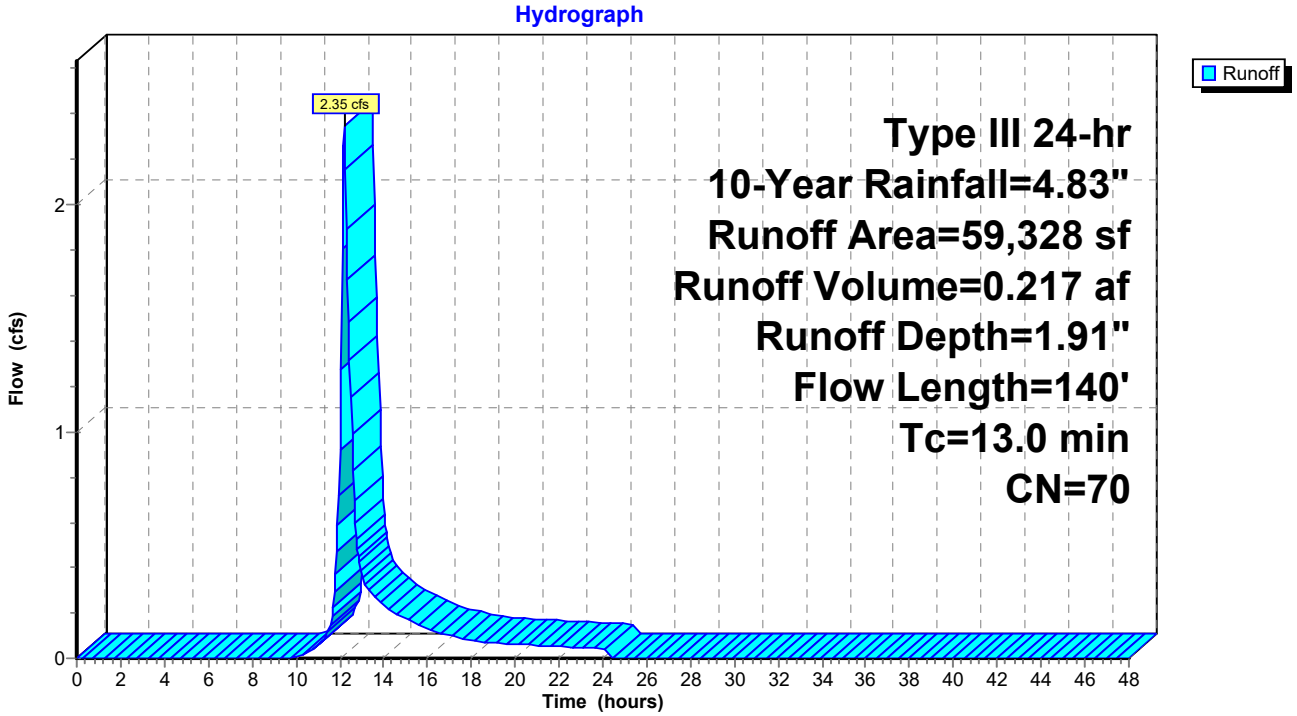
Runoff = 2.35 cfs @ 12.19 hrs, Volume= 0.217 af, Depth= 1.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
13,833	98	Paved parking, HSG B
12,046	61	>75% Grass cover, Good, HSG B
33,449	61	Pasture/grassland/range, Good, HSG B
59,328	70	Weighted Average
45,495		76.68% Pervious Area
13,833		23.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	50	0.0400	0.13		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.17"
6.8	90	0.0010	0.22		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.0	140	Total			

Subcatchment 3A: PR-3A



Summary for Subcatchment 3B: PR-3B

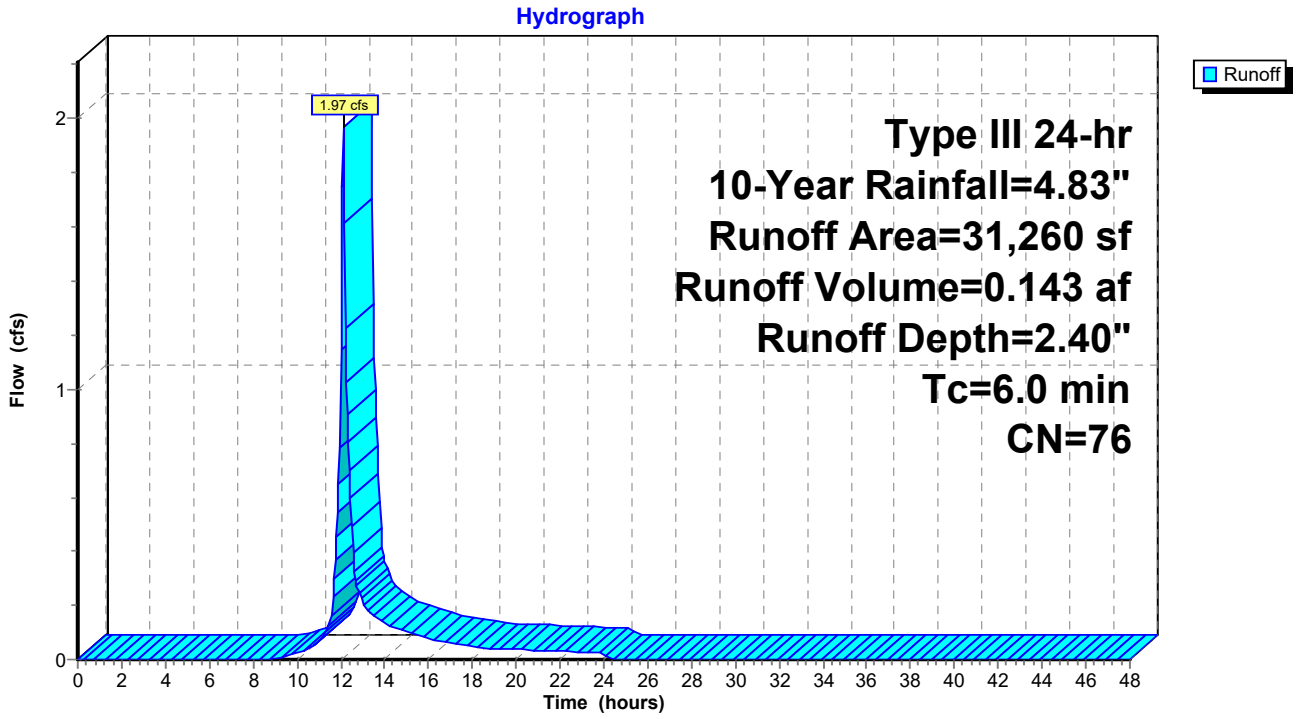
Runoff = 1.97 cfs @ 12.09 hrs, Volume= 0.143 af, Depth= 2.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
0	98	Unconnected roofs, HSG B
12,826	98	Paved parking, HSG B
18,434	61	>75% Grass cover, Good, HSG B
0	85	Gravel roads, HSG B
0	58	Meadow, non-grazed, HSG B
0	39	>75% Grass cover, Good, HSG A
31,260	76	Weighted Average
18,434		58.97% Pervious Area
12,826		41.03% Impervious Area

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

Subcatchment 3B: PR-3B



Summary for Subcatchment 3C: PR-3C

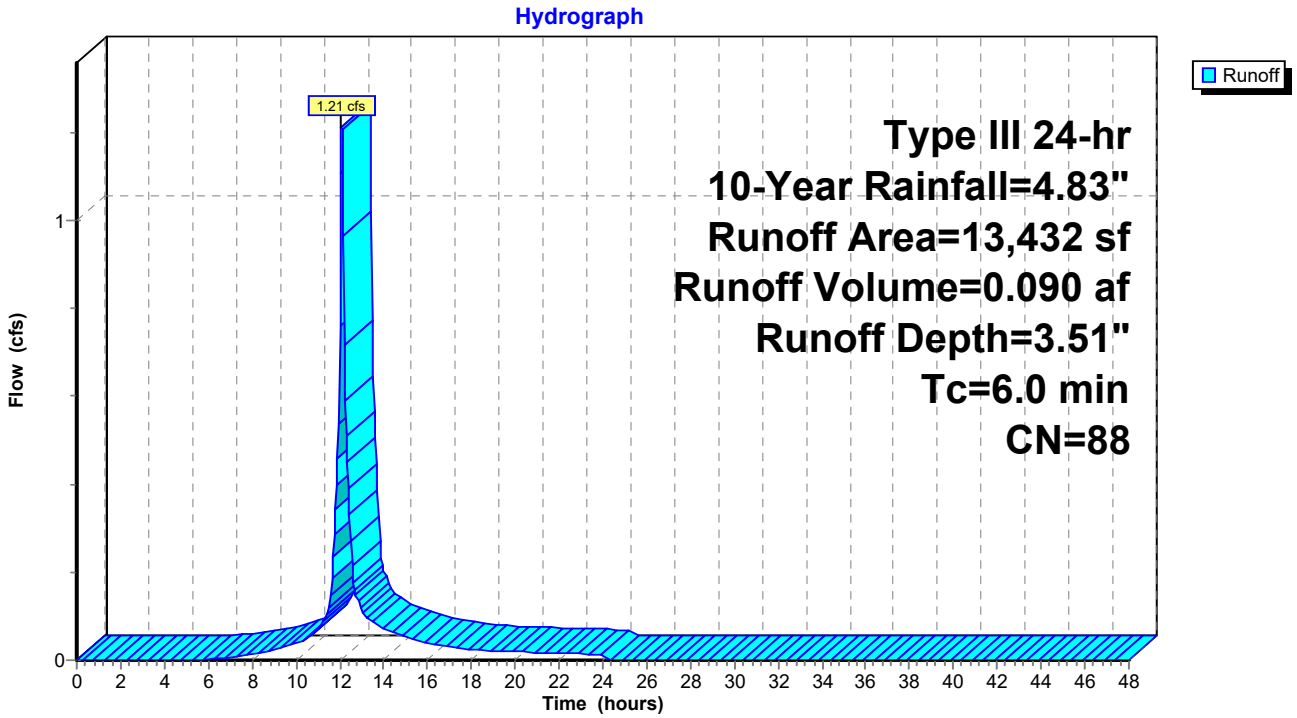
Runoff = 1.21 cfs @ 12.09 hrs, Volume= 0.090 af, Depth= 3.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
9,651	98	Unconnected pavement, HSG B
3,781	61	>75% Grass cover, Good, HSG B
13,432	88	Weighted Average
3,781		28.15% Pervious Area
9,651		71.85% Impervious Area
9,651		100.00% Unconnected

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

Subcatchment 3C: PR-3C



Summary for Subcatchment 4A: PR-4A

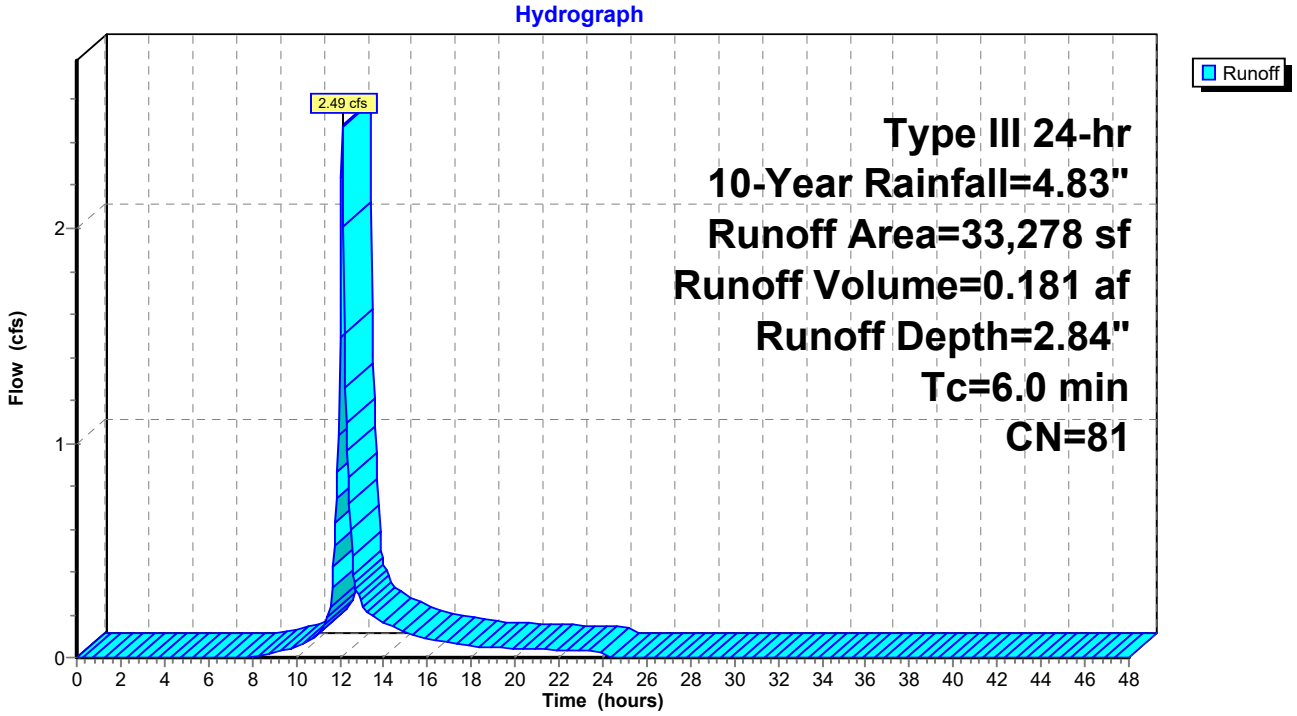
Runoff = 2.49 cfs @ 12.09 hrs, Volume= 0.181 af, Depth= 2.84"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

	Area (sf)	CN	Description
	0	98	Roofs, HSG D
*	2,426	98	Paved parking, HSG D
	30,281	80	>75% Grass cover, Good, HSG D
	571	85	Gravel roads, HSG B
	33,278	81	Weighted Average
	30,852		92.71% Pervious Area
	2,426		7.29% Impervious Area

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

Subcatchment 4A: PR-4A



Summary for Subcatchment 4B: PR-Building

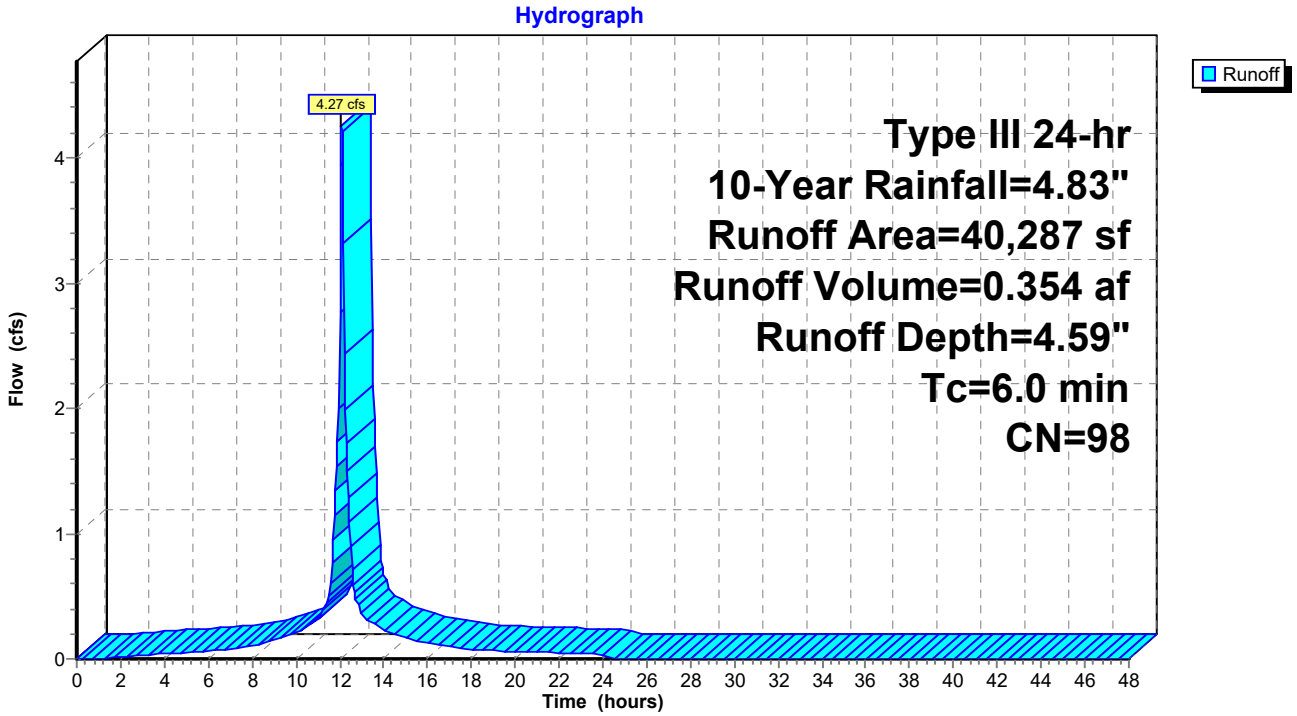
Runoff = 4.27 cfs @ 12.09 hrs, Volume= 0.354 af, Depth= 4.59"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
40,287	98	Unconnected roofs, HSG B
40,287		100.00% Impervious Area
40,287		100.00% Unconnected

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

Subcatchment 4B: PR-Building



Summary for Subcatchment 4C: PR-4C

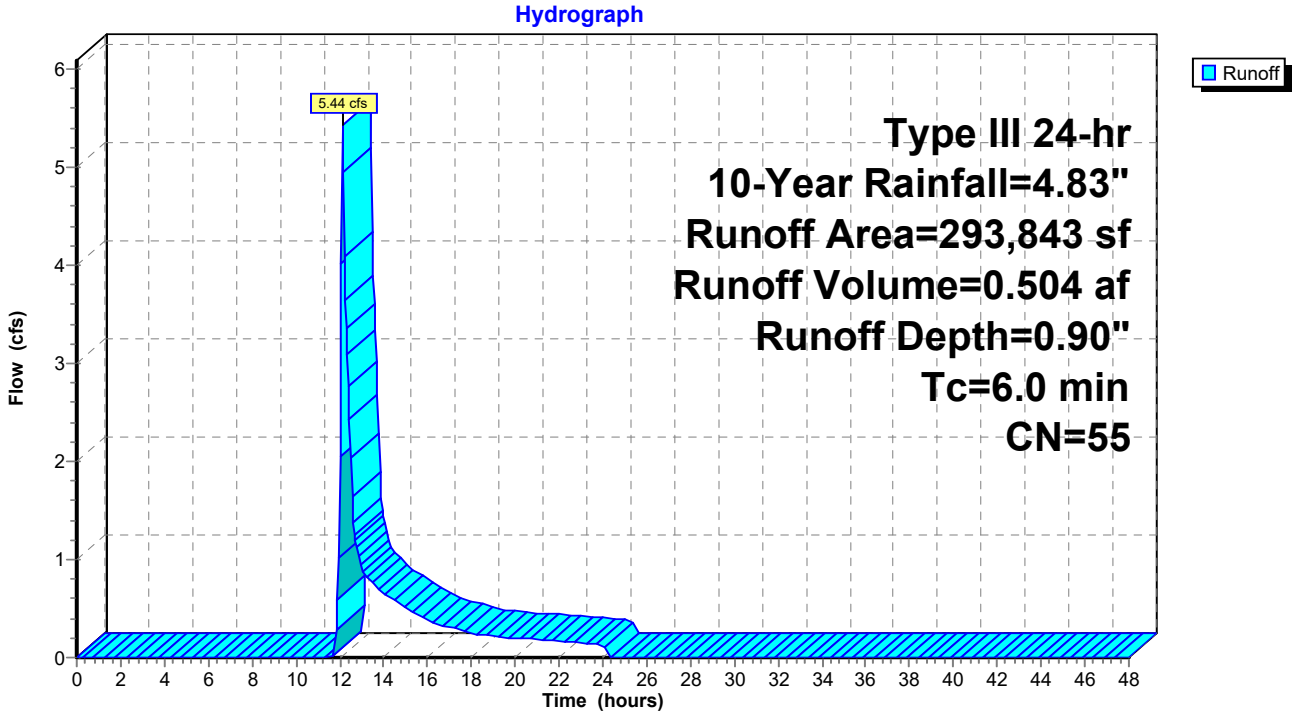
Runoff = 5.44 cfs @ 12.11 hrs, Volume= 0.504 af, Depth= 0.90"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
774	98	Unconnected pavement, HSG B
291,213	55	Woods, Good, HSG B
1,856	85	Gravel roads, HSG B
293,843	55	Weighted Average
293,069		99.74% Pervious Area
774		0.26% Impervious Area
774		100.00% Unconnected

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

Subcatchment 4C: PR-4C



Summary for Subcatchment 4D: PR-4D

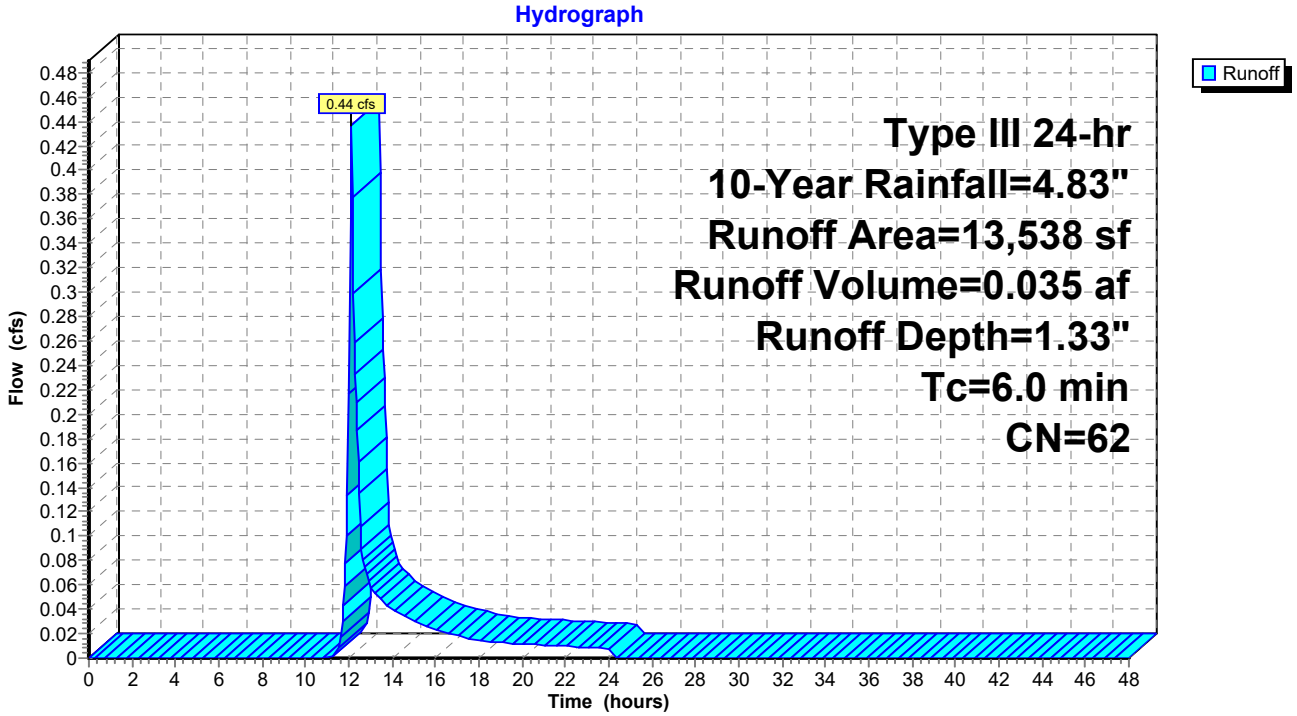
Runoff = 0.44 cfs @ 12.10 hrs, Volume= 0.035 af, Depth= 1.33"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
12,699	61	>75% Grass cover, Good, HSG B
839	85	Gravel roads, HSG B
13,538	62	Weighted Average
13,538		100.00% Pervious Area

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

Subcatchment 4D: PR-4D



Summary for Subcatchment 4E: PR-4E

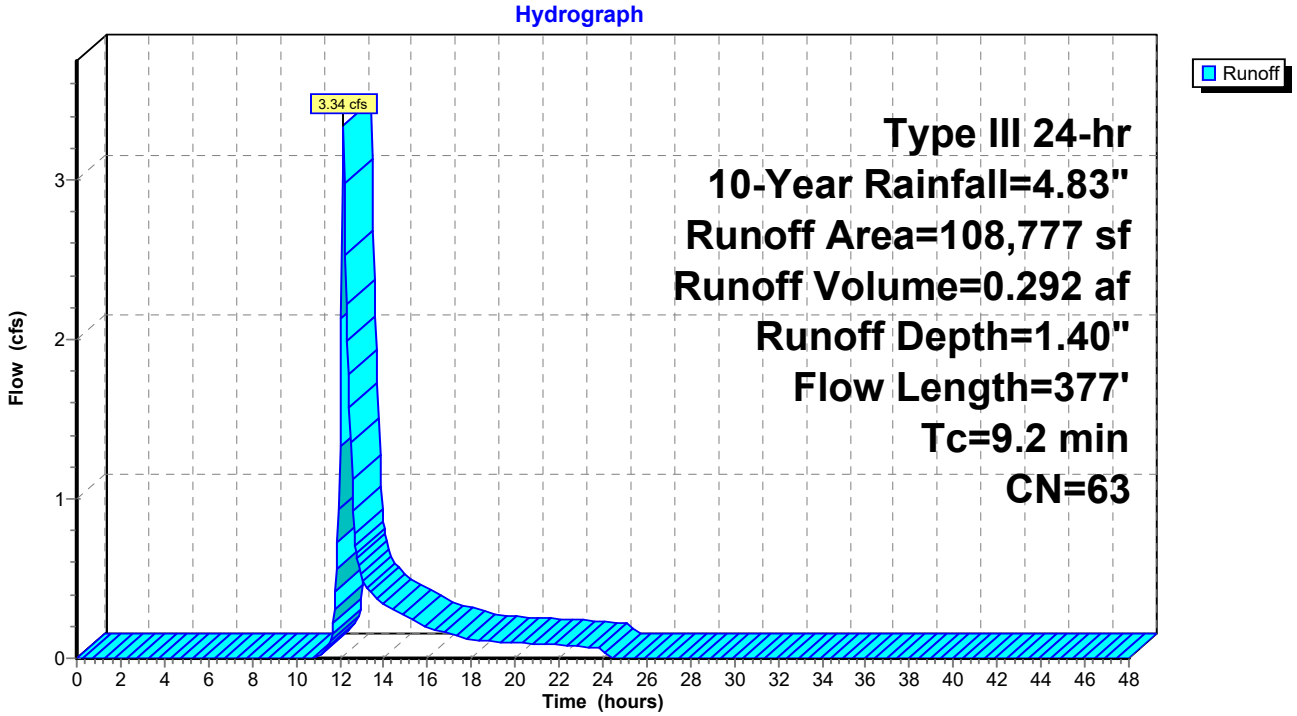
Runoff = 3.34 cfs @ 12.15 hrs, Volume= 0.292 af, Depth= 1.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
101,639	61	>75% Grass cover, Good, HSG B
7,138	85	Gravel roads, HSG B
108,777	63	Weighted Average
108,777		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	50	0.0600	0.16		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.17"
3.9	327	0.0390	1.38		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.2	377	Total			

Subcatchment 4E: PR-4E



Summary for Subcatchment 4F: PR-4F

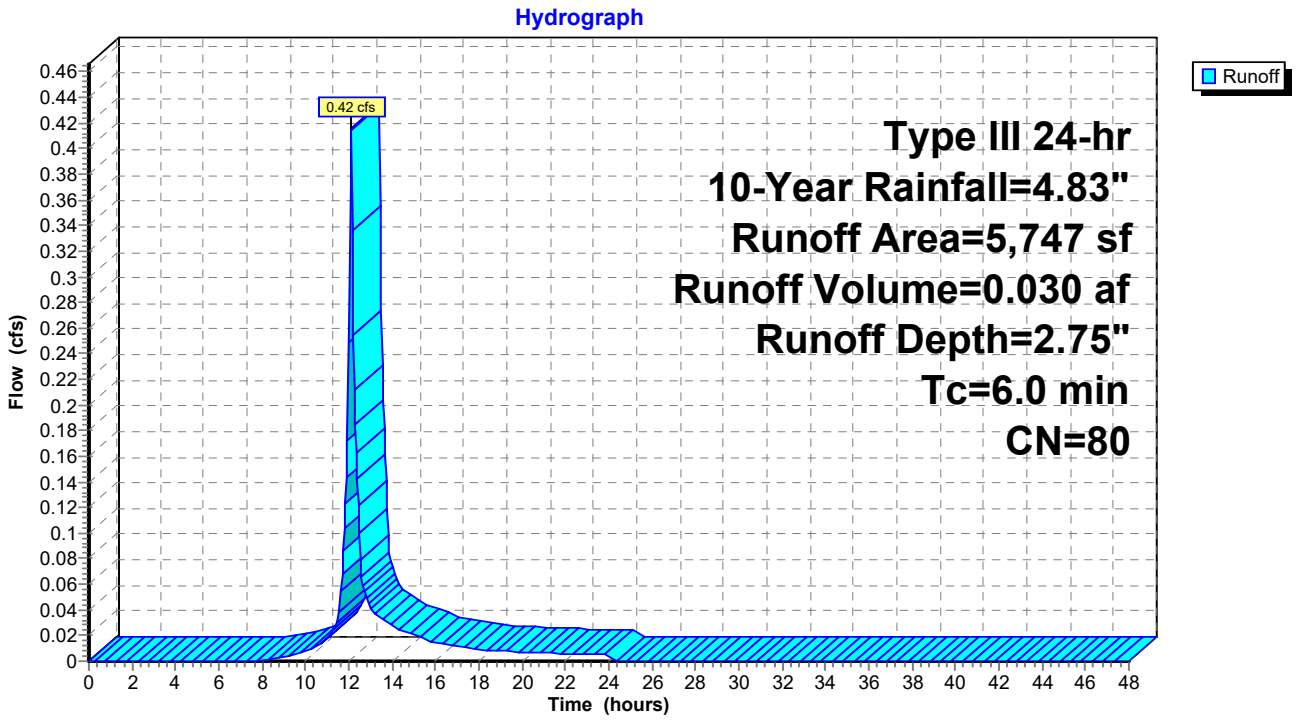
Runoff = 0.42 cfs @ 12.09 hrs, Volume= 0.030 af, Depth= 2.75"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 10-Year Rainfall=4.83"

Area (sf)	CN	Description
5,747	80	>75% Grass cover, Good, HSG D
5,747		100.00% Pervious Area

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

Subcatchment 4F: PR-4F



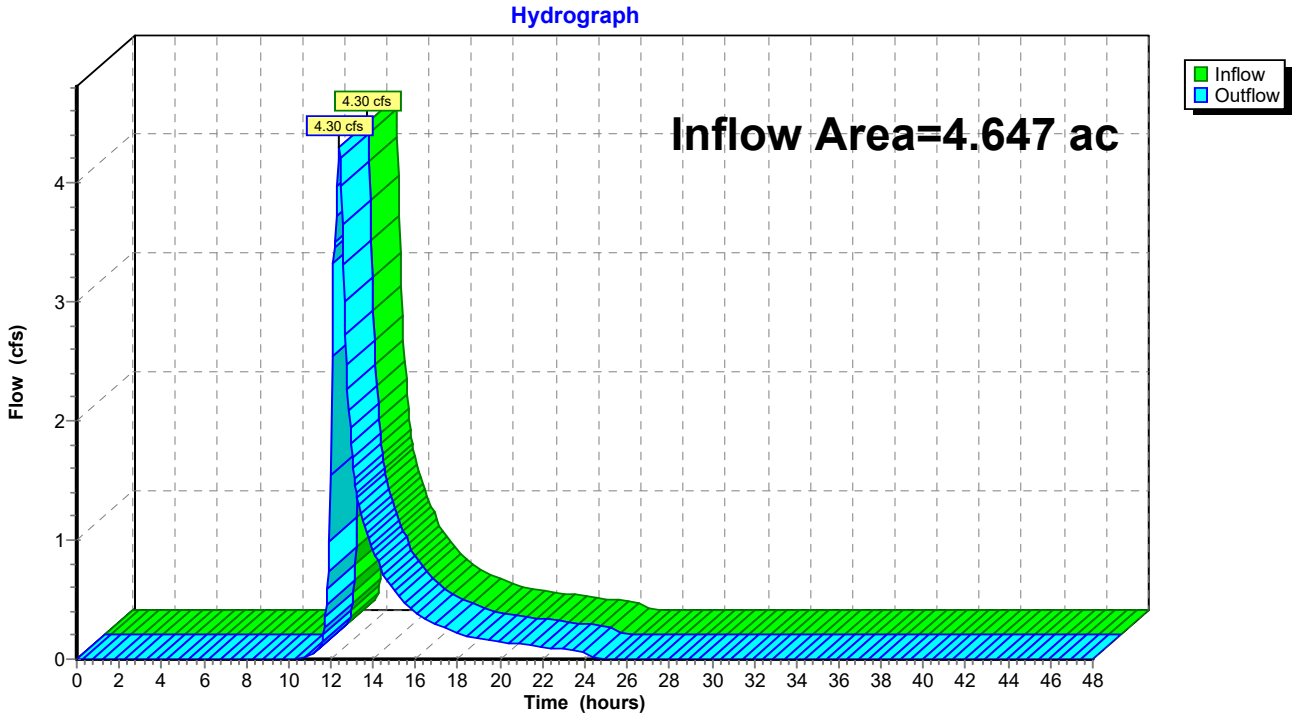
Summary for Reach DP1: DP-1 (BVW)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.647 ac, 20.69% Impervious, Inflow Depth = 1.53" for 10-Year event
Inflow = 4.30 cfs @ 12.40 hrs, Volume= 0.593 af
Outflow = 4.30 cfs @ 12.40 hrs, Volume= 0.593 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DP1: DP-1 (BVW)



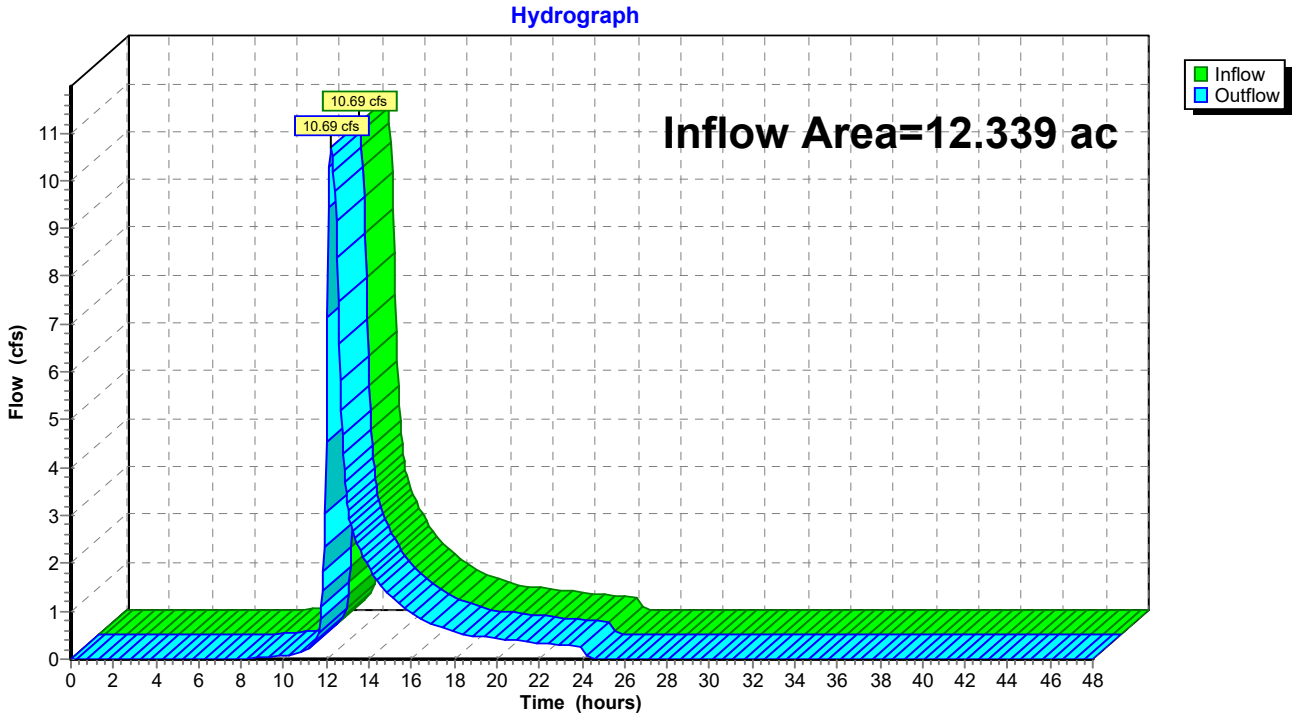
Summary for Reach DP2: DP-2 (SOUTH BEACH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 12.339 ac, 13.40% Impervious, Inflow Depth = 1.39" for 10-Year event
Inflow = 10.69 cfs @ 12.24 hrs, Volume= 1.430 af
Outflow = 10.69 cfs @ 12.24 hrs, Volume= 1.430 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DP2: DP-2 (SOUTH BEACH)



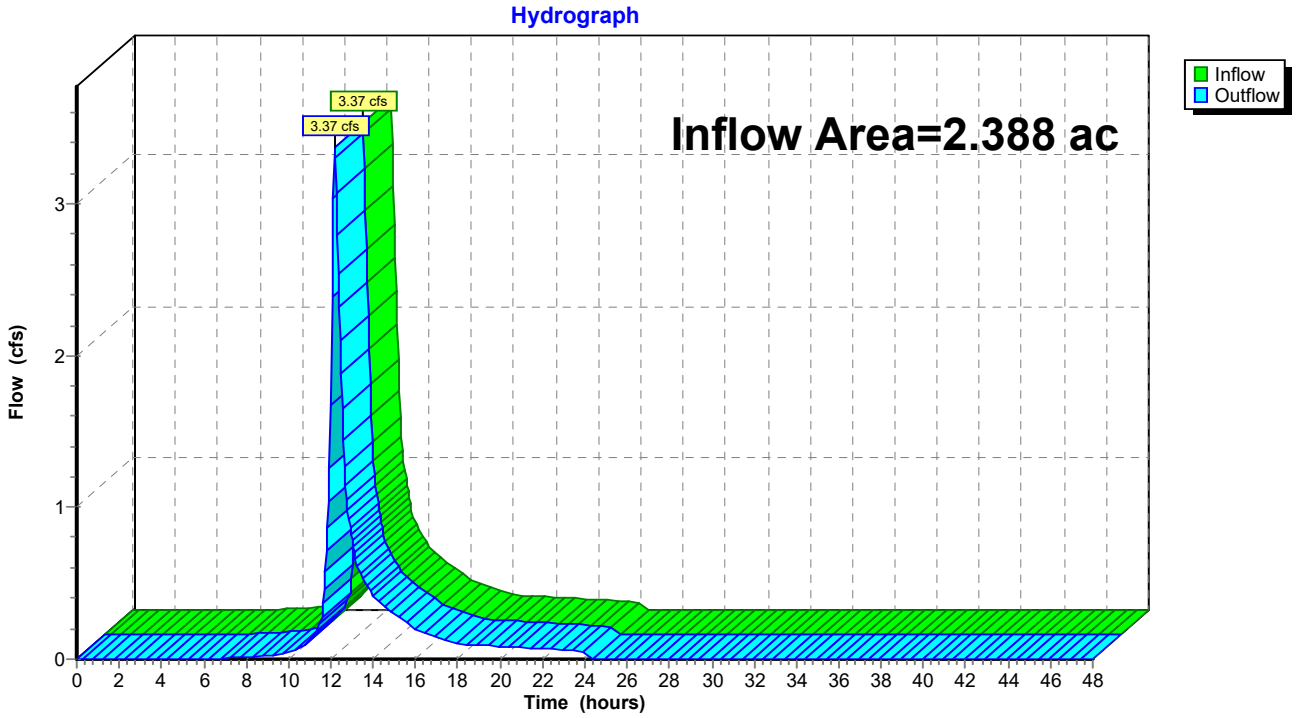
Summary for Reach DP3: DP-3 (EX PIPE TO NORTH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 2.388 ac, 34.91% Impervious, Inflow Depth = 1.82" for 10-Year event
Inflow = 3.37 cfs @ 12.17 hrs, Volume= 0.362 af
Outflow = 3.37 cfs @ 12.17 hrs, Volume= 0.362 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DP3: DP-3 (EX PIPE TO NORTH)



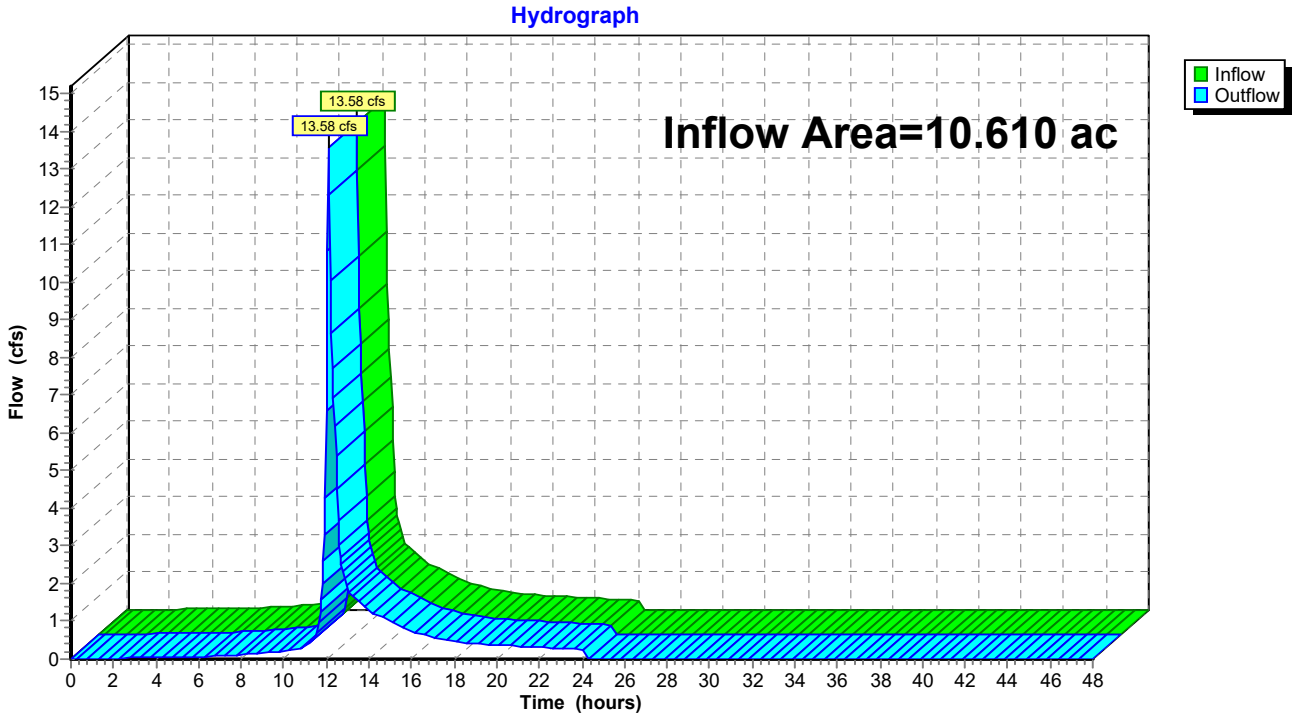
Summary for Reach DP4: DP-4 (EAST BEACH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 10.610 ac, 8.88% Impervious, Inflow Depth = 1.37" for 10-Year event
Inflow = 13.58 cfs @ 12.11 hrs, Volume= 1.215 af
Outflow = 13.58 cfs @ 12.11 hrs, Volume= 1.215 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DP4: DP-4 (EAST BEACH)



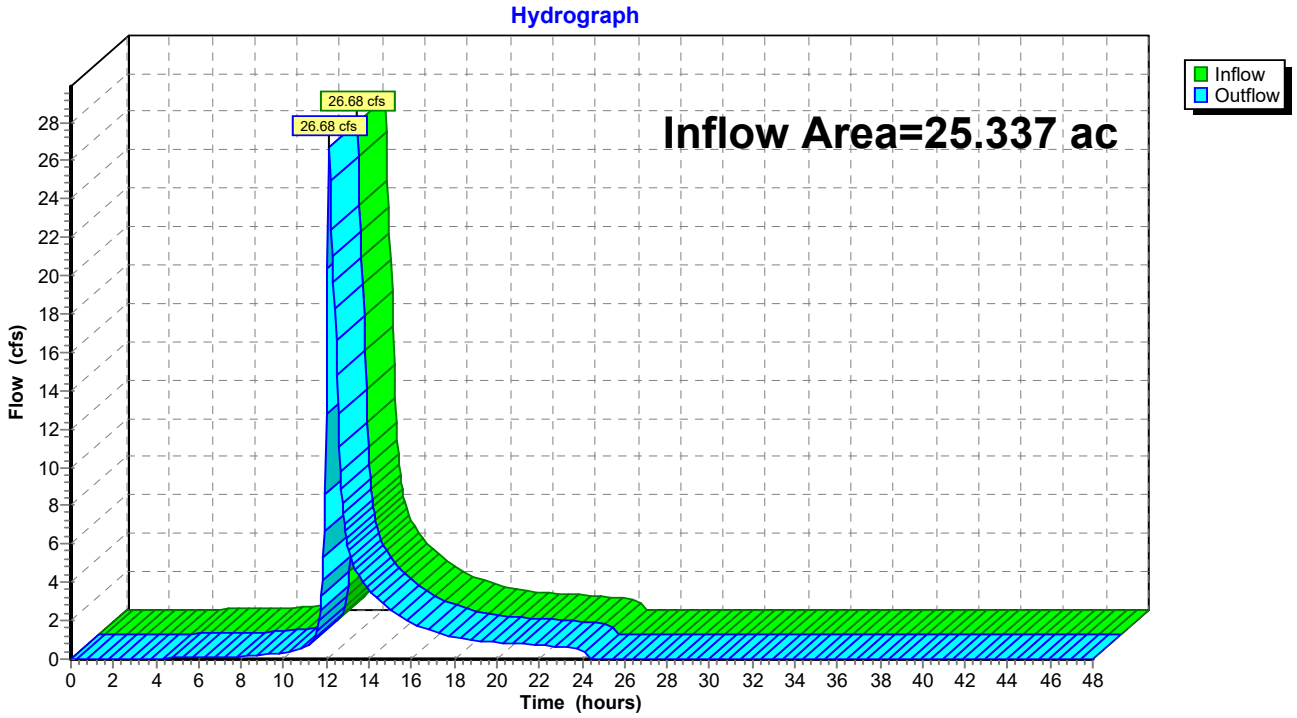
Summary for Reach TS: OCEAN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 25.337 ac, 13.54% Impervious, Inflow Depth = 1.42" for 10-Year event
Inflow = 26.68 cfs @ 12.12 hrs, Volume= 3.007 af
Outflow = 26.68 cfs @ 12.12 hrs, Volume= 3.007 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach TS: OCEAN



Summary for Pond 1N: Subsurface Infiltration System #1

Inflow Area =	0.718 ac, 41.03% Impervious, Inflow Depth = 2.40" for 10-Year event				
Inflow =	1.97 cfs @	12.09 hrs,	Volume=	0.143 af	
Outflow =	0.53 cfs @	12.48 hrs,	Volume=	0.143 af,	Atten= 73%, Lag= 23.3 min
Discarded =	0.07 cfs @	11.20 hrs,	Volume=	0.089 af	
Primary =	0.46 cfs @	12.48 hrs,	Volume=	0.055 af	

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 14.18' @ 12.48 hrs Surf.Area= 0.069 ac Storage= 0.050 af

Plug-Flow detention time= 133.6 min calculated for 0.143 af (100% of inflow)
Center-of-Mass det. time= 133.5 min (967.5 - 833.9)

Volume	Invert	Avail.Storage	Storage Description
#1A	13.00'	0.049 af	**44.83'W x 67.28'L x 2.33'H Field A** 0.162 af Overall - 0.040 af Embedded = 0.122 af x 40.0% Voids
#2A	13.50'	0.040 af	**ADS_StormTech SC-310 +Cap** x 117 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 13 Rows of 9 Chambers
		0.088 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	13.70'	**6.0" Vert. Orifice/Grate** C= 0.600
#2	Discarded	13.00'	**1.020 in/hr Exfiltration over Surface area**
#3	Device 4	15.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Primary	13.00'	**15.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 13.00' / 12.75' S= 0.0050 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 1.23 sf

Discarded OutFlow Max=0.07 cfs @ 11.20 hrs HW=13.03' (Free Discharge)
└─**2=Exfiltration** (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=0.46 cfs @ 12.48 hrs HW=14.18' (Free Discharge)
└─**4=Culvert** (Passes 0.46 cfs of 2.88 cfs potential flow)
  ├─**1=Orifice/Grate** (Orifice Controls 0.46 cfs @ 2.37 fps)
  └─**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 1N: Subsurface Infiltration System #1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-310 +Cap (ADS StormTech®SC-310 with cap length)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

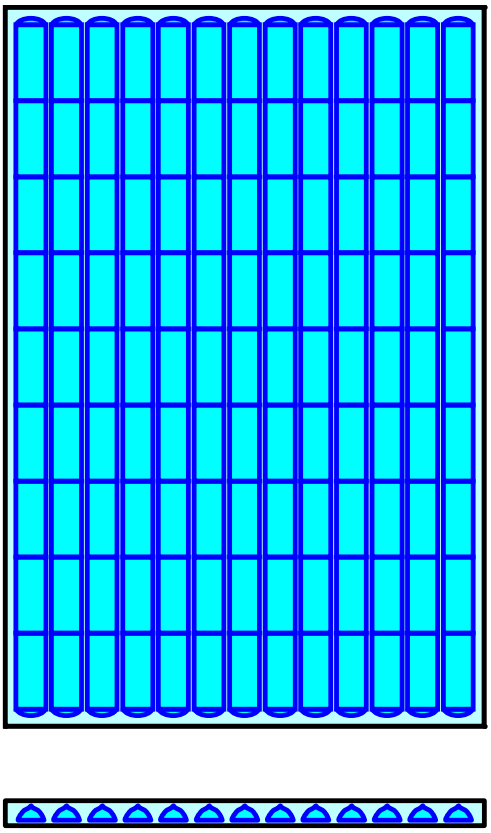
9 Chambers/Row x 7.12' Long +0.60' Cap Length x 2 = 65.28' Row Length +12.0" End Stone x 2 = 67.28' Base Length
13 Rows x 34.0" Wide + 6.0" Spacing x 12 + 12.0" Side Stone x 2 = 44.83' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

117 Chambers x 14.7 cf = 1,724.8 cf Chamber Storage

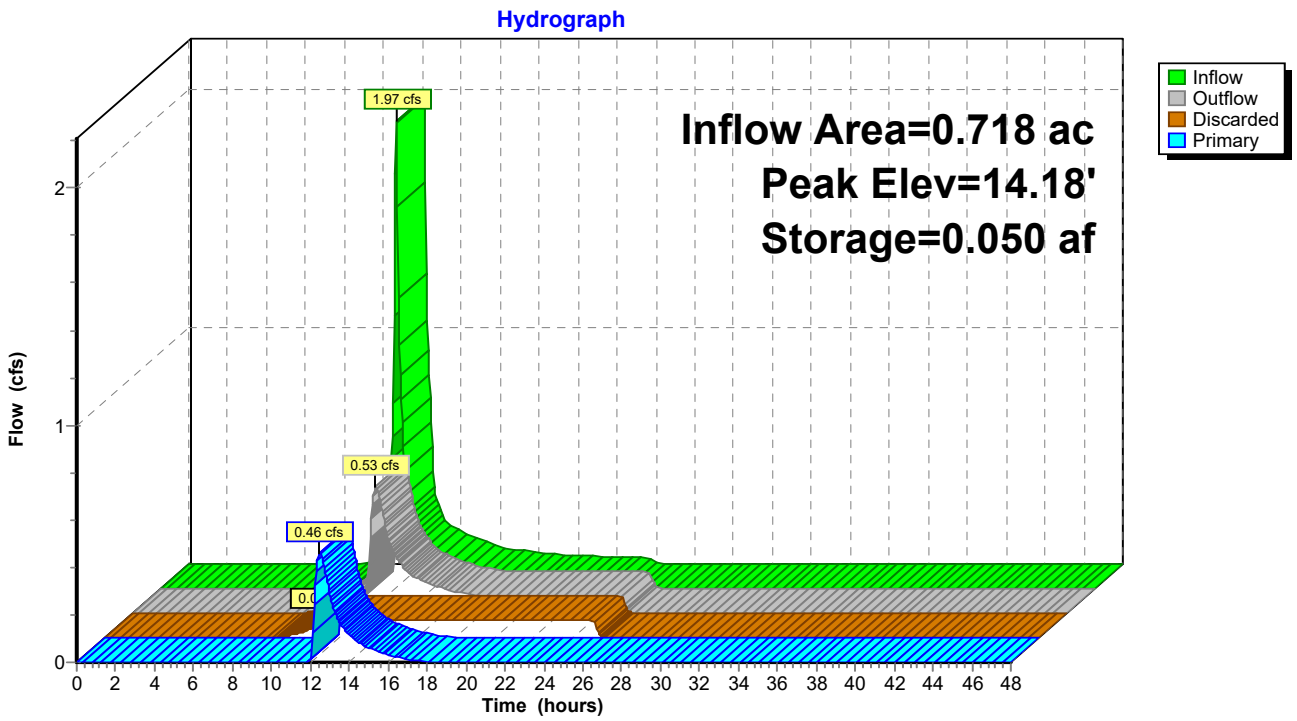
7,038.2 cf Field - 1,724.8 cf Chambers = 5,313.4 cf Stone x 40.0% Voids = 2,125.4 cf Stone Storage

Chamber Storage + Stone Storage = 3,850.2 cf = 0.088 af
Overall Storage Efficiency = 54.7%
Overall System Size = 67.28' x 44.83' x 2.33'

117 Chambers
260.7 cy Field
196.8 cy Stone



Pond 1N: Subsurface Infiltration System #1



Summary for Pond 2S-A: Bioretention - Ponding

Inflow Area = 0.517 ac, 53.05% Impervious, Inflow Depth = 2.84" for 10-Year event
Inflow = 1.68 cfs @ 12.09 hrs, Volume= 0.122 af
Outflow = 0.86 cfs @ 12.26 hrs, Volume= 0.122 af, Atten= 49%, Lag= 9.9 min
Primary = 0.86 cfs @ 12.26 hrs, Volume= 0.122 af
Secondary = 0.00 cfs @ 0.00 hrs, Volume= 0.000 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 18.00' @ 12.26 hrs Surf.Area= 1,737 sf Storage= 1,450 cf

Plug-Flow detention time= 88.2 min calculated for 0.122 af (100% of inflow)
Center-of-Mass det. time= 88.1 min (908.6 - 820.5)

Volume	Invert	Avail.Storage	Storage Description
#1	17.00'	3,490 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

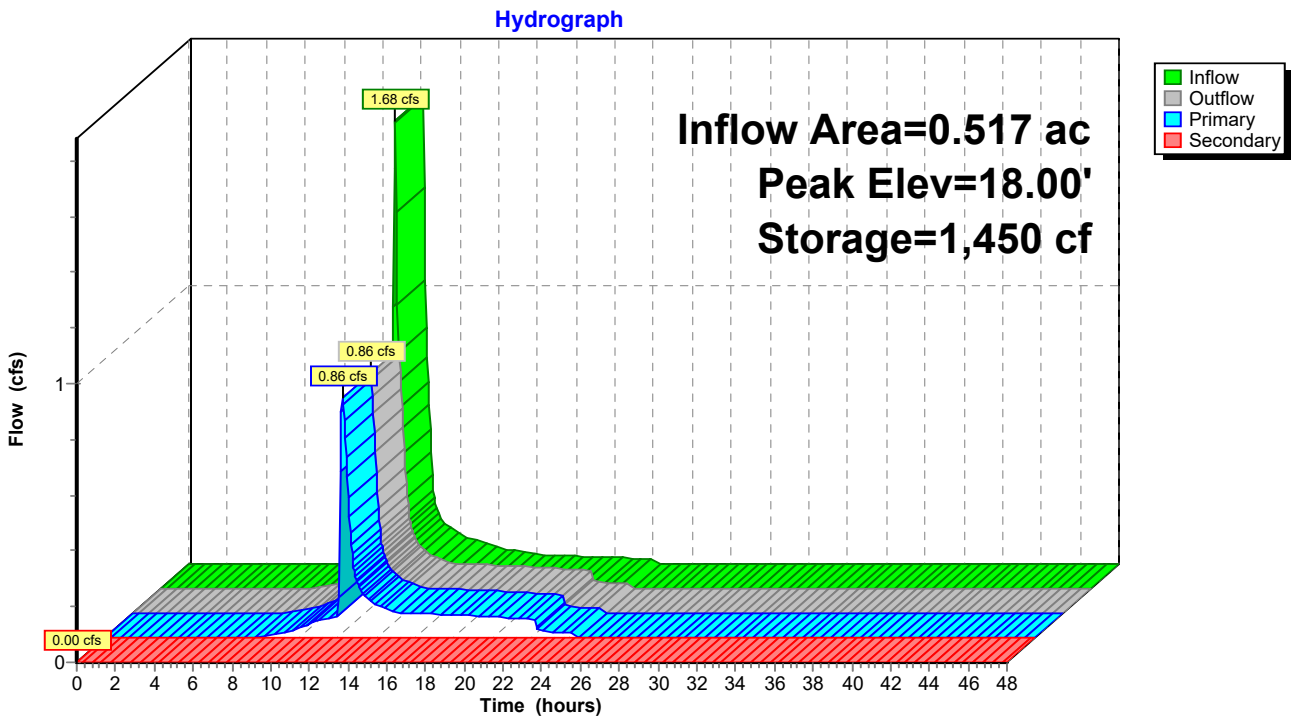
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
17.00	1,166	0	0
18.00	1,738	1,452	1,452
19.00	2,338	2,038	3,490

Device	Routing	Invert	Outlet Devices
#1	Primary	17.00'	**2.410 in/hr Flow Through Filter over Horizontal area**
#2	Secondary	18.50'	**10.0' 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
#3	Primary	17.75'	**12.0" Horiz. Infiltration Riser X 0.60** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=0.86 cfs @ 12.26 hrs HW=18.00' (Free Discharge)
└─**1=Flow Through Filter** (Exfiltration Controls 0.10 cfs)
└─**3=Infiltration Riser** (Weir Controls 0.76 cfs @ 0.98 fps)

Secondary OutFlow Max=0.00 cfs @ 0.00 hrs HW=17.00' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond 2S-A: Bioretention - Ponding



Summary for Pond 2S-B: Subsurface Infiltration System #2

Inflow Area =	1.639 ac, 22.10% Impervious, Inflow Depth = 2.46" for 10-Year event				
Inflow =	3.87 cfs @	12.11 hrs,	Volume=	0.336 af	
Outflow =	1.84 cfs @	12.43 hrs,	Volume=	0.336 af,	Atten= 53%, Lag= 19.6 min
Discarded =	0.08 cfs @	10.80 hrs,	Volume=	0.117 af	
Primary =	1.76 cfs @	12.43 hrs,	Volume=	0.219 af	

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 15.05' @ 12.43 hrs Surf.Area= 3,311 sf Storage= 4,656 cf

Plug-Flow detention time= 108.3 min calculated for 0.336 af (100% of inflow)
Center-of-Mass det. time= 108.5 min (947.3 - 838.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	13.00'	2,981 cf	**44.25'W x 74.82'L x 3.50'H Field A** 11,587 cf Overall - 4,135 cf Embedded = 7,453 cf x 40.0% Voids
#2A	13.50'	4,135 cf	**ADS_StormTech SC-740 +Cap** x 90 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 9 Rows of 10 Chambers
		7,116 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	13.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Device 5	16.00'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Device 5	13.70'	**6.0" Vert. Orifice/Grate** C= 0.600
#4	Device 5	14.50'	**8.0" Vert. Orifice/Grate** C= 0.600
#5	Primary	13.50'	**15.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 13.50' / 13.10' S= 0.0080 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 1.23 sf

Discarded OutFlow Max=0.08 cfs @ 10.80 hrs HW=13.04' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=1.75 cfs @ 12.43 hrs HW=15.04' (Free Discharge)
└─**5=Culvert** (Passes 1.75 cfs of 4.37 cfs potential flow)
  ├─**2=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)
  ├─**3=Orifice/Grate** (Orifice Controls 0.99 cfs @ 5.03 fps)
  └─**4=Orifice/Grate** (Orifice Controls 0.76 cfs @ 2.51 fps)

Pond 2S-B: Subsurface Infiltration System #2 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

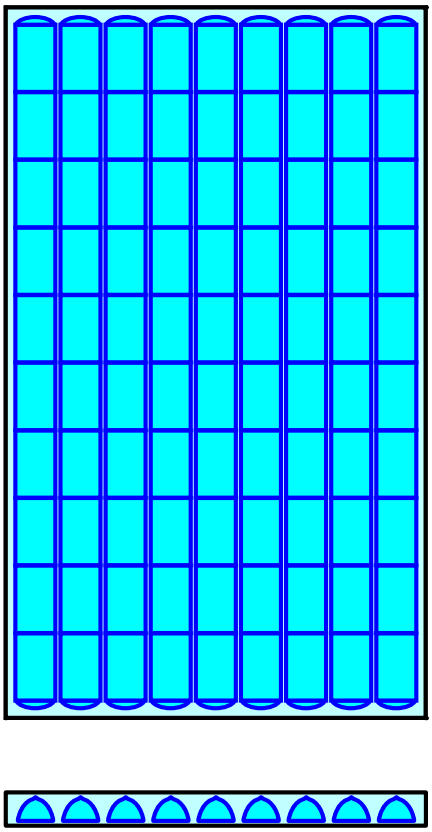
10 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 72.82' Row Length +12.0" End Stone x 2 = 74.82' Base Length
9 Rows x 51.0" Wide + 6.0" Spacing x 8 + 12.0" Side Stone x 2 = 44.25' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

90 Chambers x 45.9 cf = 4,134.6 cf Chamber Storage

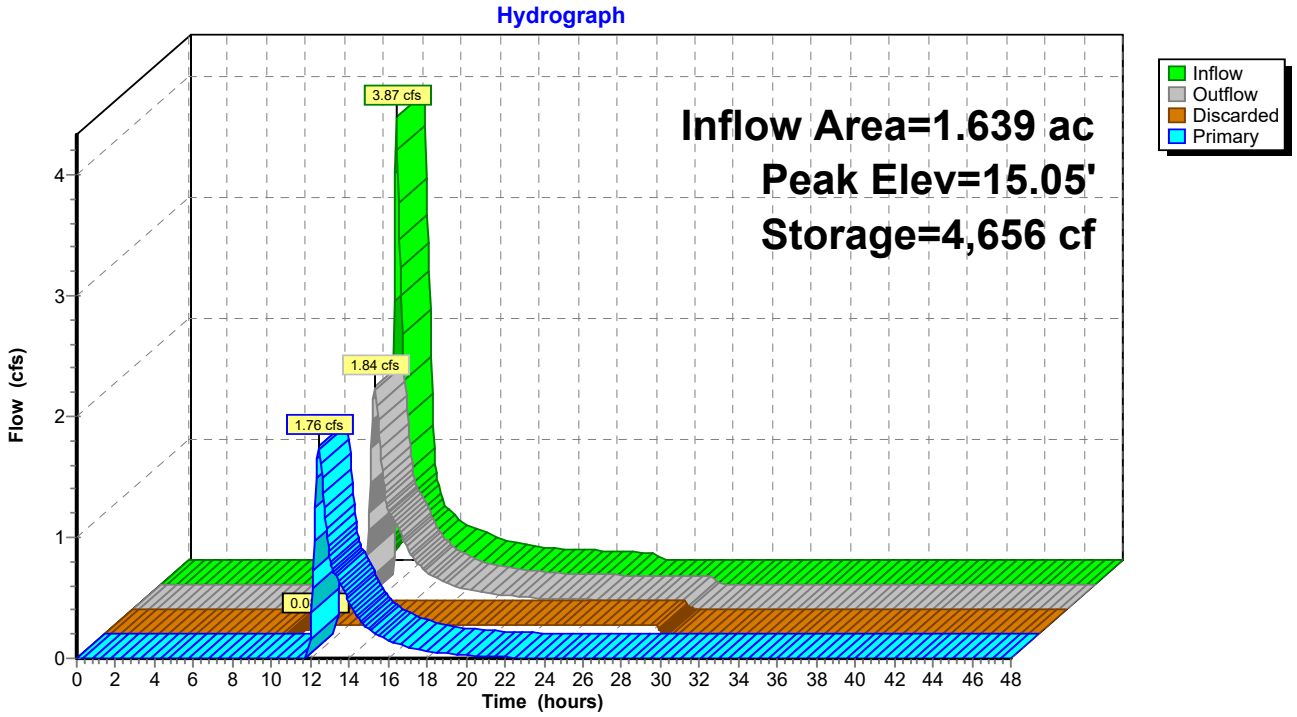
11,587.2 cf Field - 4,134.6 cf Chambers = 7,452.6 cf Stone x 40.0% Voids = 2,981.1 cf Stone Storage

Chamber Storage + Stone Storage = 7,115.7 cf = 0.163 af
Overall Storage Efficiency = 61.4%
Overall System Size = 74.82' x 44.25' x 3.50'

90 Chambers
429.2 cy Field
276.0 cy Stone



Pond 2S-B: Subsurface Infiltration System #2



Summary for Pond 6P: Subsurface Storage

Inflow Area = 0.517 ac, 53.05% Impervious, Inflow Depth = 2.84" for 10-Year event
Inflow = 0.86 cfs @ 12.26 hrs, Volume= 0.122 af
Outflow = 0.56 cfs @ 12.52 hrs, Volume= 0.122 af, Atten= 35%, Lag= 15.7 min
Discarded = 0.06 cfs @ 10.80 hrs, Volume= 0.073 af
Primary = 0.50 cfs @ 12.52 hrs, Volume= 0.050 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 13.85' @ 12.52 hrs Surf.Area= 2,338 sf Storage= 798 cf

Plug-Flow detention time= 75.4 min calculated for 0.122 af (100% of inflow)
Center-of-Mass det. time= 75.4 min (984.1 - 908.6)

Volume	Invert	Avail.Storage	Storage Description
#1	13.00'	1,403 cf	**Stone Under Basin (Prismatic)** Listed below (Recalc) 3,507 cf Overall x 40.0% Voids

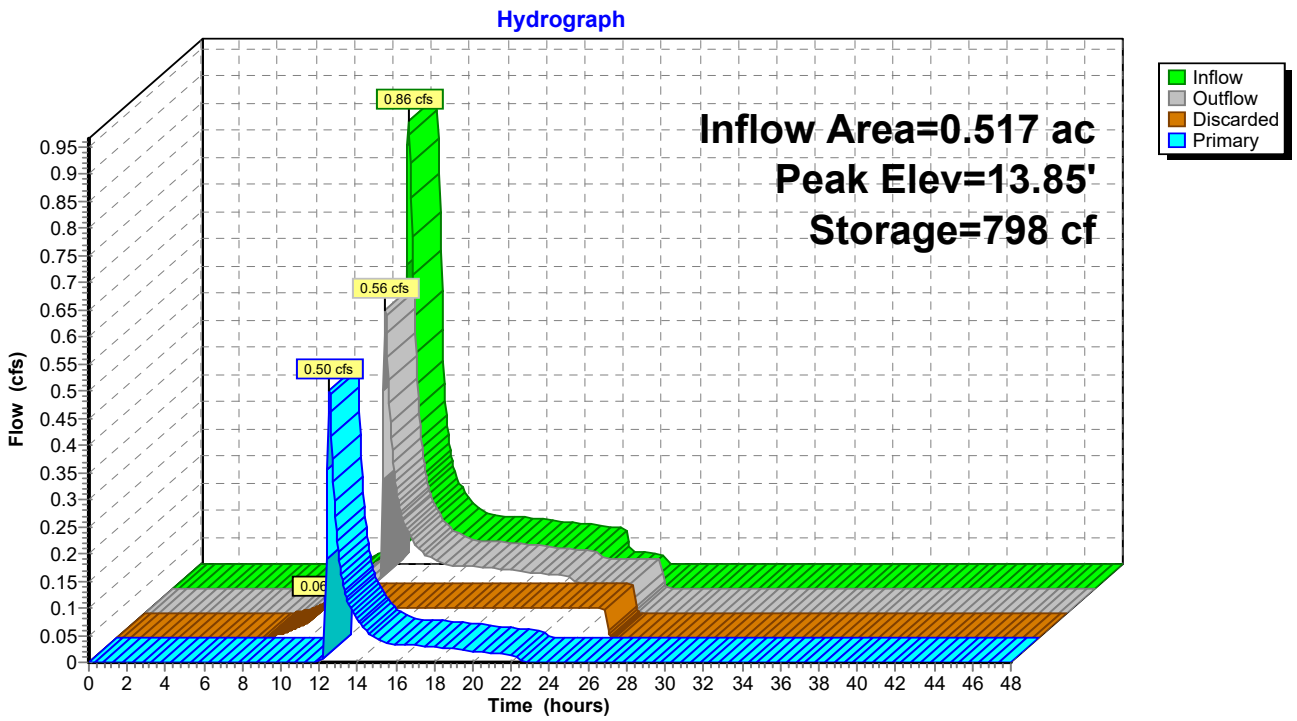
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
13.00	2,338	0	0
14.50	2,338	3,507	3,507

Device	Routing	Invert	Outlet Devices
#1	Discarded	13.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	13.50'	**12.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.06 cfs @ 10.80 hrs HW=13.02' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.06 cfs)

Primary OutFlow Max=0.50 cfs @ 12.52 hrs HW=13.85' (Free Discharge)
└─**2=Orifice/Grate** (Orifice Controls 0.50 cfs @ 2.02 fps)

Pond 6P: Subsurface Storage



Summary for Pond IB1: Infiltration Basin 1

Inflow Area = 0.764 ac, 7.29% Impervious, Inflow Depth = 2.84" for 10-Year event
Inflow = 2.49 cfs @ 12.09 hrs, Volume= 0.181 af
Outflow = 1.76 cfs @ 12.18 hrs, Volume= 0.174 af, Atten= 29%, Lag= 5.0 min
Primary = 1.76 cfs @ 12.18 hrs, Volume= 0.174 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 31.90' @ 12.18 hrs Surf.Area= 1,326 sf Storage= 999 cf

Plug-Flow detention time= 38.9 min calculated for 0.174 af (96% of inflow)
Center-of-Mass det. time= 17.9 min (838.4 - 820.5)

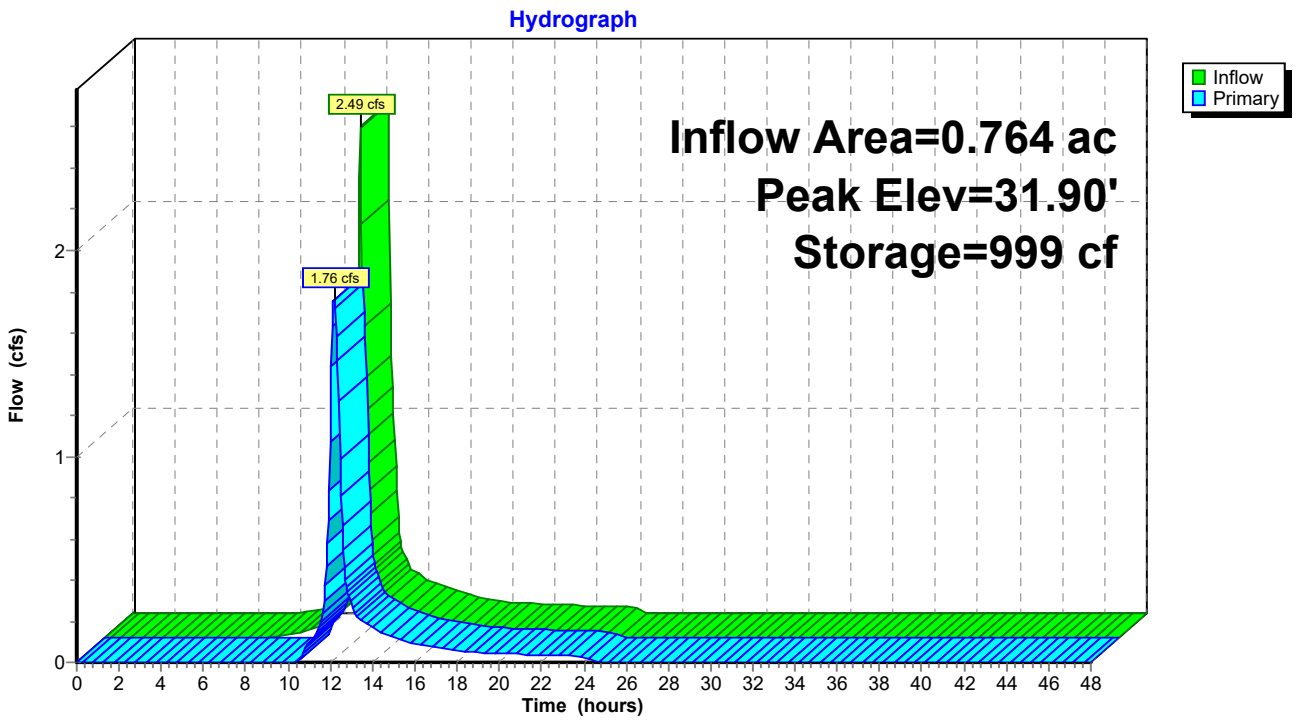
Volume	Invert	Avail.Storage	Storage Description
#1	31.00'	4,992 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
31.00	902	133.0	0	0	902
32.00	1,377	157.0	1,131	1,131	1,475
33.00	1,908	178.0	1,635	2,766	2,059
34.00	2,558	199.0	2,225	4,992	2,716

Device	Routing	Invert	Outlet Devices
#1	Primary	31.30'	**12.0" Horiz. Orifice/Grate X 0.60** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=1.75 cfs @ 12.18 hrs HW=31.90' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 1.75 cfs @ 2.23 fps)

Pond IB1: Infiltration Basin 1



Time span=0.00-48.00 hrs, dt=0.05 hrs, 961 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment1A: PR-1A Runoff Area=61,199 sf 9.62% Impervious Runoff Depth=4.54"
Flow Length=135' Tc=6.6 min CN=64 Runoff=7.22 cfs 0.532 af

Subcatchment1B: PR-1B Runoff Area=47,277 sf 17.48% Impervious Runoff Depth=4.91"
Flow Length=1,689' Tc=23.3 min CN=67 Runoff=3.94 cfs 0.444 af

Subcatchment1C: PR-1C Runoff Area=22,519 sf 53.05% Impervious Runoff Depth=6.63"
Tc=6.0 min CN=81 Runoff=3.83 cfs 0.286 af

Subcatchment1D: PR-1D Runoff Area=38,129 sf 35.02% Impervious Runoff Depth=5.77"
Tc=6.0 min CN=74 Runoff=5.77 cfs 0.421 af

Subcatchment2A: PR-2A Runoff Area=293,625 sf 4.21% Impervious Runoff Depth=3.81"
Flow Length=347' Tc=15.3 min CN=58 Runoff=22.14 cfs 2.140 af

Subcatchment2B: PR-2B Runoff Area=41,460 sf 42.97% Impervious Runoff Depth=6.76"
Flow Length=153' Tc=6.3 min CN=82 Runoff=7.11 cfs 0.536 af

Subcatchment3A: PR-3A Runoff Area=59,328 sf 23.32% Impervious Runoff Depth=5.28"
Flow Length=140' Tc=13.0 min CN=70 Runoff=6.66 cfs 0.600 af

Subcatchment3B: PR-3B Runoff Area=31,260 sf 41.03% Impervious Runoff Depth=6.02"
Tc=6.0 min CN=76 Runoff=4.91 cfs 0.360 af

Subcatchment3C: PR-3C Runoff Area=13,432 sf 71.85% Impervious Runoff Depth=7.49"
Tc=6.0 min CN=88 Runoff=2.49 cfs 0.192 af

Subcatchment4A: PR-4A Runoff Area=33,278 sf 7.29% Impervious Runoff Depth=6.63"
Tc=6.0 min CN=81 Runoff=5.66 cfs 0.422 af

Subcatchment4B: PR-Building Runoff Area=40,287 sf 100.00% Impervious Runoff Depth=8.70"
Tc=6.0 min CN=98 Runoff=7.93 cfs 0.671 af

Subcatchment4C: PR-4C Runoff Area=293,843 sf 0.26% Impervious Runoff Depth=3.44"
Tc=6.0 min CN=55 Runoff=26.12 cfs 1.936 af

Subcatchment4D: PR-4D Runoff Area=13,538 sf 0.00% Impervious Runoff Depth=4.30"
Tc=6.0 min CN=62 Runoff=1.53 cfs 0.111 af

Subcatchment4E: PR-4E Runoff Area=108,777 sf 0.00% Impervious Runoff Depth=4.42"
Flow Length=377' Tc=9.2 min CN=63 Runoff=11.37 cfs 0.920 af

Subcatchment4F: PR-4F Runoff Area=5,747 sf 0.00% Impervious Runoff Depth=6.51"
Tc=6.0 min CN=80 Runoff=0.96 cfs 0.072 af

Reach DP1: DP-1 (BVW) Inflow=17.94 cfs 1.864 af
Outflow=17.94 cfs 1.864 af

Reach DP2: DP-2 (SOUTH BEACH) Inflow=43.63 cfs 4.540 af
Outflow=43.63 cfs 4.540 af

Reach DP3: DP-3 (EX PIPE TO NORTH) Inflow=12.03 cfs 1.031 af
Outflow=12.03 cfs 1.031 af

Reach DP4: DP-4 (EAST BEACH) Inflow=47.30 cfs 3.710 af
Outflow=47.30 cfs 3.710 af

Reach TS: OCEAN Inflow=97.48 cfs 9.281 af
Outflow=97.48 cfs 9.281 af

Pond 1N: Subsurface Infiltration System #1 Peak Elev=15.33' Storage=0.088 af Inflow=4.91 cfs 0.360 af
Discarded=0.07 cfs 0.119 af Primary=3.56 cfs 0.239 af Outflow=3.63 cfs 0.358 af

Pond 2S-A: Bioretention - Ponding Peak Elev=18.56' Storage=2,526 cf Inflow=3.83 cfs 0.286 af
Primary=2.16 cfs 0.283 af Secondary=0.37 cfs 0.003 af Outflow=2.53 cfs 0.286 af

Pond 2S-B: Subsurface Infiltration System #2 Peak Elev=16.49' Storage=7,107 cf Inflow=8.37 cfs 0.837 af
Discarded=0.08 cfs 0.140 af Primary=7.21 cfs 0.697 af Outflow=7.29 cfs 0.837 af

Pond 6P: Subsurface Storage Peak Elev=14.29' Storage=1,211 cf Inflow=2.16 cfs 0.283 af
Discarded=0.06 cfs 0.095 af Primary=2.03 cfs 0.187 af Outflow=2.09 cfs 0.283 af

Pond IB1: Infiltration Basin 1 Peak Elev=32.99' Storage=2,739 cf Inflow=5.66 cfs 0.422 af
Outflow=2.95 cfs 0.416 af

Total Runoff Area = 25.337 ac Runoff Volume = 9.643 af Average Runoff Depth = 4.57"
86.46% Pervious = 21.907 ac 13.54% Impervious = 3.430 ac

Summary for Subcatchment 1A: PR-1A

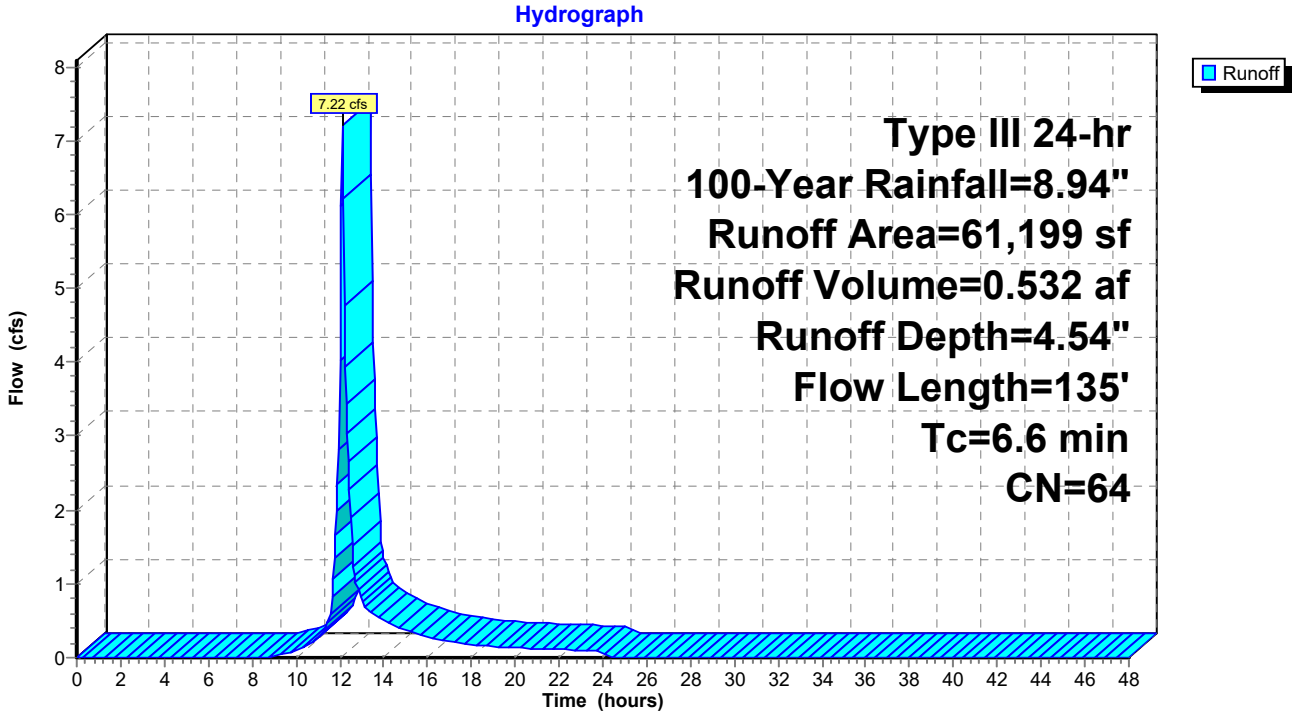
Runoff = 7.22 cfs @ 12.10 hrs, Volume= 0.532 af, Depth= 4.54"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
5,888	98	Paved parking, HSG B
5,753	85	Gravel roads, HSG B
16,513	61	>75% Grass cover, Good, HSG B
33,045	55	Woods, Good, HSG B
61,199	64	Weighted Average
55,311		90.38% Pervious Area
5,888		9.62% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.9	50	0.1300	0.21		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.17"
2.7	85	0.0110	0.52		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
6.6	135	Total			

Subcatchment 1A: PR-1A



Summary for Subcatchment 1B: PR-1B

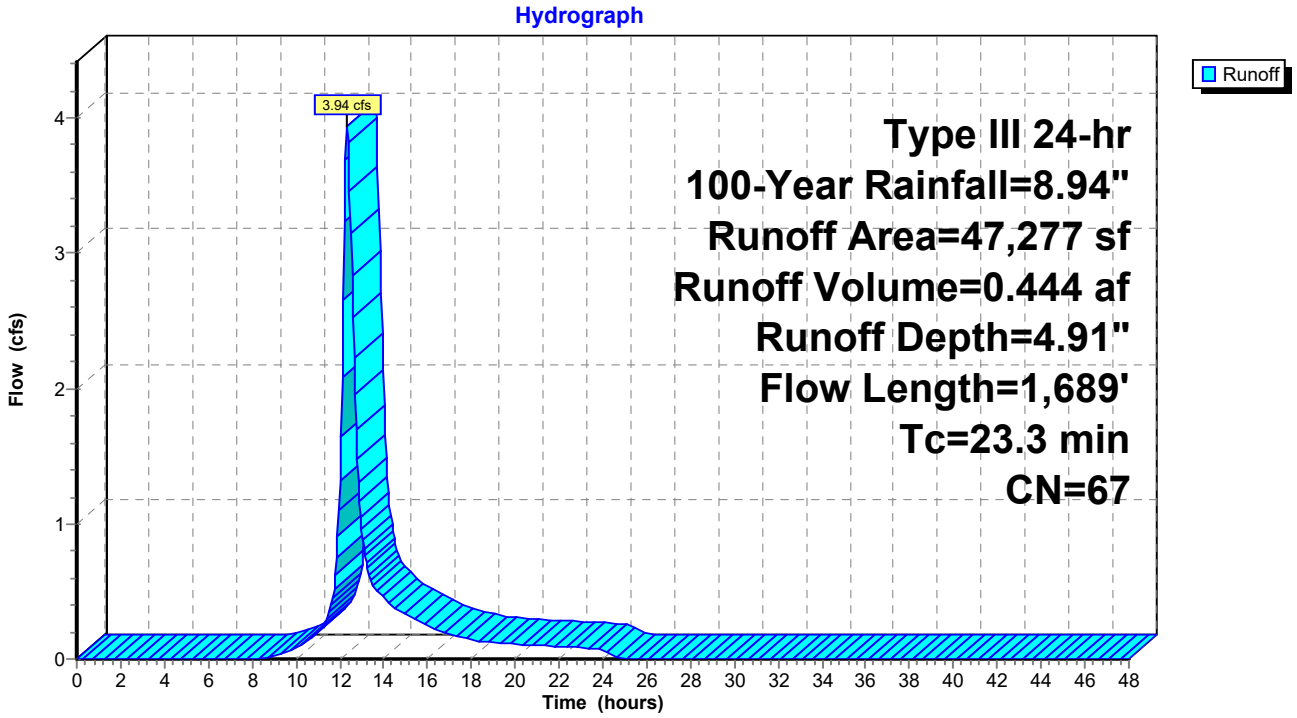
Runoff = 3.94 cfs @ 12.32 hrs, Volume= 0.444 af, Depth= 4.91"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
*	8,263	98	Pavement
	0	55	Woods, Good, HSG B
	39,014	61	>75% Grass cover, Good, HSG B
	47,277	67	Weighted Average
	39,014		82.52% Pervious Area
	8,263		17.48% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
3.7	50	0.4000	0.22		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.17"
0.1	16	0.2500	2.50		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
0.1	38	0.1300	7.32		**Shallow Concentrated Flow,** Paved Kv= 20.3 fps
19.4	1,585	0.0380	1.36		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
23.3	1,689	Total			

Subcatchment 1B: PR-1B



Summary for Subcatchment 1C: PR-1C

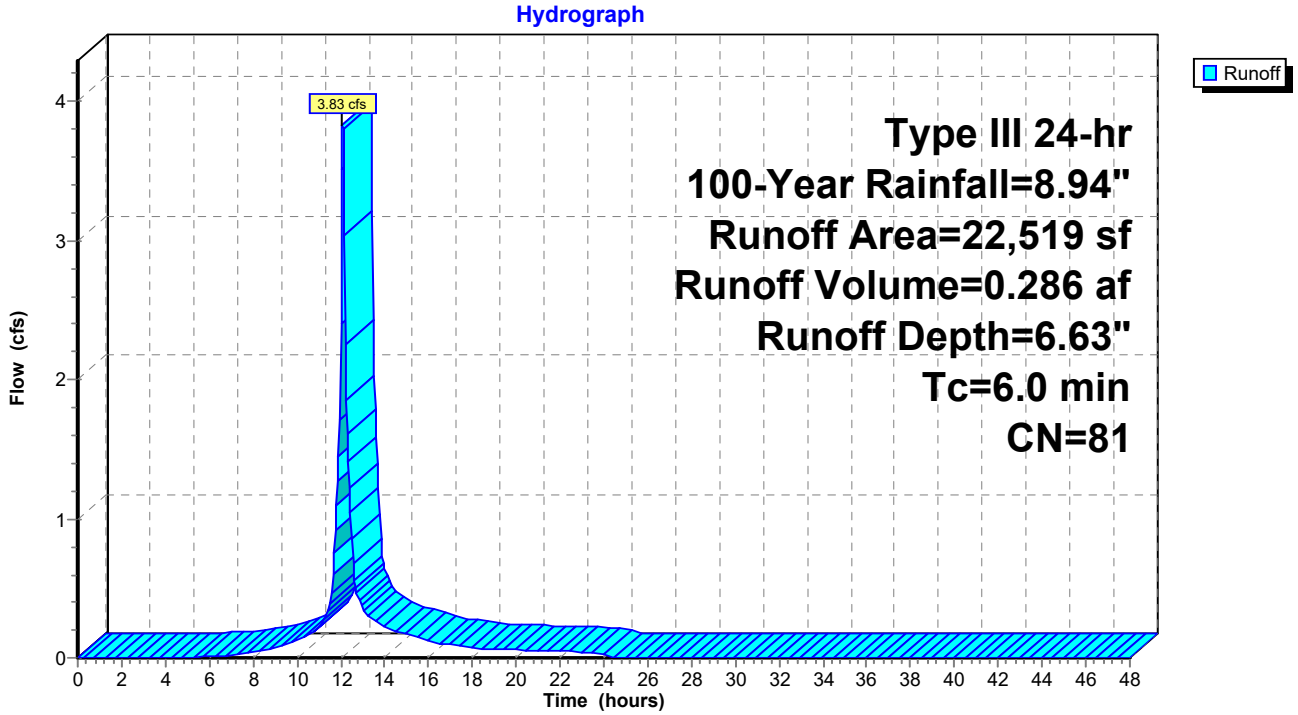
Runoff = 3.83 cfs @ 12.09 hrs, Volume= 0.286 af, Depth= 6.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
0	98	Unconnected roofs, HSG B
11,947	98	Paved parking, HSG B
10,572	61	>75% Grass cover, Good, HSG B
0	85	Gravel roads, HSG B
0	58	Meadow, non-grazed, HSG B
22,519	81	Weighted Average
10,572		46.95% Pervious Area
11,947		53.05% Impervious Area

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

Subcatchment 1C: PR-1C



Summary for Subcatchment 1D: PR-1D

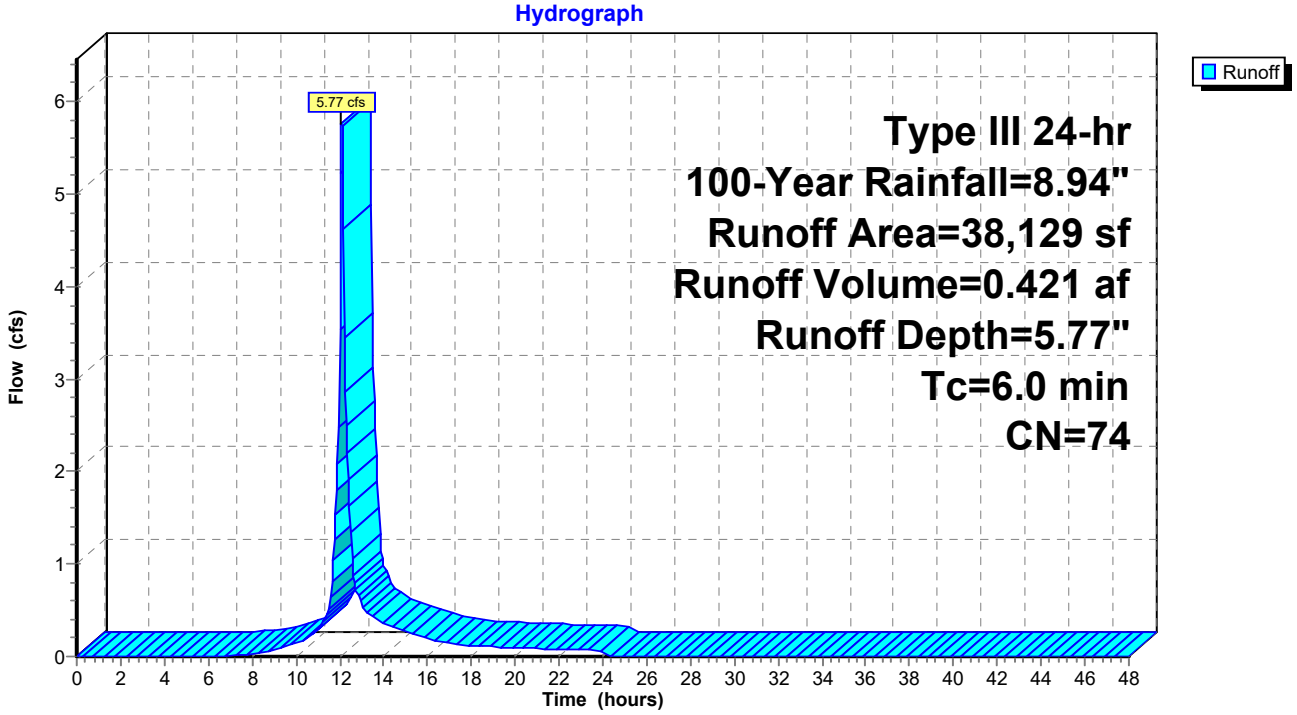
Runoff = 5.77 cfs @ 12.09 hrs, Volume= 0.421 af, Depth= 5.77"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
13,353	98	Paved parking, HSG B
24,776	61	>75% Grass cover, Good, HSG B
38,129	74	Weighted Average
24,776		64.98% Pervious Area
13,353		35.02% Impervious Area

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

Subcatchment 1D: PR-1D



Summary for Subcatchment 2A: PR-2A

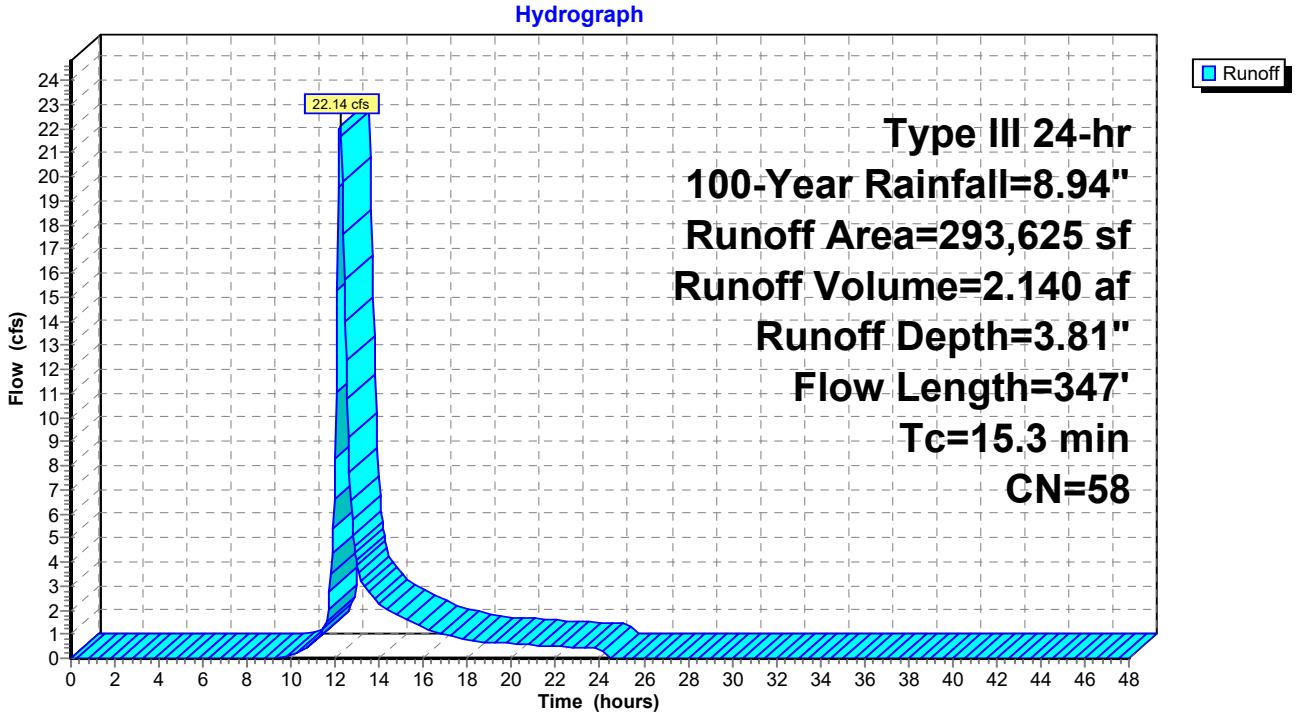
Runoff = 22.14 cfs @ 12.22 hrs, Volume= 2.140 af, Depth= 3.81"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
273,466	55	Woods, Good, HSG B
12,348	98	Paved parking, HSG B
7,811	85	Gravel roads, HSG B
293,625	58	Weighted Average
281,277		95.79% Pervious Area
12,348		4.21% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
12.4	50	0.0800	0.07		**Sheet Flow,** Woods: Dense underbrush n= 0.800 P2= 3.17"
2.9	297	0.1200	1.73		**Shallow Concentrated Flow,** Woodland Kv= 5.0 fps
15.3	347	Total			

Subcatchment 2A: PR-2A



Summary for Subcatchment 2B: PR-2B

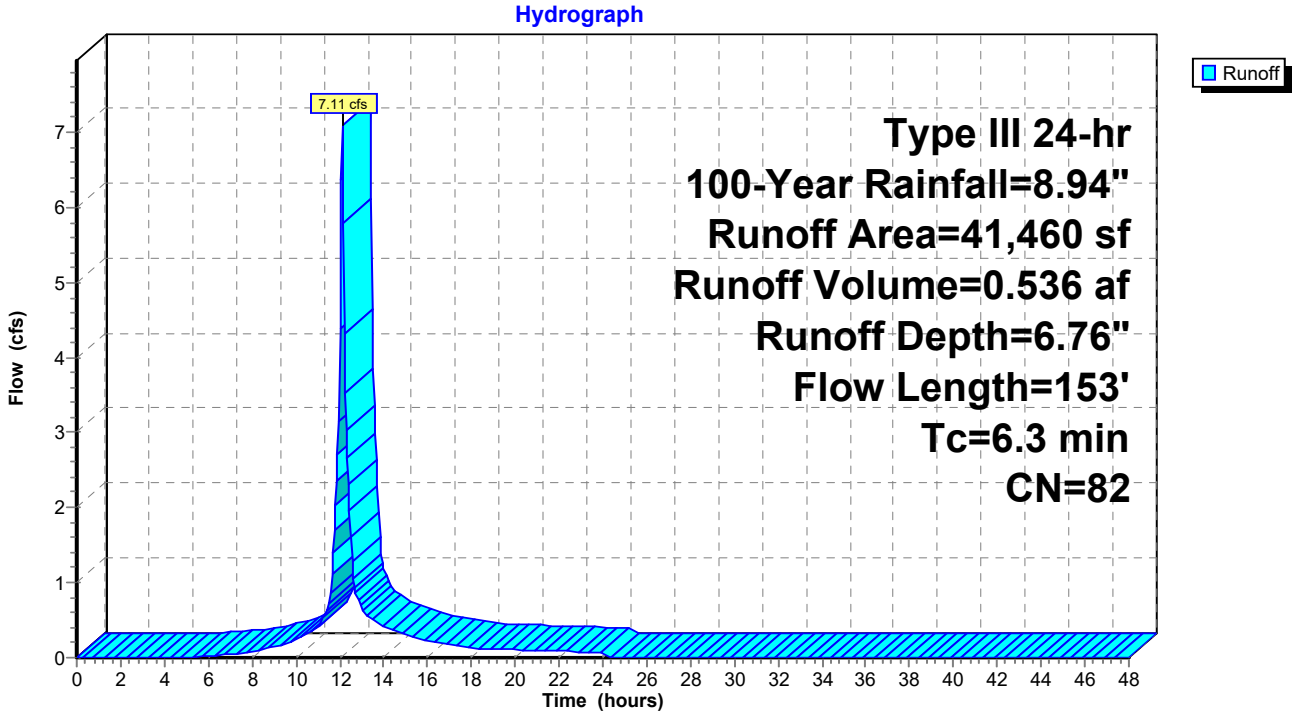
Runoff = 7.11 cfs @ 12.09 hrs, Volume= 0.536 af, Depth= 6.76"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
17,814	98	Unconnected roofs, HSG B
14,033	61	>75% Grass cover, Good, HSG B
9,613	85	Gravel roads, HSG B
41,460	82	Weighted Average
23,646		57.03% Pervious Area
17,814		42.97% Impervious Area
17,814		100.00% Unconnected

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.1	50	0.1200	0.14		**Sheet Flow,** Woods: Light underbrush n= 0.400 P2= 3.17"
0.2	103	0.2900	8.67		**Shallow Concentrated Flow,** Unpaved Kv= 16.1 fps
6.3	153	Total			

Subcatchment 2B: PR-2B



Summary for Subcatchment 3A: PR-3A

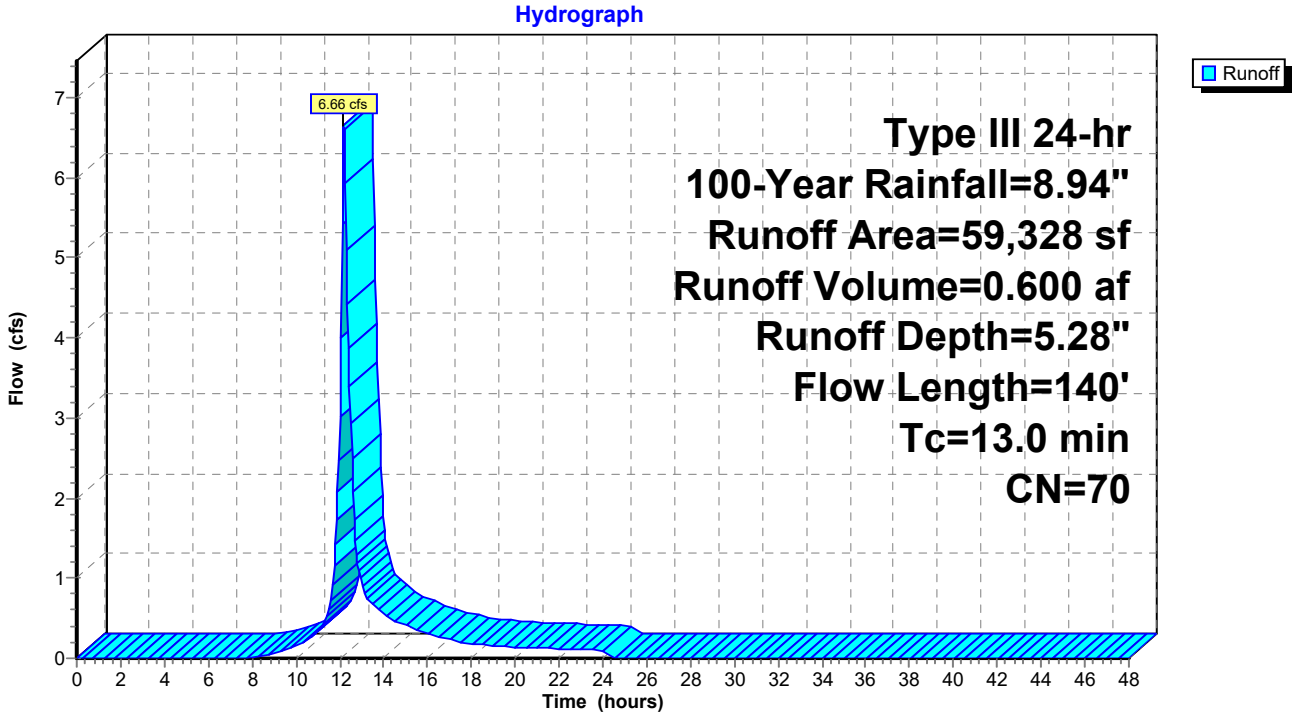
Runoff = 6.66 cfs @ 12.18 hrs, Volume= 0.600 af, Depth= 5.28"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
13,833	98	Paved parking, HSG B
12,046	61	>75% Grass cover, Good, HSG B
33,449	61	Pasture/grassland/range, Good, HSG B
59,328	70	Weighted Average
45,495		76.68% Pervious Area
13,833		23.32% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
6.2	50	0.0400	0.13		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.17"
6.8	90	0.0010	0.22		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
13.0	140	Total			

Subcatchment 3A: PR-3A



Summary for Subcatchment 3B: PR-3B

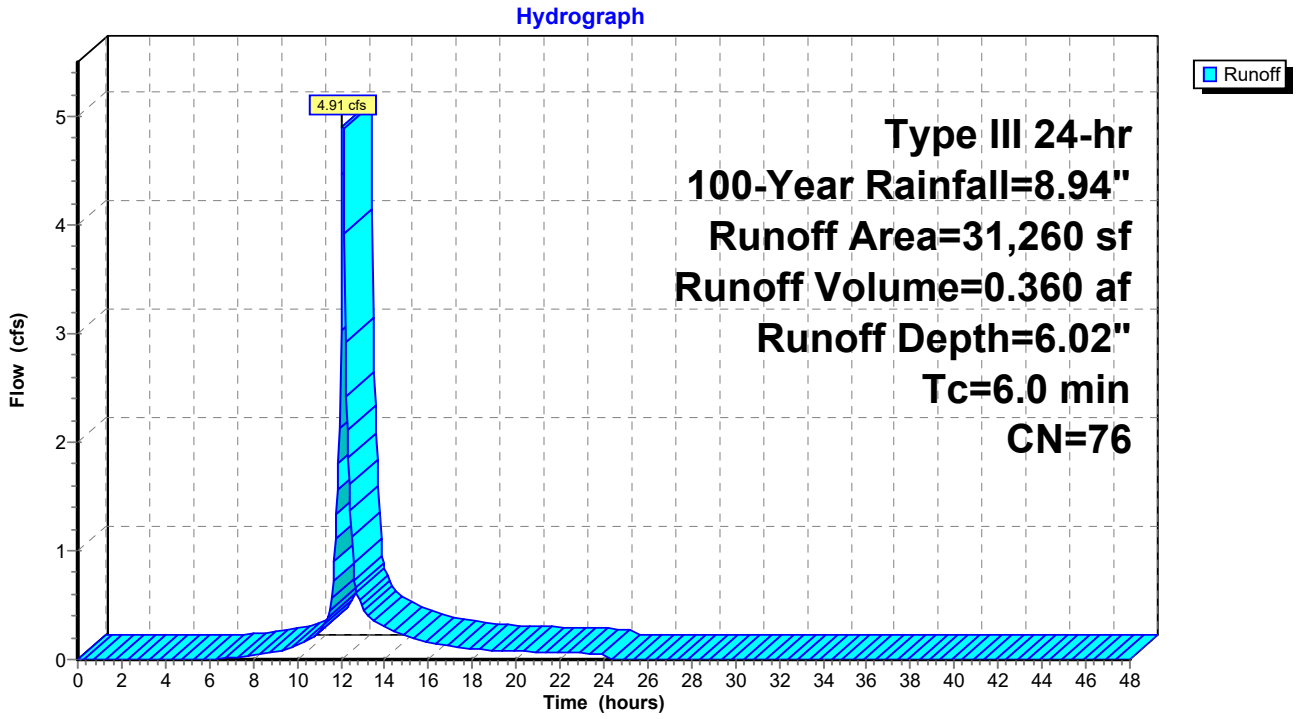
Runoff = 4.91 cfs @ 12.09 hrs, Volume= 0.360 af, Depth= 6.02"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
0	98	Unconnected roofs, HSG B
12,826	98	Paved parking, HSG B
18,434	61	>75% Grass cover, Good, HSG B
0	85	Gravel roads, HSG B
0	58	Meadow, non-grazed, HSG B
0	39	>75% Grass cover, Good, HSG A
31,260	76	Weighted Average
18,434		58.97% Pervious Area
12,826		41.03% Impervious Area

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

Subcatchment 3B: PR-3B



Summary for Subcatchment 3C: PR-3C

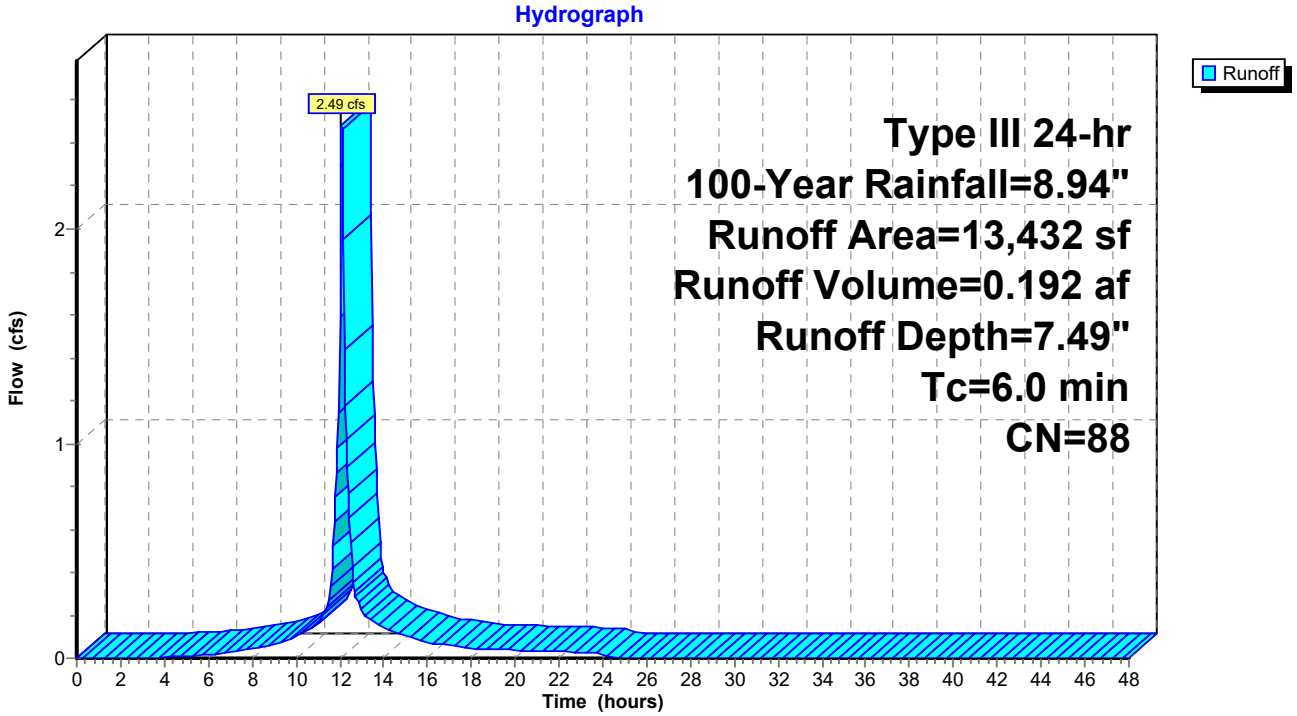
Runoff = 2.49 cfs @ 12.09 hrs, Volume= 0.192 af, Depth= 7.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
9,651	98	Unconnected pavement, HSG B
3,781	61	>75% Grass cover, Good, HSG B
13,432	88	Weighted Average
3,781		28.15% Pervious Area
9,651		71.85% Impervious Area
9,651		100.00% Unconnected

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

Subcatchment 3C: PR-3C



Summary for Subcatchment 4A: PR-4A

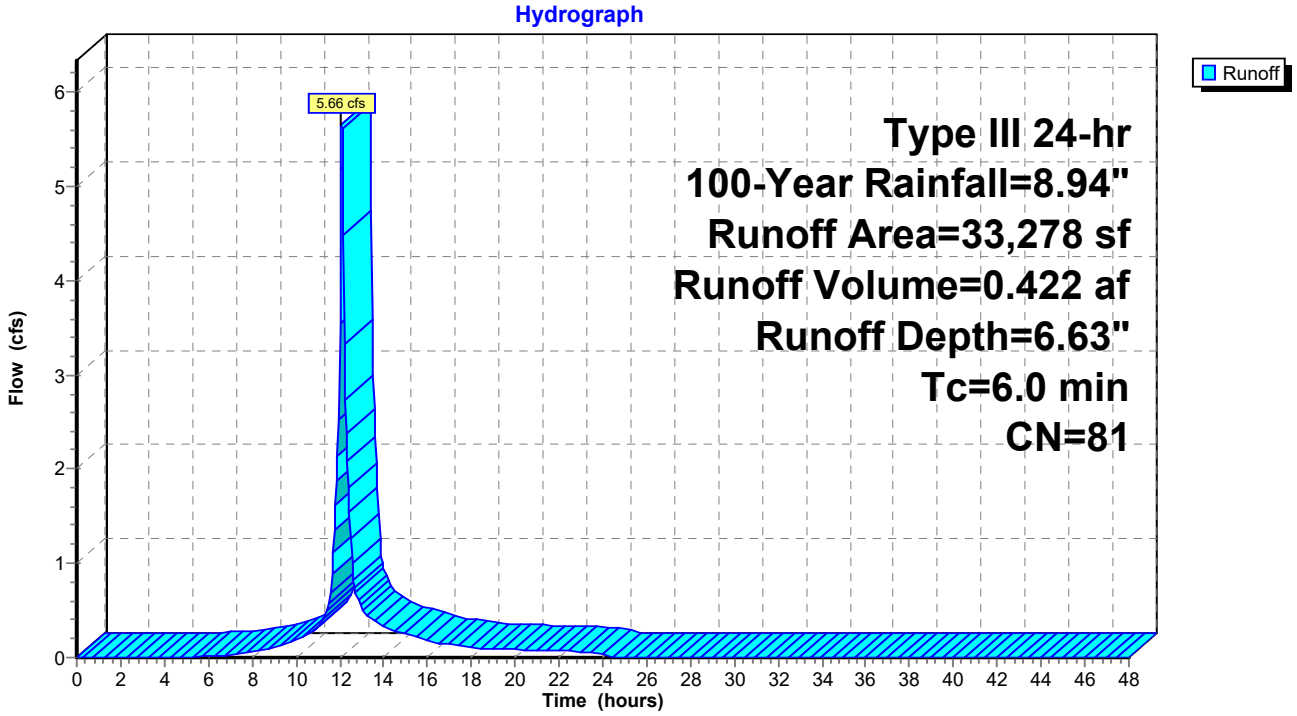
Runoff = 5.66 cfs @ 12.09 hrs, Volume= 0.422 af, Depth= 6.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

	Area (sf)	CN	Description
	0	98	Roofs, HSG D
*	2,426	98	Paved parking, HSG D
	30,281	80	>75% Grass cover, Good, HSG D
	571	85	Gravel roads, HSG B
	33,278	81	Weighted Average
	30,852		92.71% Pervious Area
	2,426		7.29% Impervious Area

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

Subcatchment 4A: PR-4A



Summary for Subcatchment 4B: PR-Building

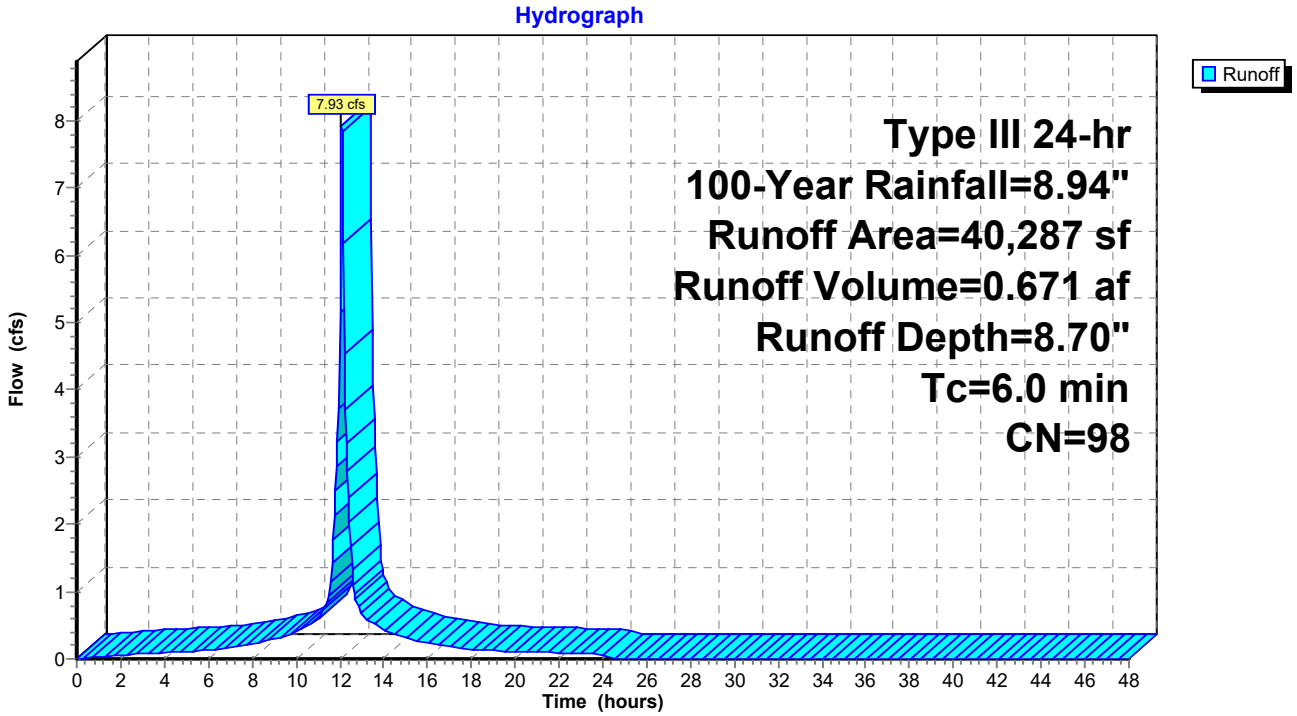
Runoff = 7.93 cfs @ 12.09 hrs, Volume= 0.671 af, Depth= 8.70"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
40,287	98	Unconnected roofs, HSG B
40,287		100.00% Impervious Area
40,287		100.00% Unconnected

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

Subcatchment 4B: PR-Building



Summary for Subcatchment 4C: PR-4C

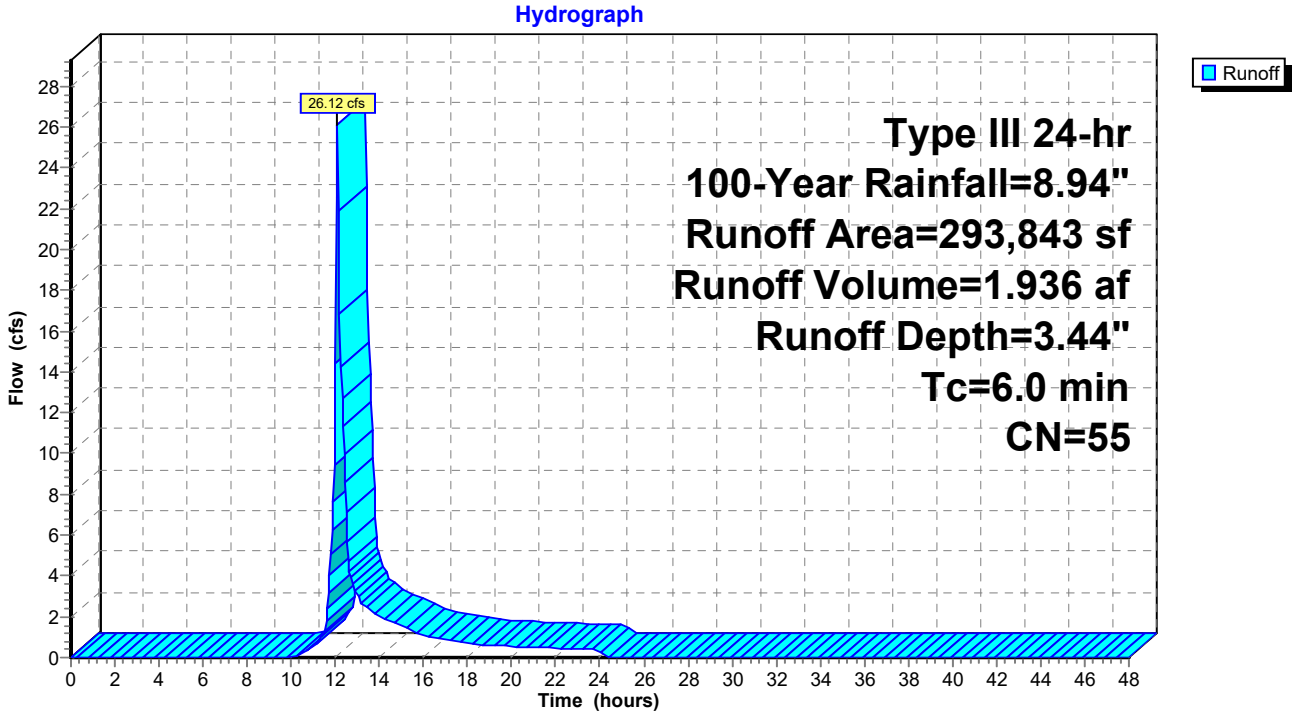
Runoff = 26.12 cfs @ 12.10 hrs, Volume= 1.936 af, Depth= 3.44"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
774	98	Unconnected pavement, HSG B
291,213	55	Woods, Good, HSG B
1,856	85	Gravel roads, HSG B
293,843	55	Weighted Average
293,069		99.74% Pervious Area
774		0.26% Impervious Area
774		100.00% Unconnected

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

Subcatchment 4C: PR-4C



Summary for Subcatchment 4D: PR-4D

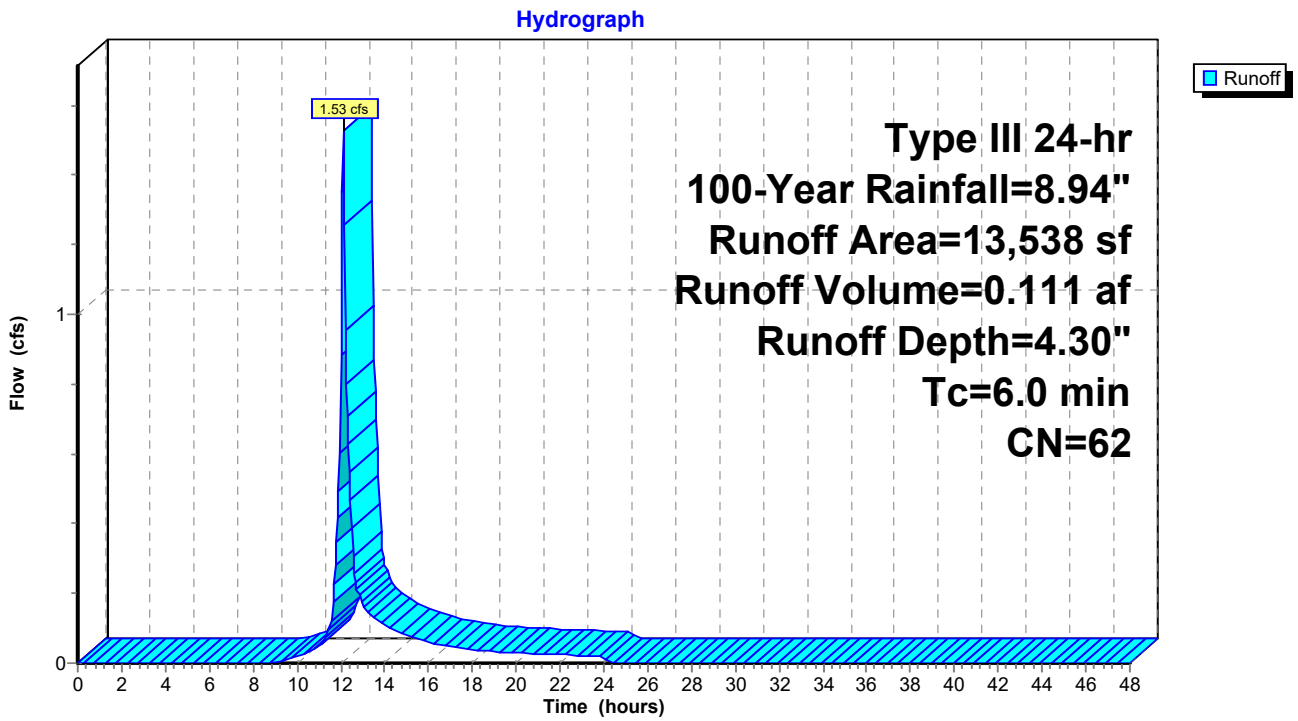
Runoff = 1.53 cfs @ 12.09 hrs, Volume= 0.111 af, Depth= 4.30"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
12,699	61	>75% Grass cover, Good, HSG B
839	85	Gravel roads, HSG B
13,538	62	Weighted Average
13,538		100.00% Pervious Area

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

Subcatchment 4D: PR-4D



Summary for Subcatchment 4E: PR-4E

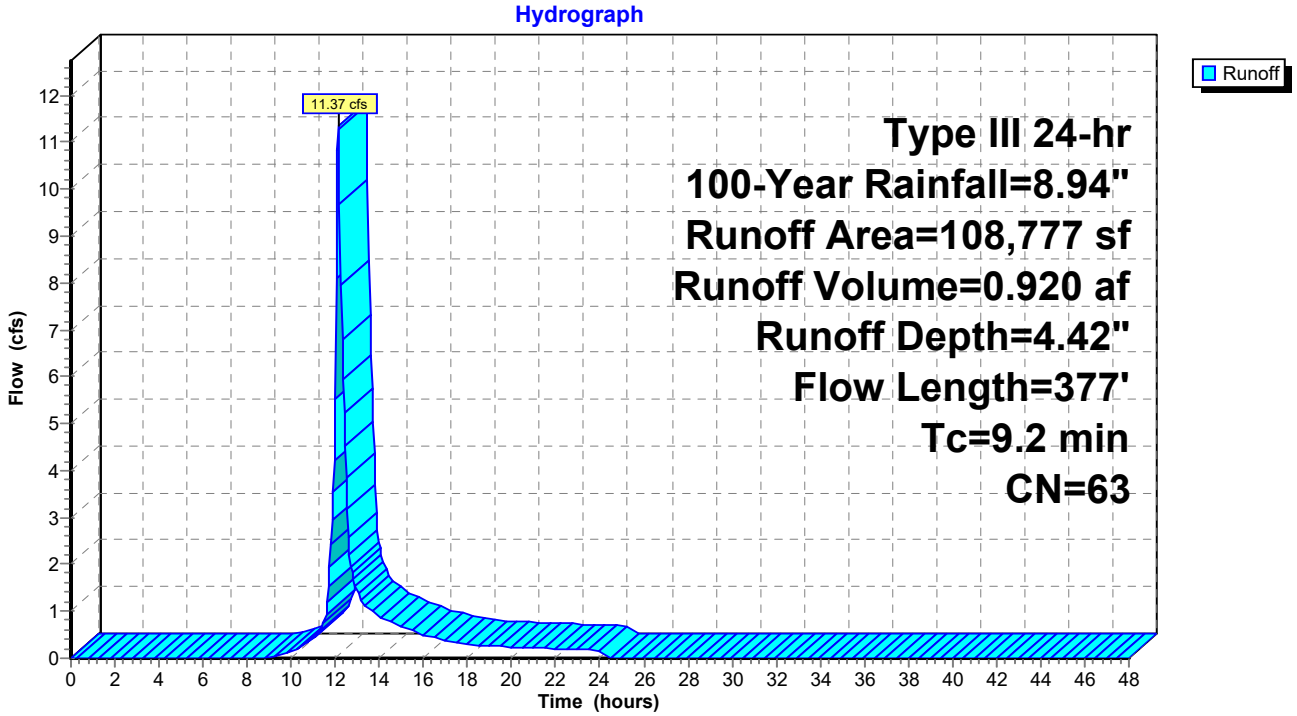
Runoff = 11.37 cfs @ 12.14 hrs, Volume= 0.920 af, Depth= 4.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
101,639	61	>75% Grass cover, Good, HSG B
7,138	85	Gravel roads, HSG B
108,777	63	Weighted Average
108,777		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
5.3	50	0.0600	0.16		**Sheet Flow,** Grass: Dense n= 0.240 P2= 3.17"
3.9	327	0.0390	1.38		**Shallow Concentrated Flow,** Short Grass Pasture Kv= 7.0 fps
9.2	377	Total			

Subcatchment 4E: PR-4E



Summary for Subcatchment 4F: PR-4F

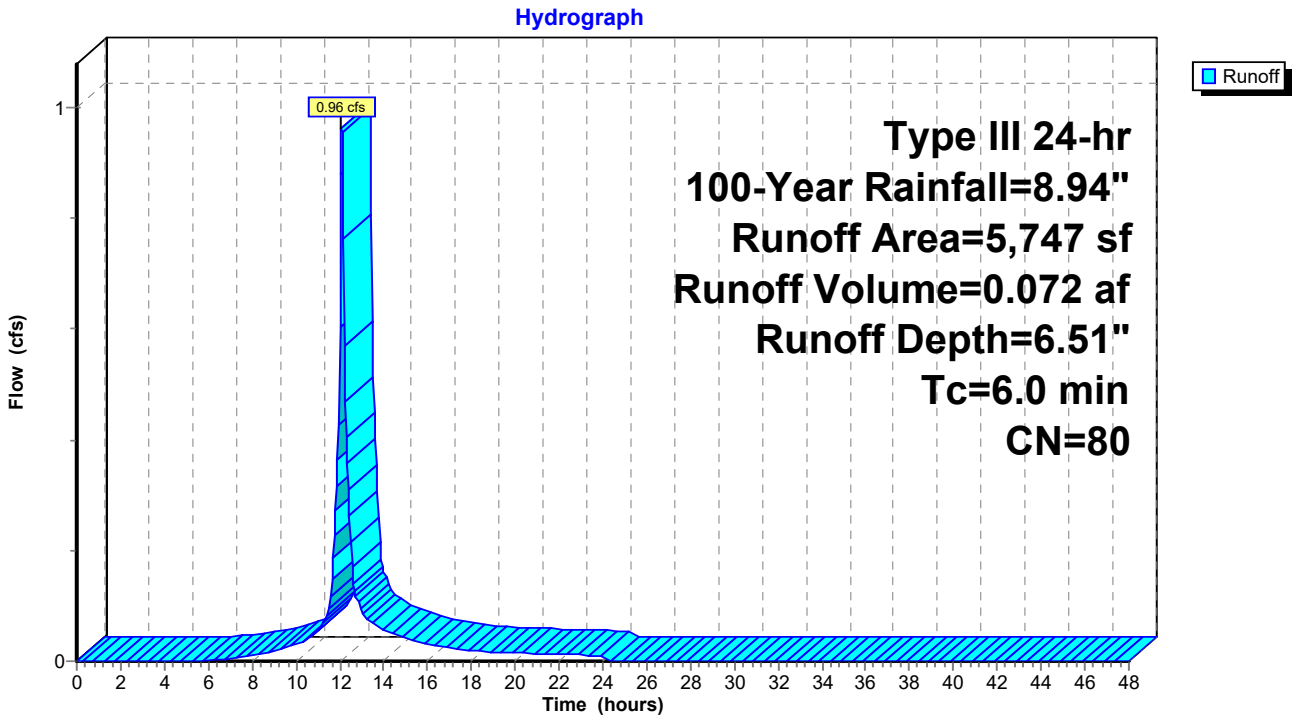
Runoff = 0.96 cfs @ 12.09 hrs, Volume= 0.072 af, Depth= 6.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Type III 24-hr 100-Year Rainfall=8.94"

Area (sf)	CN	Description
5,747	80	>75% Grass cover, Good, HSG D
5,747		100.00% Pervious Area

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

Subcatchment 4F: PR-4F



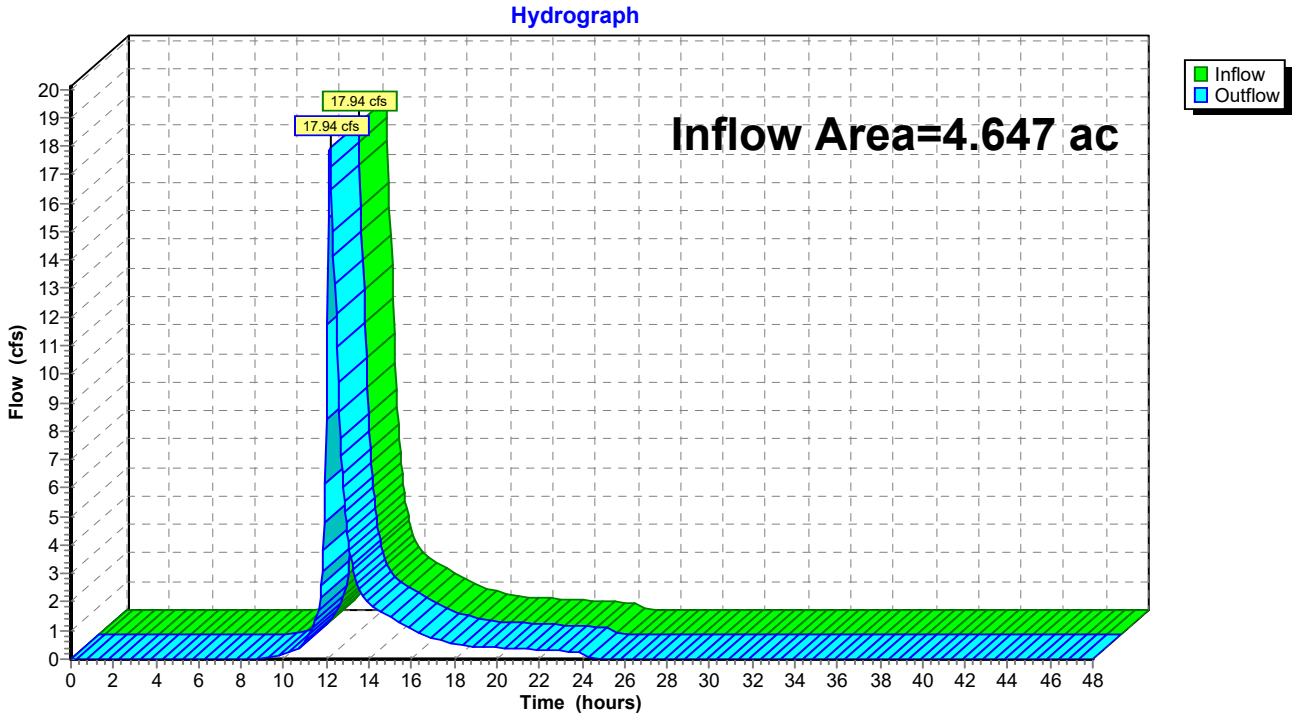
Summary for Reach DP1: DP-1 (BVW)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 4.647 ac, 20.69% Impervious, Inflow Depth = 4.81" for 100-Year event
Inflow = 17.94 cfs @ 12.17 hrs, Volume= 1.864 af
Outflow = 17.94 cfs @ 12.17 hrs, Volume= 1.864 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DP1: DP-1 (BVW)



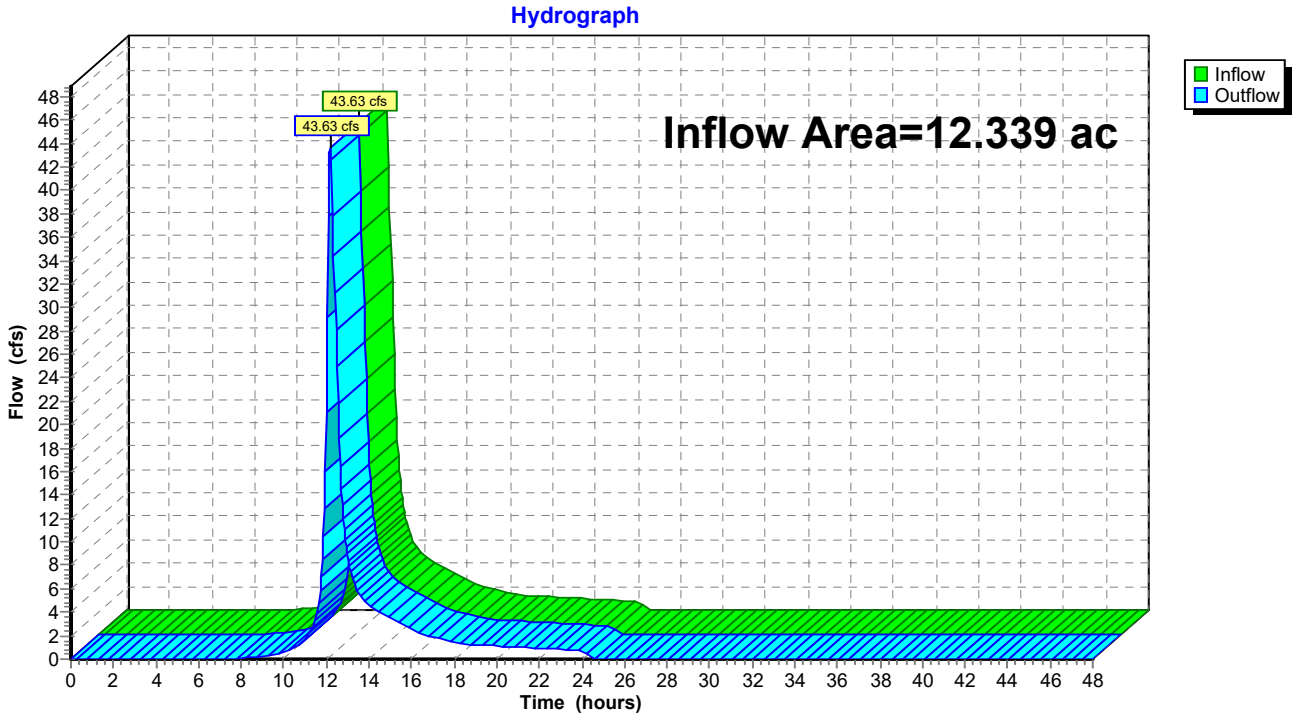
Summary for Reach DP2: DP-2 (SOUTH BEACH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 12.339 ac, 13.40% Impervious, Inflow Depth = 4.42" for 100-Year event
Inflow = 43.63 cfs @ 12.18 hrs, Volume= 4.540 af
Outflow = 43.63 cfs @ 12.18 hrs, Volume= 4.540 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DP2: DP-2 (SOUTH BEACH)



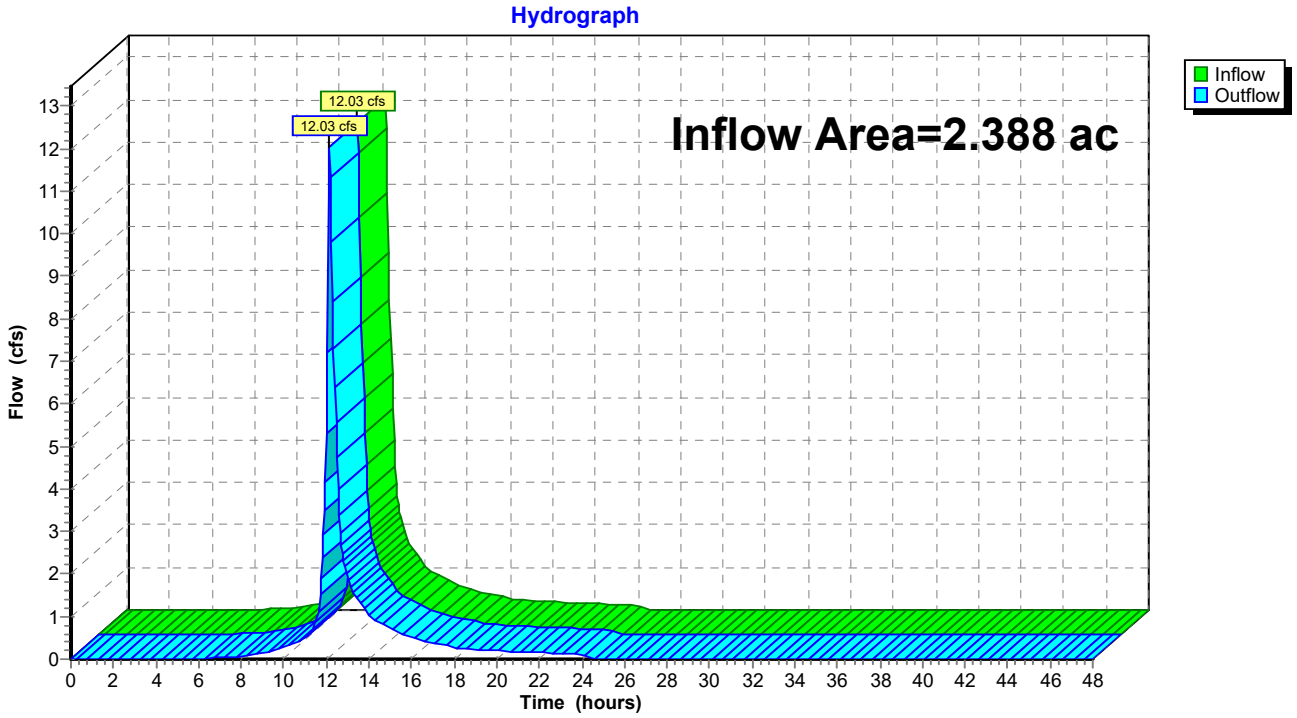
Summary for Reach DP3: DP-3 (EX PIPE TO NORTH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 2.388 ac, 34.91% Impervious, Inflow Depth = 5.18" for 100-Year event
Inflow = 12.03 cfs @ 12.16 hrs, Volume= 1.031 af
Outflow = 12.03 cfs @ 12.16 hrs, Volume= 1.031 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DP3: DP-3 (EX PIPE TO NORTH)



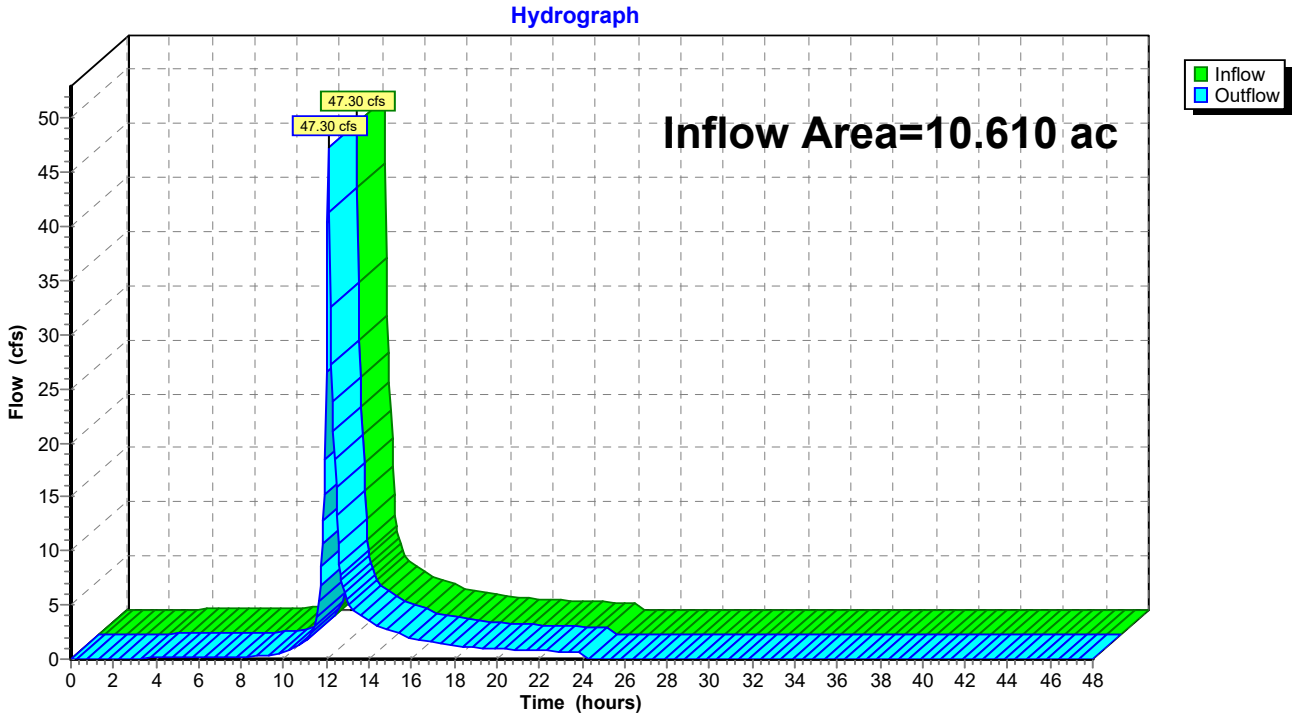
Summary for Reach DP4: DP-4 (EAST BEACH)

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 10.610 ac, 8.88% Impervious, Inflow Depth = 4.20" for 100-Year event
Inflow = 47.30 cfs @ 12.10 hrs, Volume= 3.710 af
Outflow = 47.30 cfs @ 12.10 hrs, Volume= 3.710 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach DP4: DP-4 (EAST BEACH)



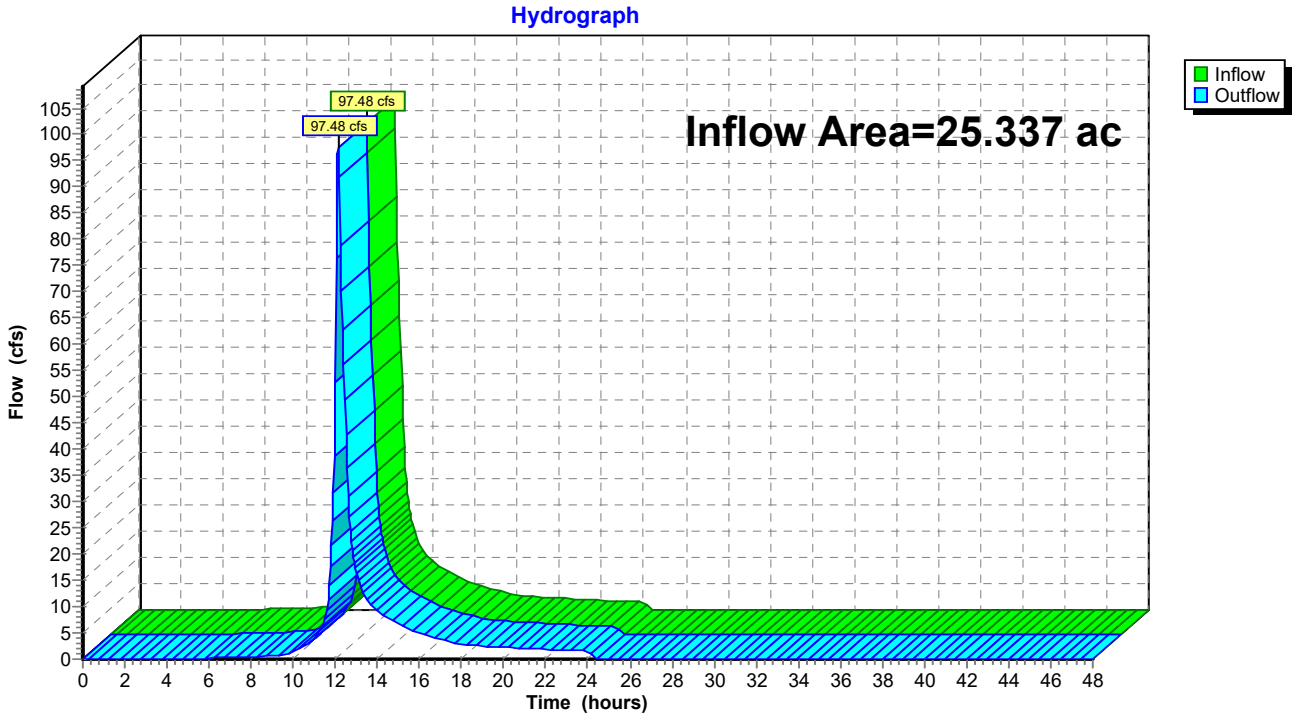
Summary for Reach TS: OCEAN

[40] Hint: Not Described (Outflow=Inflow)

Inflow Area = 25.337 ac, 13.54% Impervious, Inflow Depth = 4.40" for 100-Year event
Inflow = 97.48 cfs @ 12.13 hrs, Volume= 9.281 af
Outflow = 97.48 cfs @ 12.13 hrs, Volume= 9.281 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs

Reach TS: OCEAN



Summary for Pond 1N: Subsurface Infiltration System #1

Inflow Area =	0.718 ac, 41.03% Impervious, Inflow Depth = 6.02" for 100-Year event				
Inflow =	4.91 cfs @	12.09 hrs,	Volume=	0.360 af	
Outflow =	3.63 cfs @	12.16 hrs,	Volume=	0.358 af,	Atten= 26%, Lag= 4.1 min
Discarded =	0.07 cfs @	9.10 hrs,	Volume=	0.119 af	
Primary =	3.56 cfs @	12.16 hrs,	Volume=	0.239 af	

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs / 2
Peak Elev= 15.33' @ 12.16 hrs Surf.Area= 0.069 ac Storage= 0.088 af

Plug-Flow detention time= 93.9 min calculated for 0.358 af (99% of inflow)
Center-of-Mass det. time= 90.8 min (898.4 - 807.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	13.00'	0.049 af	**44.83'W x 67.28'L x 2.33'H Field A** 0.162 af Overall - 0.040 af Embedded = 0.122 af x 40.0% Voids
#2A	13.50'	0.040 af	**ADS_StormTech SC-310 +Cap** x 117 Inside #1 Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap 13 Rows of 9 Chambers
		0.088 af	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Device 4	13.70'	**6.0" Vert. Orifice/Grate** C= 0.600
#2	Discarded	13.00'	**1.020 in/hr Exfiltration over Surface area**
#3	Device 4	15.00'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#4	Primary	13.00'	**15.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 13.00' / 12.75' S= 0.0050 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 1.23 sf

Discarded OutFlow Max=0.07 cfs @ 9.10 hrs HW=13.02' (Free Discharge)
└─**2=Exfiltration** (Exfiltration Controls 0.07 cfs)

Primary OutFlow Max=3.50 cfs @ 12.16 hrs HW=15.33' (Free Discharge)
└─**4=Culvert** (Passes 3.50 cfs of 5.49 cfs potential flow)
  ├─**1=Orifice/Grate** (Orifice Controls 1.11 cfs @ 5.65 fps)
  └─**3=Sharp-Crested Rectangular Weir** (Weir Controls 2.39 cfs @ 1.87 fps)

Pond 1N: Subsurface Infiltration System #1 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-310 +Cap (ADS StormTech®SC-310 with cap length)
Effective Size= 28.9"W x 16.0"H => 2.07 sf x 7.12'L = 14.7 cf
Overall Size= 34.0"W x 16.0"H x 7.56'L with 0.44' Overlap

34.0" Wide + 6.0" Spacing = 40.0" C-C Row Spacing

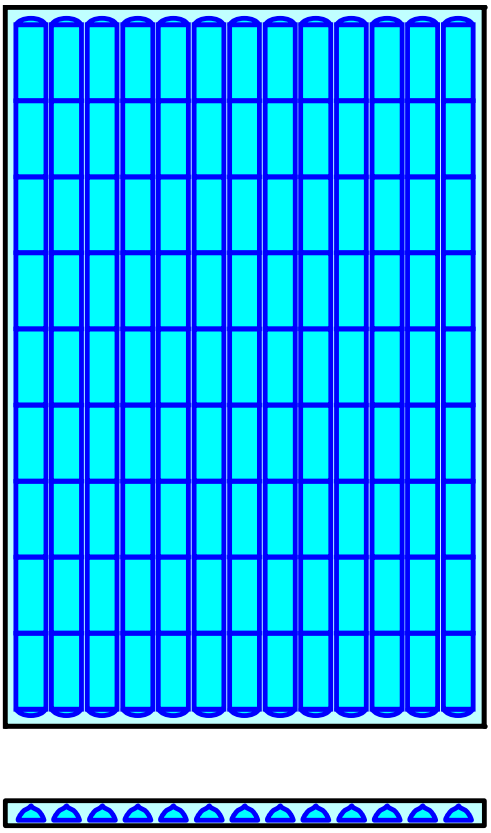
9 Chambers/Row x 7.12' Long +0.60' Cap Length x 2 = 65.28' Row Length +12.0" End Stone x 2 = 67.28' Base Length
13 Rows x 34.0" Wide + 6.0" Spacing x 12 + 12.0" Side Stone x 2 = 44.83' Base Width
6.0" Base + 16.0" Chamber Height + 6.0" Cover = 2.33' Field Height

117 Chambers x 14.7 cf = 1,724.8 cf Chamber Storage

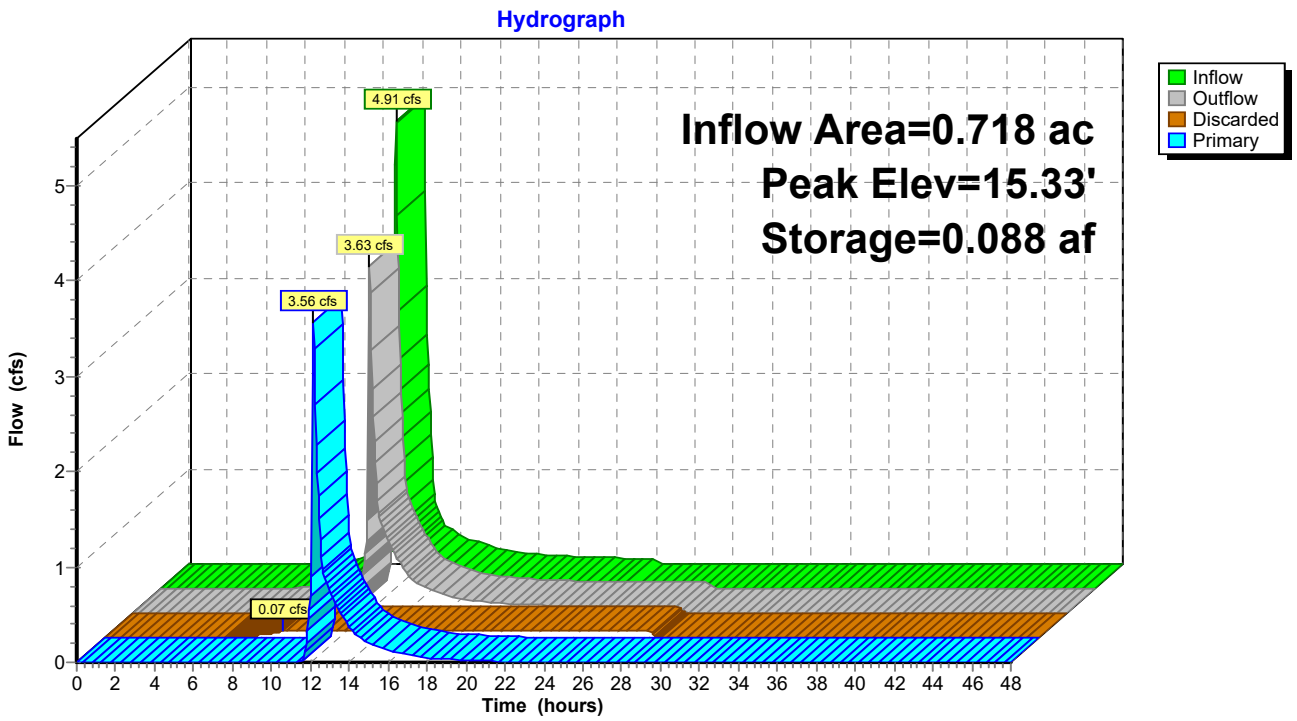
7,038.2 cf Field - 1,724.8 cf Chambers = 5,313.4 cf Stone x 40.0% Voids = 2,125.4 cf Stone Storage

Chamber Storage + Stone Storage = 3,850.2 cf = 0.088 af
Overall Storage Efficiency = 54.7%
Overall System Size = 67.28' x 44.83' x 2.33'

117 Chambers
260.7 cy Field
196.8 cy Stone



Pond 1N: Subsurface Infiltration System #1



Summary for Pond 2S-A: Bioretention - Ponding

Inflow Area = 0.517 ac, 53.05% Impervious, Inflow Depth = 6.63" for 100-Year event
Inflow = 3.83 cfs @ 12.09 hrs, Volume= 0.286 af
Outflow = 2.53 cfs @ 12.19 hrs, Volume= 0.286 af, Atten= 34%, Lag= 6.3 min
Primary = 2.16 cfs @ 12.19 hrs, Volume= 0.283 af
Secondary = 0.37 cfs @ 12.19 hrs, Volume= 0.003 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 18.56' @ 12.19 hrs Surf.Area= 2,076 sf Storage= 2,526 cf

Plug-Flow detention time= 65.2 min calculated for 0.285 af (100% of inflow)
Center-of-Mass det. time= 65.3 min (861.8 - 796.5)

Volume	Invert	Avail.Storage	Storage Description
#1	17.00'	3,490 cf	**Custom Stage Data (Prismatic)** Listed below (Recalc)

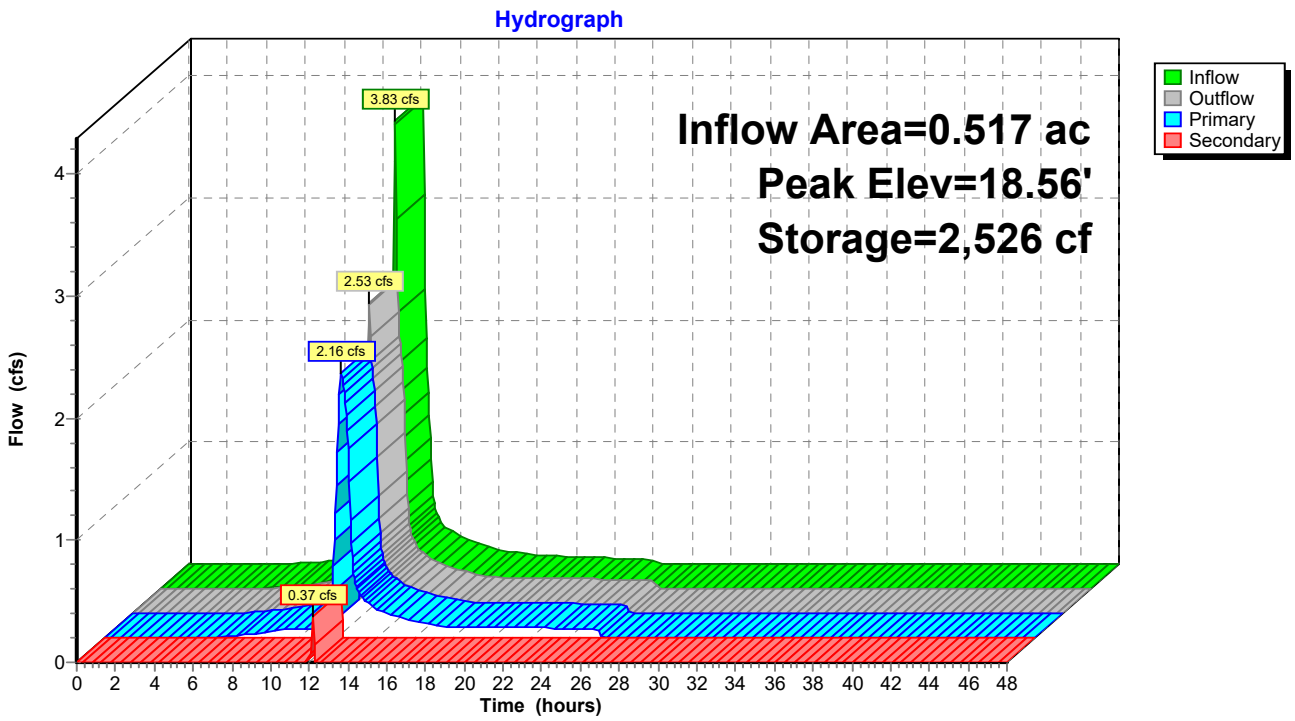
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
17.00	1,166	0	0
18.00	1,738	1,452	1,452
19.00	2,338	2,038	3,490

Device	Routing	Invert	Outlet Devices
#1	Primary	17.00'	**2.410 in/hr Flow Through Filter over Horizontal area**
#2	Secondary	18.50'	**10.0' 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
#3	Primary	17.75'	**12.0" Horiz. Infiltration Riser X 0.60** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.16 cfs @ 12.19 hrs HW=18.56' (Free Discharge)
└─**1=Flow Through Filter** (Exfiltration Controls 0.12 cfs)
└─**3=Infiltration Riser** (Orifice Controls 2.04 cfs @ 2.60 fps)

Secondary OutFlow Max=0.35 cfs @ 12.19 hrs HW=18.56' (Free Discharge)
└─**2=Broad-Crested Rectangular Weir** (Weir Controls 0.35 cfs @ 0.58 fps)

Pond 2S-A: Bioretention - Ponding



Summary for Pond 2S-B: Subsurface Infiltration System #2

Inflow Area =	1.639 ac, 22.10% Impervious, Inflow Depth = 6.13" for 100-Year event				
Inflow =	8.37 cfs @	12.10 hrs,	Volume=	0.837 af	
Outflow =	7.29 cfs @	12.17 hrs,	Volume=	0.837 af,	Atten= 13%, Lag= 4.5 min
Discarded =	0.08 cfs @	8.45 hrs,	Volume=	0.140 af	
Primary =	7.21 cfs @	12.17 hrs,	Volume=	0.697 af	

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 16.49' @ 12.17 hrs Surf.Area= 3,311 sf Storage= 7,107 cf

Plug-Flow detention time= 66.3 min calculated for 0.837 af (100% of inflow)
Center-of-Mass det. time= 66.4 min (878.2 - 811.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	13.00'	2,981 cf	**44.25'W x 74.82'L x 3.50'H Field A** 11,587 cf Overall - 4,135 cf Embedded = 7,453 cf x 40.0% Voids
#2A	13.50'	4,135 cf	**ADS_StormTech SC-740 +Cap** x 90 Inside #1 Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap 9 Rows of 10 Chambers
		7,116 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Discarded	13.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Device 5	16.00'	**5.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)
#3	Device 5	13.70'	**6.0" Vert. Orifice/Grate** C= 0.600
#4	Device 5	14.50'	**8.0" Vert. Orifice/Grate** C= 0.600
#5	Primary	13.50'	**15.0" Round Culvert** L= 50.0' CPP, square edge headwall, Ke= 0.500 Inlet / Outlet Invert= 13.50' / 13.10' S= 0.0080 '/' Cc= 0.900 n= 0.020 Corrugated PE, corrugated interior, Flow Area= 1.23 sf

Discarded OutFlow Max=0.08 cfs @ 8.45 hrs HW=13.04' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.08 cfs)

Primary OutFlow Max=6.93 cfs @ 12.17 hrs HW=16.46' (Free Discharge)
└─**5=Culvert** (Barrel Controls 6.93 cfs @ 5.64 fps)
  ├─**2=Sharp-Crested Rectangular Weir** (Passes < 4.97 cfs potential flow)
  ├─**3=Orifice/Grate** (Passes < 1.50 cfs potential flow)
  └─**4=Orifice/Grate** (Passes < 2.14 cfs potential flow)

Pond 2S-B: Subsurface Infiltration System #2 - Chamber Wizard Field A

Chamber Model = ADS_StormTechSC-740 +Cap (ADS StormTech®SC-740 with cap length)
Effective Size= 44.6"W x 30.0"H => 6.45 sf x 7.12'L = 45.9 cf
Overall Size= 51.0"W x 30.0"H x 7.56'L with 0.44' Overlap

51.0" Wide + 6.0" Spacing = 57.0" C-C Row Spacing

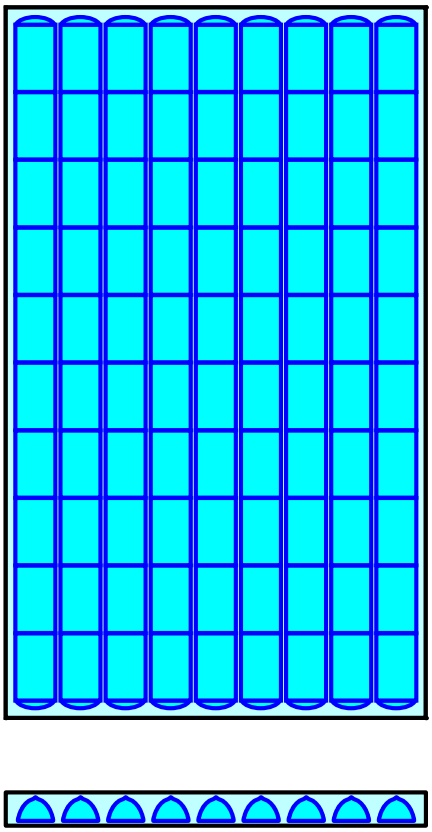
10 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 72.82' Row Length +12.0" End Stone x 2 = 74.82' Base Length
9 Rows x 51.0" Wide + 6.0" Spacing x 8 + 12.0" Side Stone x 2 = 44.25' Base Width
6.0" Base + 30.0" Chamber Height + 6.0" Cover = 3.50' Field Height

90 Chambers x 45.9 cf = 4,134.6 cf Chamber Storage

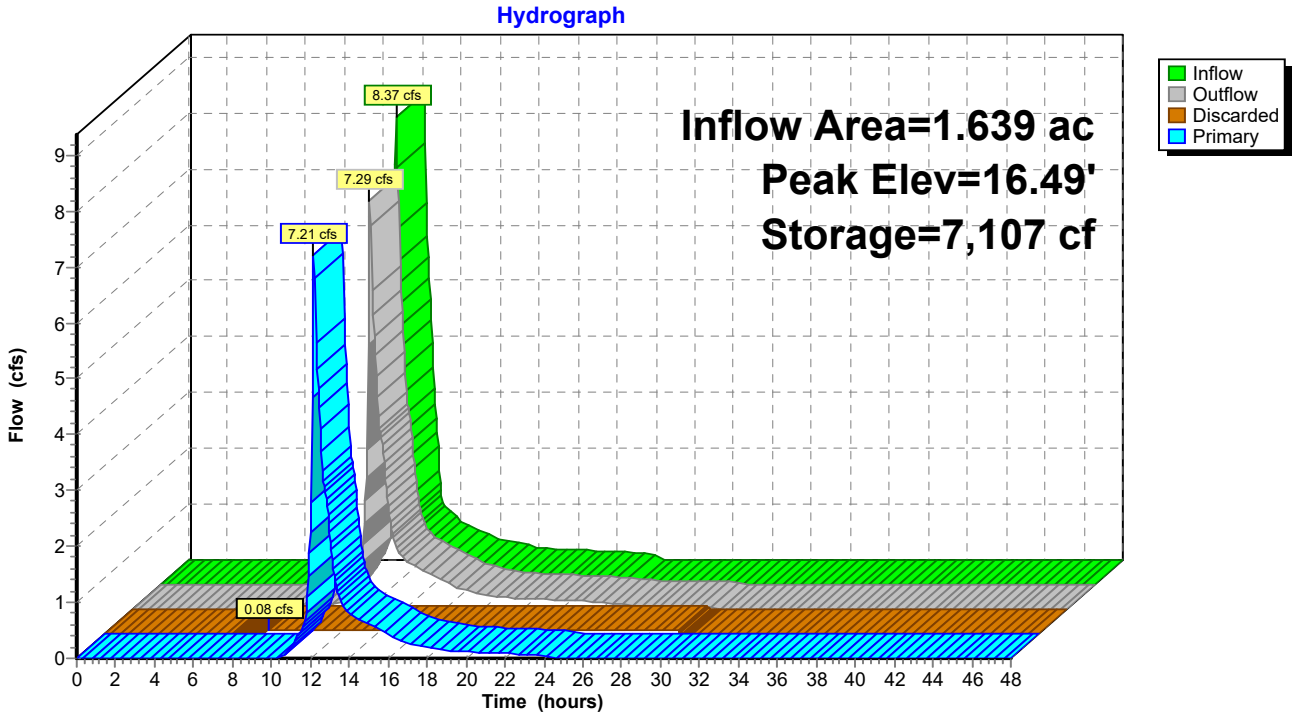
11,587.2 cf Field - 4,134.6 cf Chambers = 7,452.6 cf Stone x 40.0% Voids = 2,981.1 cf Stone Storage

Chamber Storage + Stone Storage = 7,115.7 cf = 0.163 af
Overall Storage Efficiency = 61.4%
Overall System Size = 74.82' x 44.25' x 3.50'

90 Chambers
429.2 cy Field
276.0 cy Stone



Pond 2S-B: Subsurface Infiltration System #2



Summary for Pond 6P: Subsurface Storage

Inflow Area =	0.517 ac, 53.05% Impervious, Inflow Depth = 6.56" for 100-Year event				
Inflow =	2.16 cfs @	12.19 hrs,	Volume=	0.283 af	
Outflow =	2.09 cfs @	12.29 hrs,	Volume=	0.283 af,	Atten= 3%, Lag= 5.8 min
Discarded =	0.06 cfs @	8.70 hrs,	Volume=	0.095 af	
Primary =	2.03 cfs @	12.29 hrs,	Volume=	0.187 af	

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 14.29' @ 12.29 hrs Surf.Area= 2,338 sf Storage= 1,211 cf

Plug-Flow detention time= 45.4 min calculated for 0.282 af (100% of inflow)
Center-of-Mass det. time= 45.5 min (908.7 - 863.2)

Volume	Invert	Avail.Storage	Storage Description
#1	13.00'	1,403 cf	**Stone Under Basin (Prismatic)** Listed below (Recalc) 3,507 cf Overall x 40.0% Voids

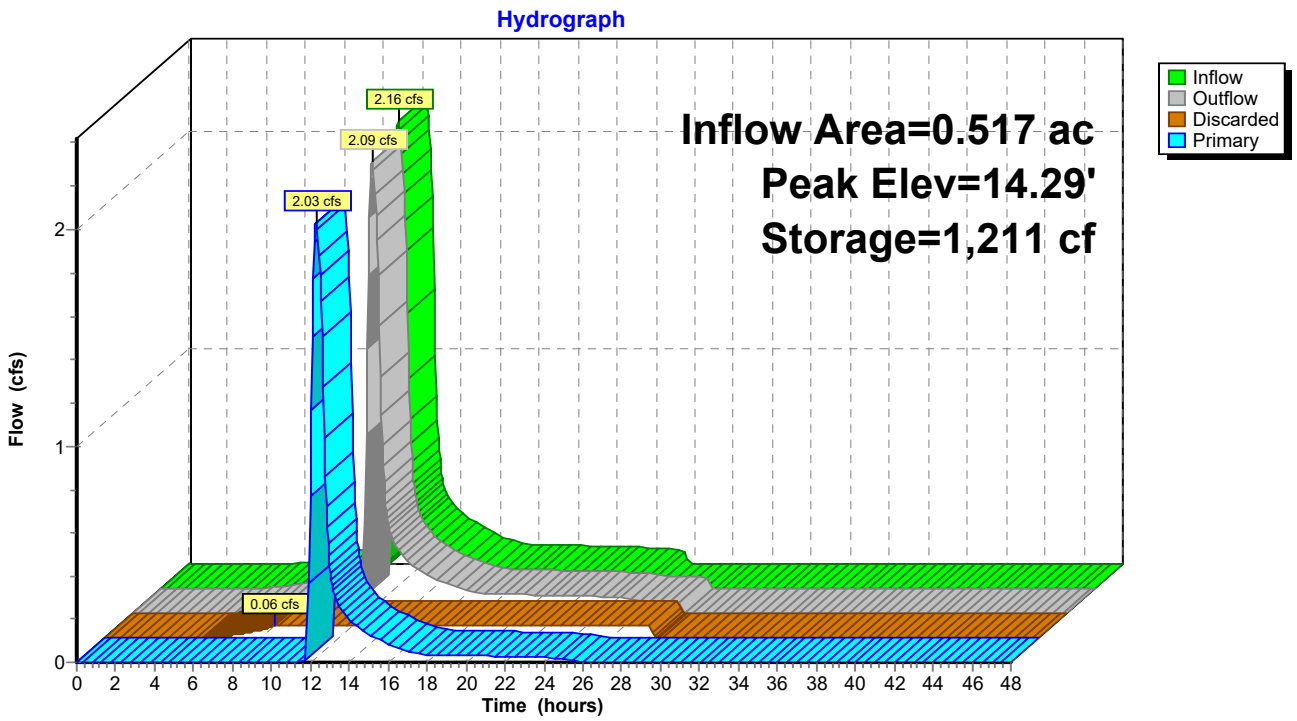
Elevation (feet)	Surf.Area (sq-ft)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)
13.00	2,338	0	0
14.50	2,338	3,507	3,507

Device	Routing	Invert	Outlet Devices
#1	Discarded	13.00'	**1.020 in/hr Exfiltration over Surface area**
#2	Primary	13.50'	**12.0" Vert. Orifice/Grate** C= 0.600

Discarded OutFlow Max=0.06 cfs @ 8.70 hrs HW=13.02' (Free Discharge)
└─**1=Exfiltration** (Exfiltration Controls 0.06 cfs)

Primary OutFlow Max=2.03 cfs @ 12.29 hrs HW=14.29' (Free Discharge)
└─**2=Orifice/Grate** (Orifice Controls 2.03 cfs @ 3.03 fps)

Pond 6P: Subsurface Storage



Summary for Pond IB1: Infiltration Basin 1

Inflow Area = 0.764 ac, 7.29% Impervious, Inflow Depth = 6.63" for 100-Year event
Inflow = 5.66 cfs @ 12.09 hrs, Volume= 0.422 af
Outflow = 2.95 cfs @ 12.24 hrs, Volume= 0.416 af, Atten= 48%, Lag= 8.8 min
Primary = 2.95 cfs @ 12.24 hrs, Volume= 0.416 af

Routing by Stor-Ind method, Time Span= 0.00-48.00 hrs, dt= 0.05 hrs
Peak Elev= 32.99' @ 12.24 hrs Surf.Area= 1,900 sf Storage= 2,739 cf

Plug-Flow detention time= 25.2 min calculated for 0.416 af (98% of inflow)
Center-of-Mass det. time= 15.4 min (811.9 - 796.5)

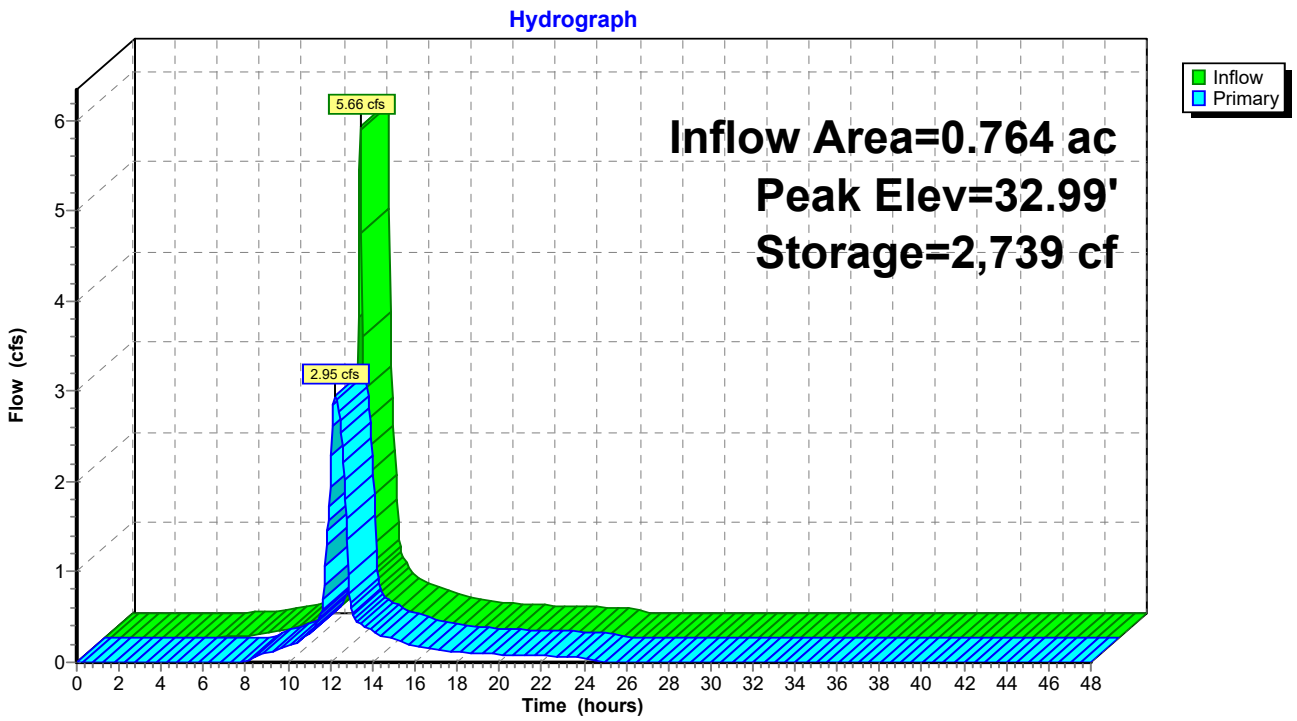
Volume	Invert	Avail.Storage	Storage Description
#1	31.00'	4,992 cf	**Custom Stage Data (Irregular)** Listed below (Recalc)

Elevation (feet)	Surf.Area (sq-ft)	Perim. (feet)	Inc.Store (cubic-feet)	Cum.Store (cubic-feet)	Wet.Area (sq-ft)
31.00	902	133.0	0	0	902
32.00	1,377	157.0	1,131	1,131	1,475
33.00	1,908	178.0	1,635	2,766	2,059
34.00	2,558	199.0	2,225	4,992	2,716

Device	Routing	Invert	Outlet Devices
#1	Primary	31.30'	**12.0" Horiz. Orifice/Grate X 0.60** C= 0.600 Limited to weir flow at low heads

Primary OutFlow Max=2.94 cfs @ 12.24 hrs HW=32.98' (Free Discharge)
└─**1=Orifice/Grate** (Orifice Controls 2.94 cfs @ 3.75 fps)

Pond IB1: Infiltration Basin 1



APPENDIX D

Long-Term Pollution Prevention and Stormwater Operation and Maintenance Plan

Nitsch Engineering

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LONG-TERM POLLUTION PREVENTION PLAN AND STORMWATER OPERATION AND MAINTENANCE PLAN

Northeastern University Coastal Sustainability Institute, Nahant, MA

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1.0 INTRODUCTION

The purpose of this document is to specify the pollution prevention measures and stormwater management system operation and maintenance for the Northeastern University Coastal Sustainability Institute site. The Responsible Party indicated below shall implement the management practices outlined in this document and proactively conduct operations at the project site in an environmentally responsible manner. Compliance with this Manual does not in any way dismiss the responsible party, owner, property manager, or occupants from compliance with other applicable federal, state or local laws.

Responsible Party:

Ronald Lavoie
Ast. Vice President – Facilities Operations and Services, Northeastern University
360 Huntington Avenue
Boston, MA 02115
617.373.2700
r.lavoie@northeastern.edu

This Document has been prepared in compliance with Standards 4 and 9 of the 2008 Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards, which state:

Standard 4:
The Long-Term Pollution Prevention Plan shall include the proper procedures for the following:

- Good housekeeping
- Storing materials and waste products inside or under cover
- Routine inspections of stormwater best management practices
- Spill prevention and response
- Minimize Soil Erosions
- Maintenance of lawns, gardens, and other landscaped areas
- Pet waste management
- Proper management of deicing chemicals and snow

Standard 9:
The Long-Term Operation and Maintenance Plan shall at a minimum include:

- Stormwater management system(s) owner(s)
- The party or parties responsible for operation and maintenance, including how future property owners shall be notified of the presence of the stormwater management system and the requirement for operation and maintenance
- The routine and non-routine maintenance tasks to be undertaken after construction is complete and a schedule for implementing those tasks
- A plan that is drawn to scale and shows the location of all stormwater BMPs in each treatment train along with the discharge point
- A description of public safety features
- An estimated operations and maintenance budget

2.0 LONG-TERM POLLUTION PREVENTION PLAN

The Responsible Party shall implement the following good housekeeping procedures at the project site to reduce the possibility of accidental releases and to reduce safety hazards.

2.1 Storage of Hazardous Materials

To prevent leaks and spills, keep hazardous materials and waste products under cover or inside. Use drip pans or spill containment systems to prevent chemicals from entering the drainage system. Inspect storage areas for materials and waste products at least once per year to determine amount and type of the material on site, and if the material requires disposal.

Securely store liquid petroleum products and other liquid chemicals in federally- and state-approved containers. Restrict access to maintenance personnel and administrators.

2.2 Storage of Waste Products

Collect and store all waste materials in securely lidded dumpster(s) or other secure containers as applicable to the material. Keep dumpster lids closed and the areas around them clean. Do not fill the dumpsters with liquid waste or hose them out. Sweep areas around the dumpster regularly and put the debris in the garbage, instead of sweeping or hosing it into the parking lot. Legally dispose of collected waste on a regular basis.

Segregate liquid wastes, including motor oil, antifreeze, solvents, and lubricants, from solid waste and recycle through hazardous waste disposal companies, whenever possible. Separate oil filters, batteries, tires, and metal filings from grinding and polishing metal parts from common trash items and recycle. These items are not trash and are illegal to dump. Contact a hazardous waste hauler for proper disposal to a hazardous waste collection center.

2.3 Spill Prevention and Response

Implement spill response procedures for releases of significant materials such as fuels, oils, or chemical materials onto the ground or other area that could reasonably be expected to discharge to surface or groundwater.

- For minor spills, keep fifty (50) gallon spill control kits and Speedy Dry at all shop and work areas.
- Immediately contact applicable Federal, State, and local agencies for reportable quantities as required by law.
- Immediately perform applicable containment and cleanup procedures following a spill release.
- Promptly remove and dispose of all material collected during the response in accordance with Federal, State and local requirements. A licensed emergency response contractor may be required to assist in cleanup of releases depending on the amount of the release, and the ability of the Contractor to perform the required response.
- Reportable quantities of chemicals, fuels, or oils are established under the Clean Water Act and enforced through Massachusetts Department of Environmental Protection (DEP).

2.4 Minimize Soil Erosion

Soil erosion facilitates mechanical transport of nutrients, pathogens, and organic matter to surface water bodies. Repair all areas where erosion is occurring throughout the project site. Stabilize bare soil with riprap, seed, mulch, or vegetation.

2.5 Maintenance of Lawns, Gardens, and other Landscaped Areas

Pesticides and fertilizers shall not be used in the landscaped areas associated with the project site and shall not be stored on-site. Dumping of lawn wastes, brush or leaves or other materials or debris is not permitted in any Resource Area. Grass clippings, pruned branches and any other landscaped waste should be disposed of or composted in an appropriate location. No irrigation shall be used in the landscaped areas for this project.

2.6 Management of Deicing Chemicals and Snow

The qualified contractor selected for snow plowing and deicing shall be made fully aware of the requirements of this section.

No road salt (sodium chloride) shall be stored on-site. The use of magnesium chloride de-icing product with a 0.5 to 1.0 percent sodium chloride mix for snow and ice treatment is permitted. The product shall be stored in a locked room inside the building and shall be used at exterior stairs and walkways. The snow plow contractor shall adhere to this magnesium chloride use and storage requirements.

During typical snow plowing operations, snow shall be pushed to the designated snow removal areas. Snow shall not be stockpiled in wetland resource areas or the 100-foot Buffer Zone, catch basins, or bioretention basin. In severe conditions where snow cannot be stockpiled on site, the snow shall be removed from the site and properly disposed of in accordance with DEP Guideline BRP601-01.

Before winter begins, the property owner and the contractor shall review snow plowing, deicing, and stockpiling procedures. Areas designated for stockpiling should be cleaned of any debris.

2.7 Coordination with other Permits and Requirements

Certain conditions of other approvals affecting the long-term management of the property shall be considered part of this Long-Term Pollution Prevention Plan. The Owner shall become familiar with those documents and comply with the guidelines set forth in those documents.

3.0 STORMWATER MANAGEMENT SYSTEM OPERATION AND MAINTENANCE PLAN

3.1 Introduction

This Operation and Maintenance Plan (O&M Plan) for the Northeastern University Coastal Sustainability Institute site is required under Standard 9 of the 2008 MassDEP Stormwater Handbook to provide best management practices for implementing maintenance activities for the stormwater management system in a manner that minimizes impacts to wetland resource areas.

The Owner shall implement this O&M Plan and proactively conduct operations at the site in an environmentally responsible manner. Compliance with this O&M Plan does not in any way dismiss the Owner from compliance with other applicable Federal, State or local laws.

Routine maintenance during construction and post-development phases of the project, as defined in the Operation and Maintenance Plan, shall be permitted without amendment to the Order of Conditions. A continuing condition in the Certificate of Compliance shall ensure that maintenance can be performed without triggering further filings under the Wetlands Protection Act.

All stormwater best management practices (BMPs) shall be operated and maintained in accordance with the design plans and the Operation and Maintenance Plan approved by the issuing authority. The Owner shall:

a. Maintain an operation and maintenance log for the last three years, including inspections, repairs, replacement and disposal (for disposal the log shall indicate the type of material and the disposal location). This is a rolling log in which the responsible party records all operation and maintenance activities for the past three years.

b. Make this log available to MassDEP and the Conservation Commission upon request; and

c. Allow members and agents of the MassDEP and the Conservation Commission to enter and inspect the premises to evaluate and ensure that the Owner complies with the Operation and Maintenance requirements for each BMP.

3.2 Stormwater Operation and Maintenance Requirements

Inspect and maintain the stormwater management system as directed below. Refer to the Stormwater Management System Location Map (Figure 1) for the location of each component of the system. Repairs to any component of the system shall be made as soon as possible to prevent any potential pollutants (including silt) from entering the resource areas.

<u>Deep Sump and Hooded Catch Basins</u>

Inspect catch basins four times per year, including after the foliage season. Other inspection and maintenance requirements include:

- Remove organic material, sediment and hydrocarbons four times per year or whenever the depth of deposits is greater than or equal to one half the depth from the bottom of the invert of the lowest pipe in the basin.
- Always clean out catch basins after street sweeping. If any evidence of hydrocarbons is found during inspection, the material shall be immediately removed using absorbent pads or other suitable measures and dispose of legally. Remove other accumulated debris as necessary.
- Transport and disposal of accumulated sediment off-site shall be in accordance with applicable local, state and federal guidelines and regulations.

Area Drains

Inspect area drains at least once per month and remove debris from the grate. Clean out accumulated sediments at least once per year and more frequently as necessary.

Water Quality Units (Proprietary Separators)

Maintain water quality units according the recommendations set forth by the manufacturer. General inspection and maintenance procedures for proprietary devices are provided below:

- Inspect units following completion of construction, prior to being put into service.
- Inspect units at least twice per year following installation and no less than once per year thereafter.
- Inspect units immediately after any oil, fuel or chemical spill.
- All inspections shall include checking the oil level and sediment depth in the unit. Removal of sediments/oils shall occur per manufacturer recommendations.
- A licensed waste management company shall remove captured petroleum waste products from any oil, chemical or fuel spills and dispose.
- OSHA confined space entry protocols shall be followed if entry into the unit is required.

Vegetated Swales

Vegetated swales shall be inspected twice per year during the first year after construction. In subsequent years, the swales shall be inspected annually and after rain events greater than 3 inches in 24 hours. Inspection and maintenance procedures for drainage channels are provided below:

- Inspect the riprap on the channel bottom and side slopes for signs of erosion and formation of rills and gullies. Replace riprap as necessary.
- Remove accumulated trash and debris.
- Remove sediment as needed. Use hand methods (i.e. a person with a shovel) when cleaning to minimize disturbance to vegetation and underlying soils.

Level Spreaders

Inspect level spreaders regularly, especially after major storm events (rainfall totals greater than 2.5 inches in 24 hours). Repair any erosion or low spots in the level spreader.

Isolator Row

The Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes. If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

Refer to Attachment A, the manufacturer's maintenance manual for the Isolator Row, for detailed maintenance instructions.

Subsurface Chamber Systems

Inspect subsurface chamber systems twice per year. Inspect the inlets and observation ports to determine if there is accumulated sediment within the system. Remove all debris and accumulated sediment that may clog the system.

Bioretention Area

Perform annual maintenance of all components of the bioretention area, including plants, soil, and mulch. Table 1, below, outlines recommended maintenance activities.

Table 1. Bioretention area maintenance recommendations

Location	Description	Frequency	Time of Year
Surface	Inspect and remove trash	Monthly	Year round
Soil	Inspect and repair erosion	Monthly	Year round
Organic Layer	Remulch void areas	Annually	Spring
	Remove previous mulch layer before applying new layer (optional)	Annually	Spring
Plants	Water vegetation at end of day for 14 consecutive days after planting	Immediately after planting	As needed
	Remove and replace all dead and diseased vegetation that cannot be treated	Annually	Spring
	Treat all diseased trees and shrubs	As needed	Variable

During and after storm events, record the length of time standing water remains in the bioretention areas. If the time is greater than 72 hours, thoroughly inspect the basins for signs of clogging and develop a corrective action plan. The corrective action plan, prepared by a qualified professional, will outline procedures to restore infiltrative function. The owner of the site shall take immediate action to implement these corrective measures.

Stormwater Outfalls

Inspect flared end sections and associated riprap spillways at least once per year and after major storm events (rainfall totals greater than 2.5 inches in 24 hours) to ensure that the stability of the outlet area is maintained. Keep the outfall area clear of debris such as trash, branches, and sediment. Make repairs immediately if riprap displacement or downstream channel scour is observed.

3.3 Repair of the Stormwater Management System

The stormwater management system shall be maintained. The repair of any component of the system shall be made as soon as possible to prevent any potential pollutants including silt from entering the resource areas or the existing closed drainage system.

3.4 Reporting

The Owner shall maintain a record of drainage system inspections and maintenance (per this Plan) and submit a yearly report to the Nahant Conservation Commission.

STORMWATER MANAGEMENT SYSTEM INSPECTION FORM

Northeastern University Coastal
Sustainability Institute
Nahant, Massachusetts

Inspected by:_____
Date:_____

Component	Status/Inspection	Action Taken
Deep Sump Catch Basins, Area Drains and Drain Manholes		
Bioretention Basin		
Isolator Row		
Subsurface Chambers		
Water Quality Units		
Stormwater Outfalls & Level Spreaders		
General site conditions – evidence of erosion, etc.		

SUBMIT COPIES OF STORMWATER MANAGEMENT SYSTEM INSPECTION FORM TO THE NAHANT CONSERVATION COMMISSION WITH THE YEARLY REPORT.

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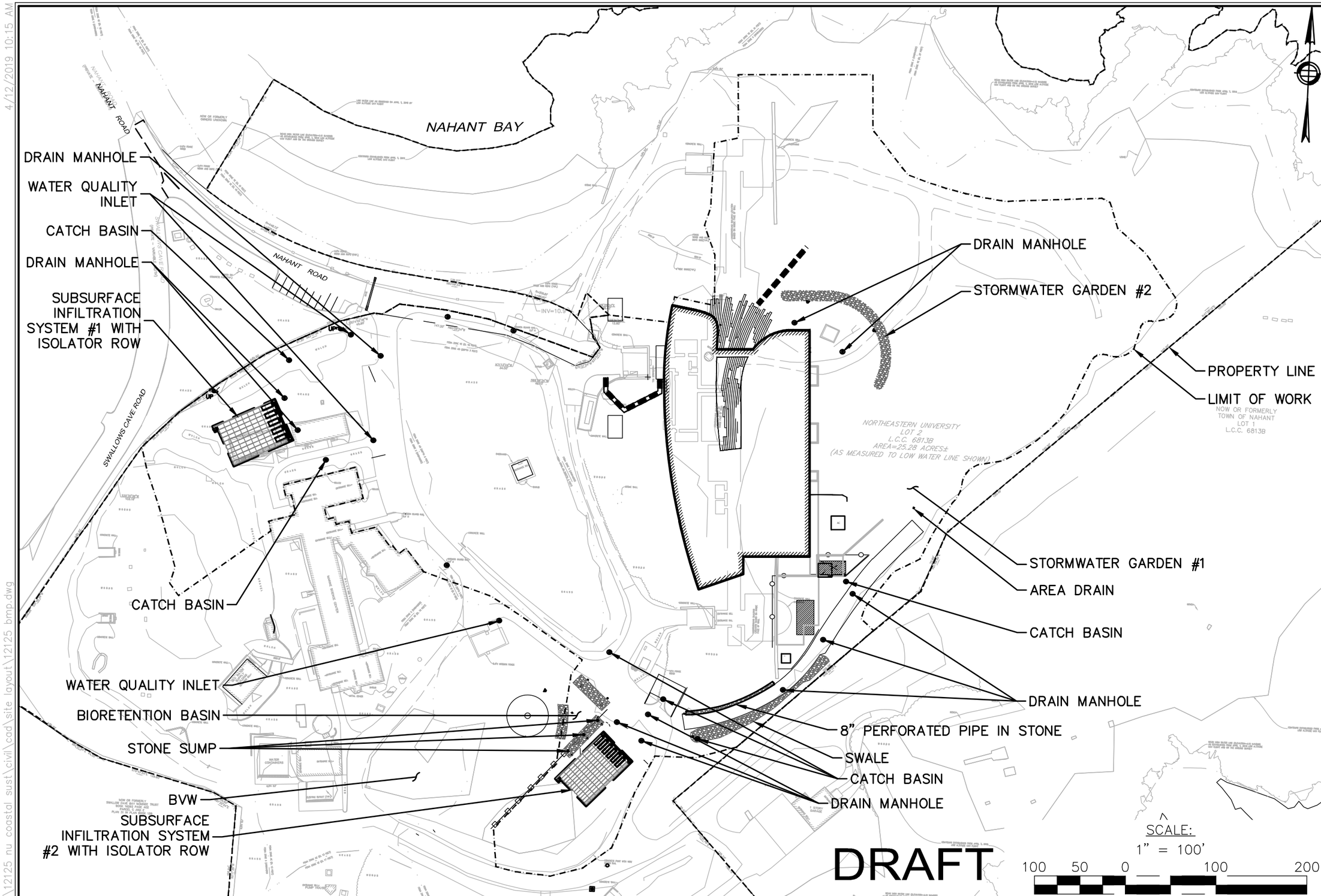

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- Land Surveying
- Transportation Engineering
- Structural Engineering
- Green Infrastructure
- Planning
- GIS

STORMWATER MANAGEMENT LOCATION PLAN
NORTHEASTERN UNIVERSITY COASTAL SUSTAINABILITY INSTITUTE
430 NAHANT ROAD, NAHANT, MA

PREPARED FOR:
NORTHEASTERN UNIVERSITY
360 HUNTINGTON AVENUE, BOSTON, MA

PROJECT #	12125
FILE:	12125CSN.DWG
SCALE:	1"=100'
DATE:	04-29-2019
PROJECT MGR:	WM
SURVEYOR:	NITSCH
DRAFTED BY:	AM
CHECKED BY:	BV

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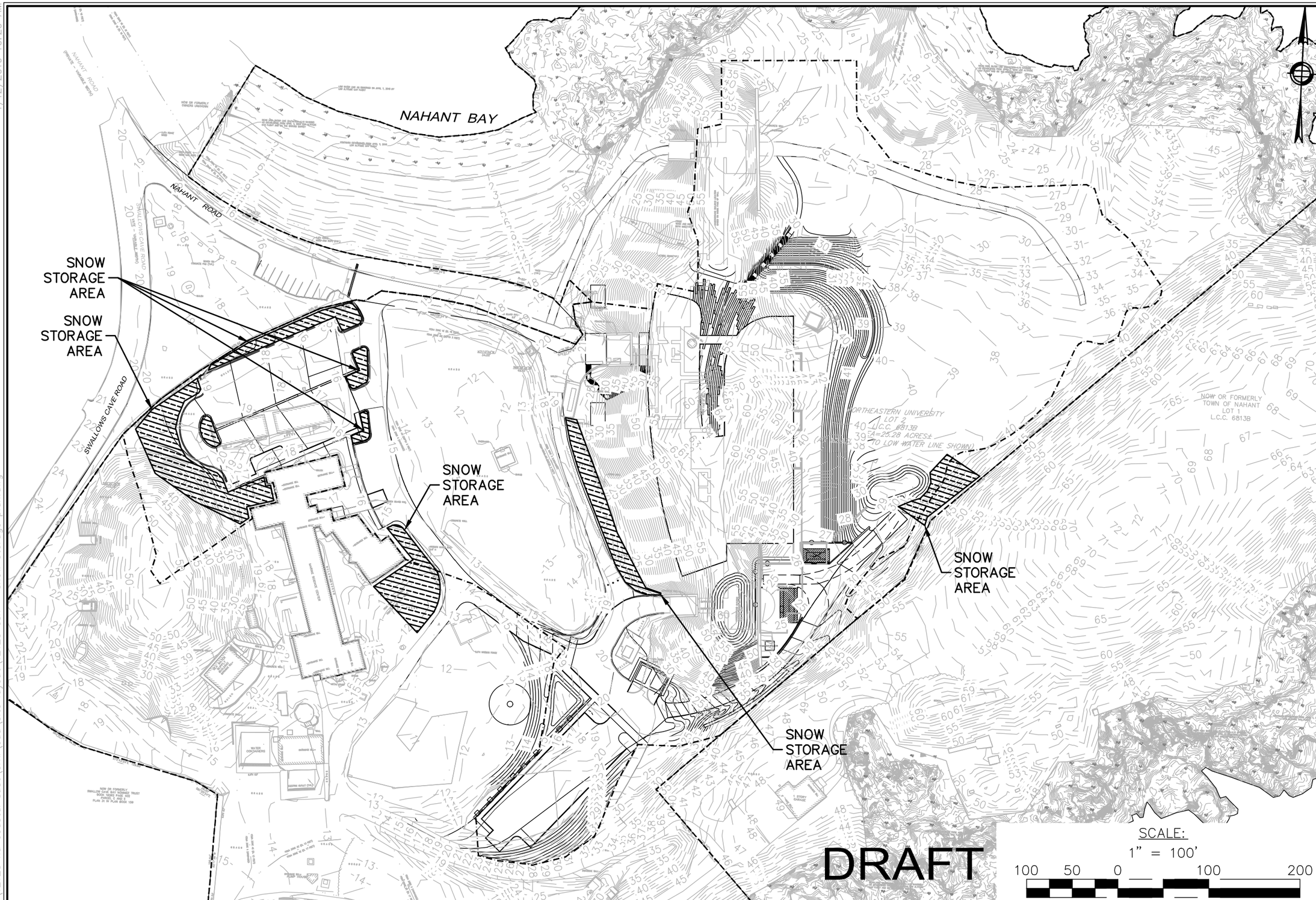

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SNOW STORAGE PLAN

NORTHEASTERN UNIVERSITY COASTAL SUSTAINABILITY INSTITUTE
430 NAHANT ROAD, NAHANT, MA

PREPARED FOR:

NORTHEASTERN UNIVERSITY
360 HUNTINGTON AVENUE, BOSTON, MA

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DATE:	04-29-2019
PROJECT MGR:	WM
SURVEYOR:	NITSCH
DRAFTED BY:	AM
CHECKED BY:	BV

SN-1

ATTACHMENT A

StormTech Isolator Row and Subsurface Chambers

StormTech®

Detention • Retention • Water Quality

A division of ADS®

Save Valuable Land and Protect Water Resources

Isolator® Row O&M Manual

StormTech® Chamber System for Stormwater Management

1.0 The Isolator® Row

1.1 INTRODUCTION

An important component of any Stormwater Pollution Prevention Plan is inspection and maintenance. The StormTech Isolator Row is a patented technique to inexpensively enhance Total Suspended Solids (TSS) removal and provide easy access for inspection and maintenance.

Looking down the Isolator Row from the manhole opening, woven geotextile is shown between the chamber and stone base.

1.2 THE ISOLATOR ROW

The Isolator Row is a row of StormTech chambers, either SC-310, SC-310-3, SC-740, DC-780, MC-3500 or MC-4500 models, that is surrounded with filter fabric and connected to a closely located manhole for easy access. The fabric-wrapped chambers provide for settling and filtration of sediment as storm water rises in the Isolator Row and ultimately passes through the filter fabric. The open bottom chambers and perforated sidewalls (SC-310, SC-310-3 and SC-740 models) allow storm water to flow both vertically and horizontally out of the chambers. Sediments are captured in the Isolator Row protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

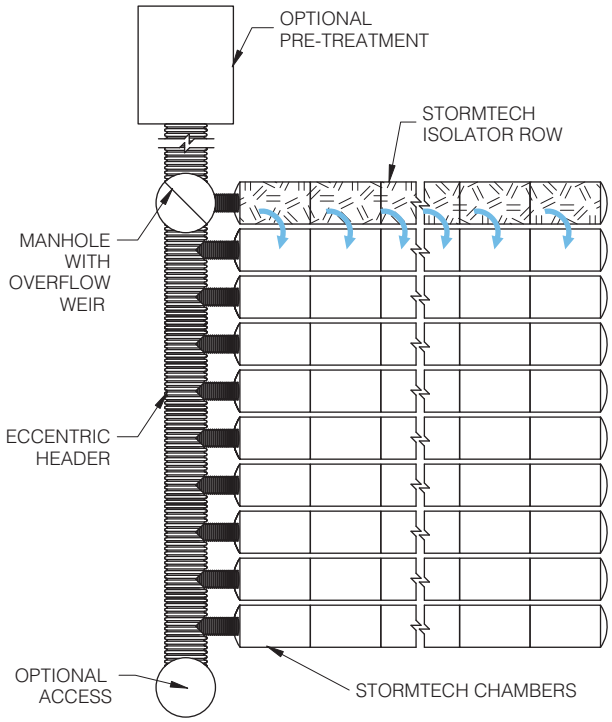
Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for storm water filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of the underlying stone and remain intact during high pressure jetting. A non-woven fabric is placed over the chambers to provide a filter media for flows passing through the perforations in the sidewall of the chamber. The non-woven fabric is not required over the DC-780, MC-3500 or MC-4500 models as these chambers do not have perforated side walls.

The Isolator Row is typically designed to capture the "first flush" and offers the versatility to be sized on a volume basis or flow rate basis. An upstream manhole not only provides access to the Isolator Row but typically includes a high flow weir such that storm water flowrates or volumes that exceed the capacity of the Isolator Row overtop the over flow weir and discharge through a manifold to the other chambers.

The Isolator Row may also be part of a treatment train. By treating storm water prior to entry into the chamber system, the service life can be extended and pollutants such as hydrocarbons can be captured. Pre-treatment best management practices can be as simple as deep sump catch basins, oil-water separators or can be innovative storm water treatment devices. The design of the treatment train and selection of pretreatment devices by the design engineer is often driven by regulatory requirements. Whether pretreatment is used or not, the Isolator Row is recommended by StormTech as an effective means to minimize maintenance requirements and maintenance costs.

Note: See the StormTech Design Manual for detailed information on designing inlets for a StormTech system, including the Isolator Row.

StormTech Isolator Row with Overflow Spillway
(not to scale)



2.0 Isolator Row Inspection/Maintenance

StormTech

2.1 INSPECTION

The frequency of Inspection and Maintenance varies by location. A routine inspection schedule needs to be established for each individual location based upon site specific variables. The type of land use (i.e. industrial, commercial, residential), anticipated pollutant load, percent imperviousness, climate, etc. all play a critical role in determining the actual frequency of inspection and maintenance practices.

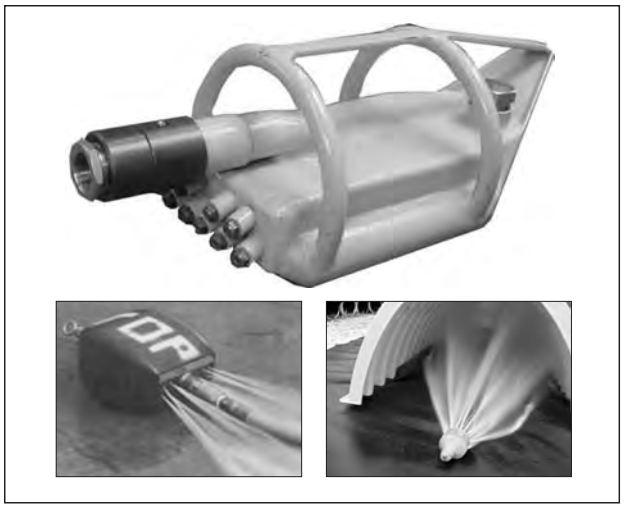
At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

The Isolator Row incorporates a combination of standard manhole(s) and strategically located inspection ports (as needed). The inspection ports allow for easy access to the system from the surface, eliminating the need to perform a confined space entry for inspection purposes.

If upon visual inspection it is found that sediment has accumulated, a stadia rod should be inserted to determine the depth of sediment. When the average depth of sediment exceeds 3 inches throughout the length of the Isolator Row, clean-out should be performed.

2.2 MAINTENANCE

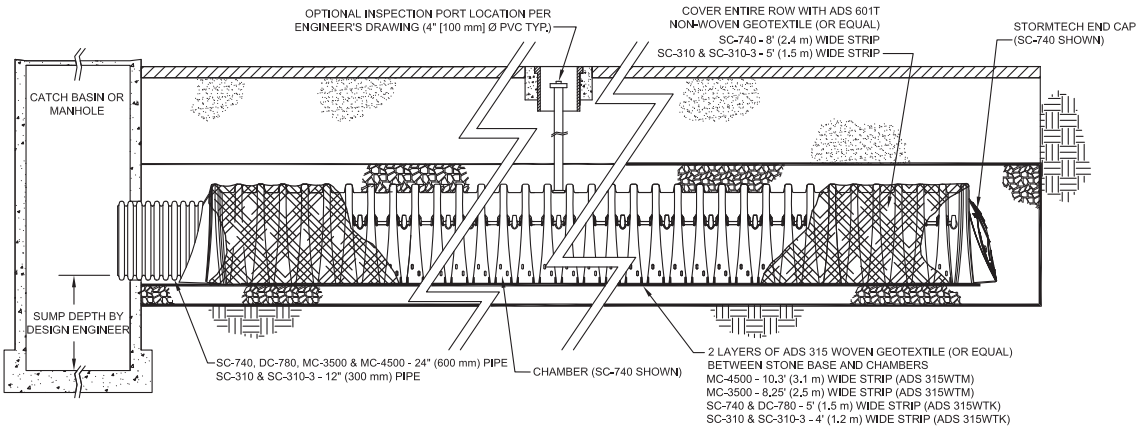
The Isolator Row was designed to reduce the cost of periodic maintenance. By "isolating" sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via a manhole(s) located on the end(s) of the row for cleanout. If entry into the manhole is required, please follow local and OSHA rules for a confined space entries.



Examples of culvert cleaning nozzles appropriate for Isolator Row maintenance. (These are not StormTech products.)

Maintenance is accomplished with the JetVac process. The JetVac process utilizes a high pressure water nozzle to propel itself down the Isolator Row while scouring and suspending sediments. As the nozzle is retrieved, the captured pollutants are flushed back into the manhole for vacuuming. Most sewer and pipe maintenance companies have vacuum/JetVac combination vehicles. Selection of an appropriate JetVac nozzle will improve maintenance efficiency. Fixed nozzles designed for culverts or large diameter pipe cleaning are preferable. Rear facing jets with an effective spread of at least 45" are best. Most JetVac reels have 400 feet of hose allowing maintenance of an Isolator Row up to 50 chambers long. **The JetVac process shall only be performed on StormTech Isolator Rows that have AASHTO class 1 woven geotextile (as specified by StormTech) over their angular base stone.**

StormTech Isolator Row (not to scale)



NOTE: NON-WOVEN FABRIC IS ONLY REQUIRED OVER THE INLET PIPE CONNECTION INTO THE END CAP FOR DC-780, MC-3500 AND MC-4500 CHAMBER MODELS AND IS NOT REQUIRED OVER THE ENTIRE ISOLATOR ROW.

3.0 Isolator Row Step By Step Maintenance Procedures

Step 1) Inspect Isolator Row for sediment

A) Inspection ports (if present)

i. Remove lid from floor box frame

ii. Remove cap from inspection riser

iii. Using a flashlight and stadia rod, measure depth of sediment and record results on maintenance log.

iv. If sediment is at, or above, 3 inch depth proceed to Step 2. If not proceed to step 3.

B) All Isolator Rows

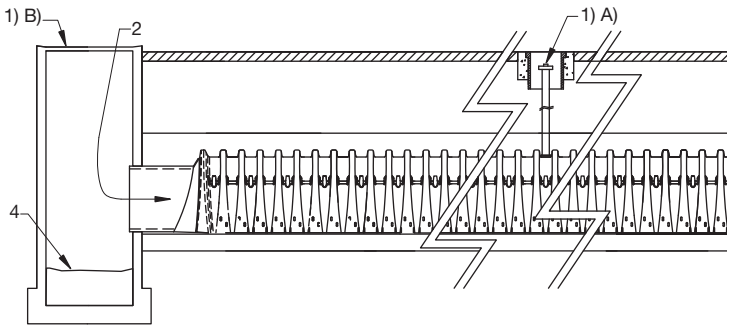
i. Remove cover from manhole at upstream end of Isolator Row

ii. Using a flashlight, inspect down Isolator Row through outlet pipe

1. Mirrors on poles or cameras may be used to avoid a confined space entry
2. Follow OSHA regulations for confined space entry if entering manhole

iii. If sediment is at or above the lower row of sidewall holes (approximately 3 inches) proceed to Step 2. If not proceed to Step 3.

StormTech Isolator Row (not to scale)



Step 2) Clean out Isolator Row using the JetVac process

A) A fixed culvert cleaning nozzle with rear facing nozzle spread of 45 inches or more is preferable

B) Apply multiple passes of JetVac until backflush water is clean

C) Vacuum manhole sump as required

Step 3) Replace all caps, lids and covers, record observations and actions

Step 4) Inspect & clean catch basins and manholes upstream of the StormTech system

Sample Maintenance Log

Date	Stadia Rod Readings		Sediment Depth (1) - (2)	Observations/Actions	Inspector
	Fixed point to chamber bottom (1)	Fixed point to top of sediment (2)			
3/15/01	6.3 ft.	none		New installation. Fixed point is CI frame at grade	djm
9/24/01		6.2	0.1 ft.	Some grit felt	sm
6/20/03		5.8	0.5 ft.	Mucky feel, debris visible in manhole and in Isolator row, maintenance due	rv
7/7/03	6.3 ft.		0	System jetted and vacuumed	djm

StormTech®

Detention • Retention • Water Quality

A division of ADS

70 Inwood Road, Suite 3 | Rocky Hill | Connecticut | 06067

860.529.8188 | 888.892.2694 | fax 866.328.8401 | www.stormtech.com

ADS "Terms and Conditions of Sale" are available on the ADS website, www.ads-pipe.com

Advanced Drainage Systems, the ADS logo, and the green stripe are registered trademarks of Advanced Drainage Systems.

Stormtech® and the Isolator® Row are registered trademarks of StormTech, Inc.

Green Building Council Member logo is a registered trademark of the U.S. Green Building Council.

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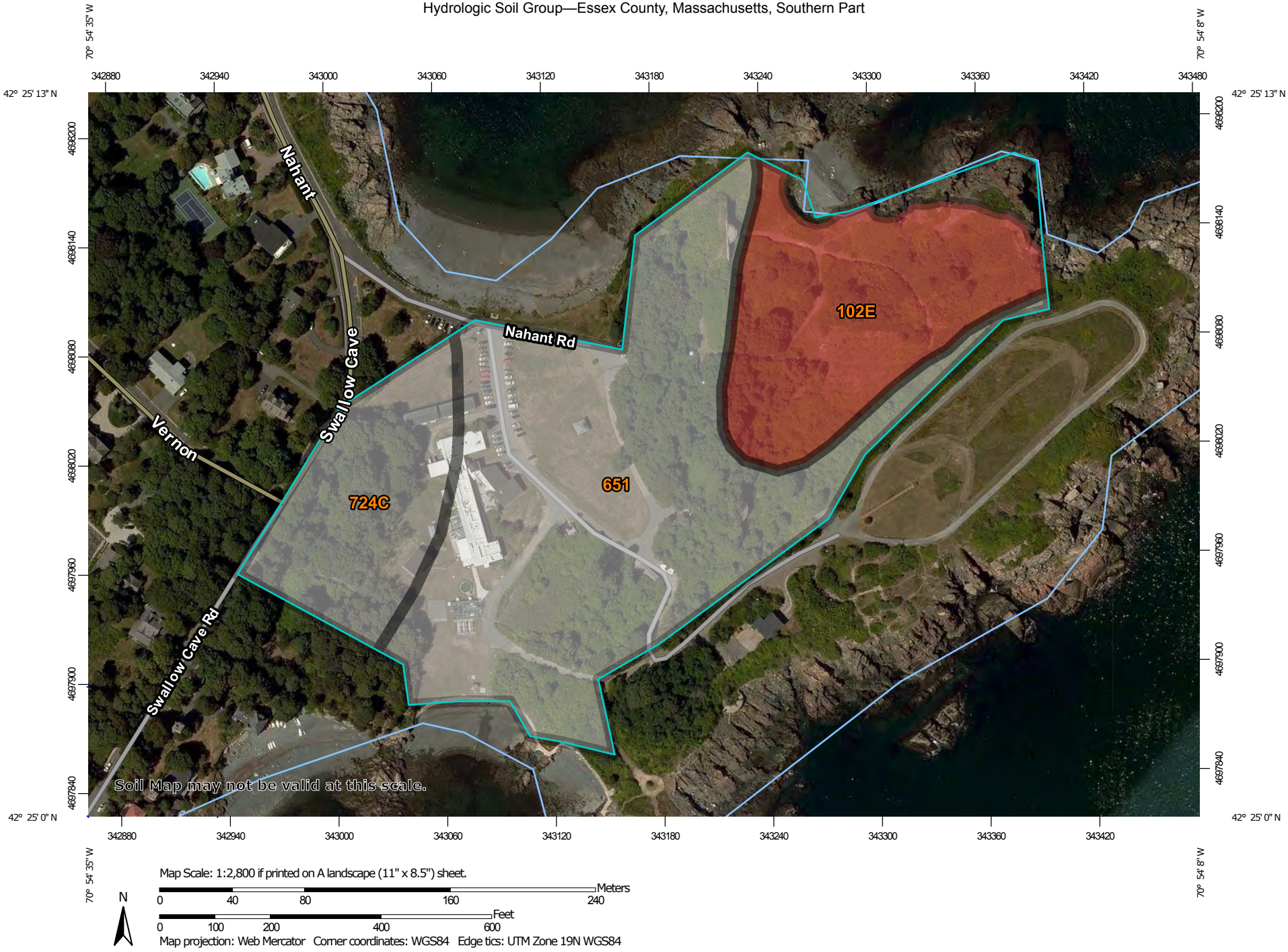
APPENDIX E

Soil Investigations

NRCS Soil Maps and Descriptions

Geotechnical Report Will Include Geotechnical Report in Final Submission

Hydrologic Soil Group—Essex County, Massachusetts, Southern Part



MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Rating Polygons

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

Soil Rating Lines

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

Soil Rating Points

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

Water Features

Streams and Canals

Transportation

- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:15,800.

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

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

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Essex County, Massachusetts, Southern Part
Survey Area Data: Version 14, Oct 6, 2017

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

Date(s) aerial images were photographed: Mar 30, 2011—Aug 25, 2014

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Hydrologic Soil Group

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
102E	Chatfield-Hollis-Rock outcrop complex, 15 to 35 percent slopes	D	4.3	24.0%
651	Udorthents, smoothed		10.2	57.0%
724C	Hollis-Urban land-Rock outcrop complex, sloping		2.9	16.0%
Totals for Area of Interest			**17.9**	**100.0%**

Description

Hydrologic soil groups are based on estimates of runoff potential. Soils are assigned to one of four groups according to the rate of water infiltration when the soils are not protected by vegetation, are thoroughly wet, and receive precipitation from long-duration storms.

The soils in the United States are assigned to four groups (A, B, C, and D) and three dual classes (A/D, B/D, and C/D). The groups are defined as follows:

Group A. Soils having a high infiltration rate (low runoff potential) when thoroughly wet. These consist mainly of deep, well drained to excessively drained sands or gravelly sands. These soils have a high rate of water transmission.

Group B. Soils having a moderate infiltration rate when thoroughly wet. These consist chiefly of moderately deep or deep, moderately well drained or well drained soils that have moderately fine texture to moderately coarse texture. These soils have a moderate rate of water transmission.

Group C. Soils having a slow infiltration rate when thoroughly wet. These consist chiefly of soils having a layer that impedes the downward movement of water or soils of moderately fine texture or fine texture. These soils have a slow rate of water transmission.

Group D. Soils having a very slow infiltration rate (high runoff potential) when thoroughly wet. These consist chiefly of clays that have a high shrink-swell potential, soils that have a high water table, soils that have a claypan or clay layer at or near the surface, and soils that are shallow over nearly impervious material. These soils have a very slow rate of water transmission.

If a soil is assigned to a dual hydrologic group (A/D, B/D, or C/D), the first letter is for drained areas and the second is for undrained areas. Only the soils that in their natural condition are in group D are assigned to dual classes.

Rating Options

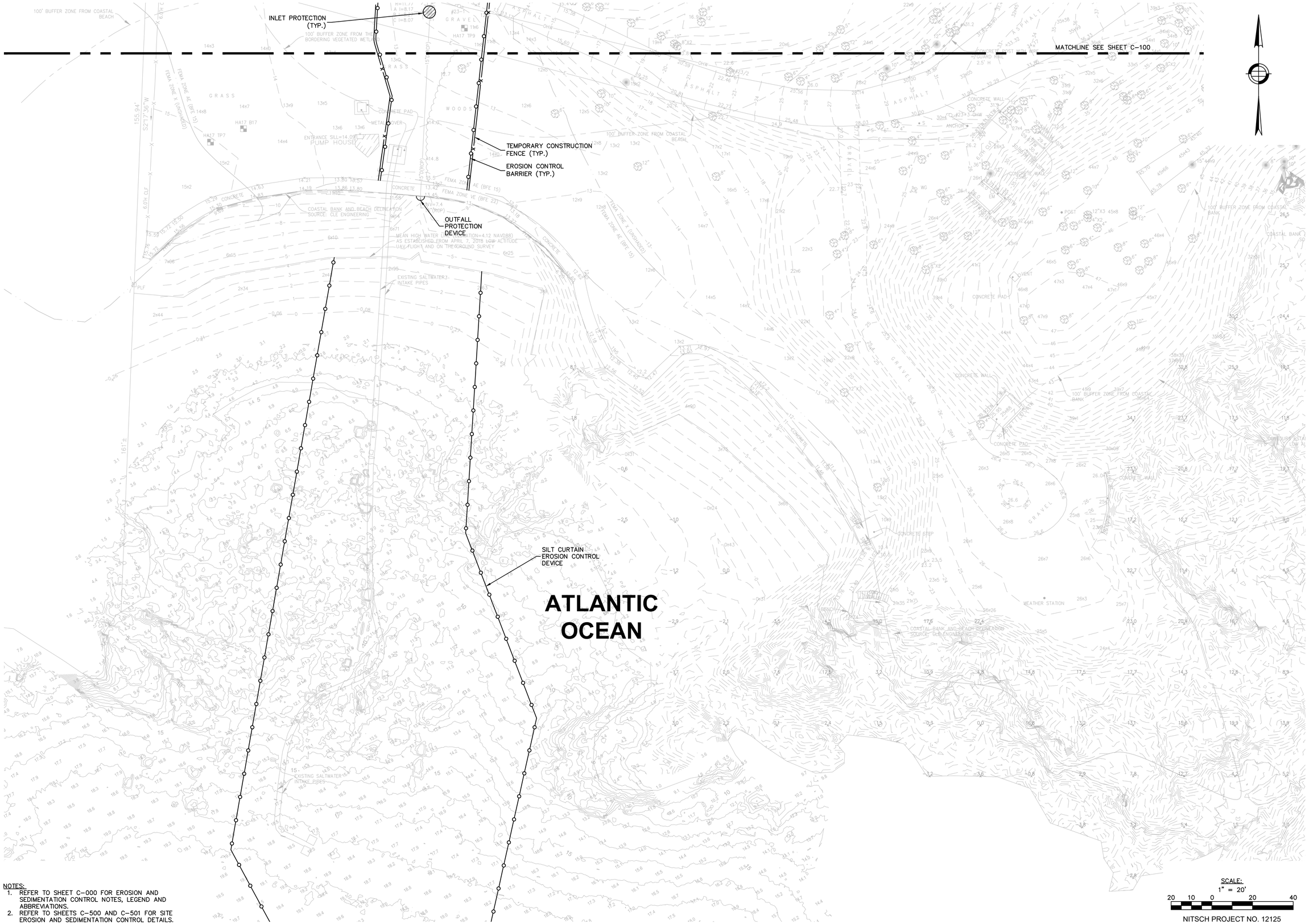
Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Project Plans
(Separate Volume)

SECTION 13



NOTES:
1. REFER TO SHEET C-000 FOR EROSION AND SEDIMENTATION CONTROL NOTES, LEGEND AND ABBREVIATIONS.
2. REFER TO SHEETS C-500 AND C-501 FOR SITE EROSION AND SEDIMENTATION CONTROL DETAILS.

SCALE:
1" = 20'
20 10 0 20 40

NITSCH PROJECT NO. 12125

NORTHEASTERN UNIVERSITY
BOSTON, MASSACHUSETTS

PROJECT:

Nahant Sea Water Pump House

430 NAHANT RD
NAHANT, MA 01908

100% SCHEMATIC DESIGN - FOR ESTIMATE

No.	Date	Revision

CONSULTANT:

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www.nitscheng.com
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Boston, MA 02108
T: (617) 338-0063
F: (617) 338-6472

JONES ARCH
Jones Architecture, INC
10 Derby Square
Salem, MA 01970
978.744.5200
www.jonesarch.com

STAMP:

DATE: 08/10/2018

PROJECT NUMBER: 1227.89

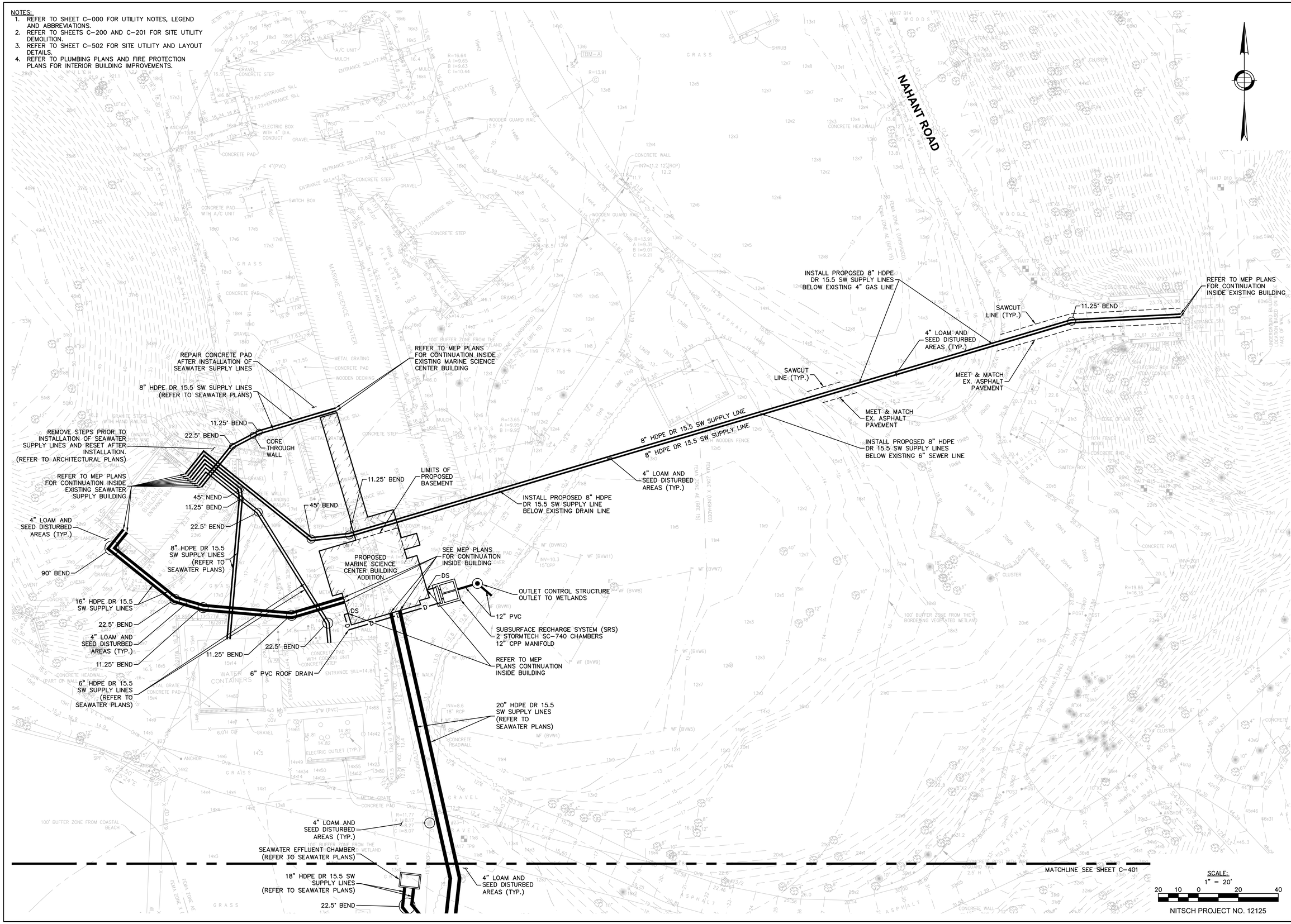
SCALE: 1"=20'

DRAWING TITLE:

SITE EROSION AND SEDIMENTATION CONTROL PLAN II

C-101

NOTES:
1. REFER TO SHEET C-000 FOR UTILITY NOTES, LEGEND AND ABBREVIATIONS.
2. REFER TO SHEETS C-200 AND C-201 FOR SITE UTILITY DEMOLITION.
3. REFER TO SHEET C-502 FOR SITE UTILITY AND LAYOUT DETAILS.
4. REFER TO PLUMBING PLANS AND FIRE PROTECTION PLANS FOR INTERIOR BUILDING IMPROVEMENTS.



NITSCH PROJECT NO. 12125

PROJECT:

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NAHANT, MA 01908

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www.jonesarch.com

STAMP:

DATE: 08/10/2018

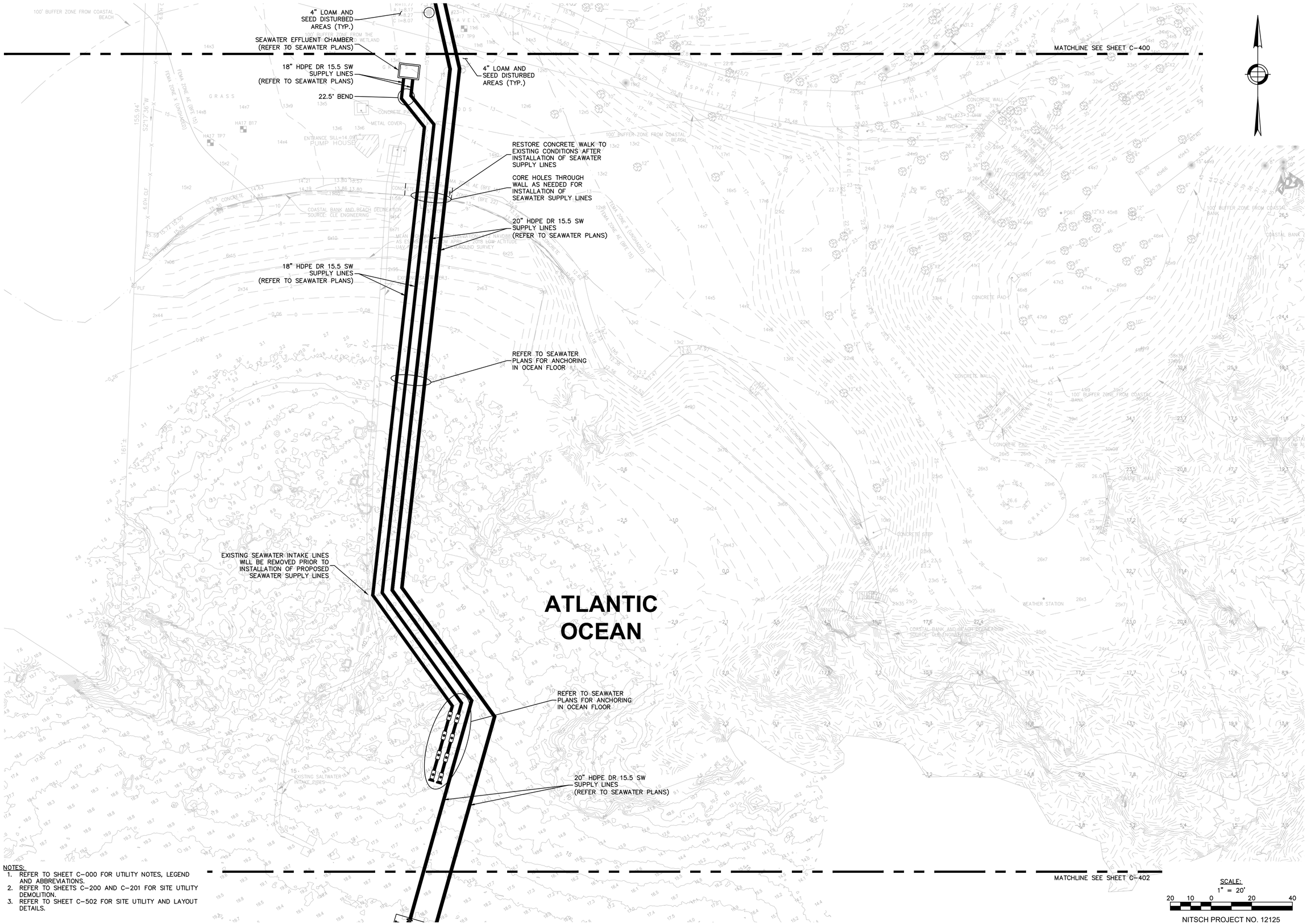
PROJECT NUMBER: 1227.89

SCALE: 1"=20'

DRAWING TITLE:

SITE UTILITY PLAN I

C-400



NOTES:

1. REFER TO SHEET C-000 FOR UTILITY NOTES, LEGEND AND ABBREVIATIONS.
2. REFER TO SHEETS C-200 AND C-201 FOR SITE UTILITY DEMOLITION.
3. REFER TO SHEET C-502 FOR SITE UTILITY AND LAYOUT DETAILS.

SCALE:
1" = 20'
20 10 0 20 40

NITSCH PROJECT NO. 12125

PROJECT:

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NAHANT, MA 01908

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DATE: 08/10/2018

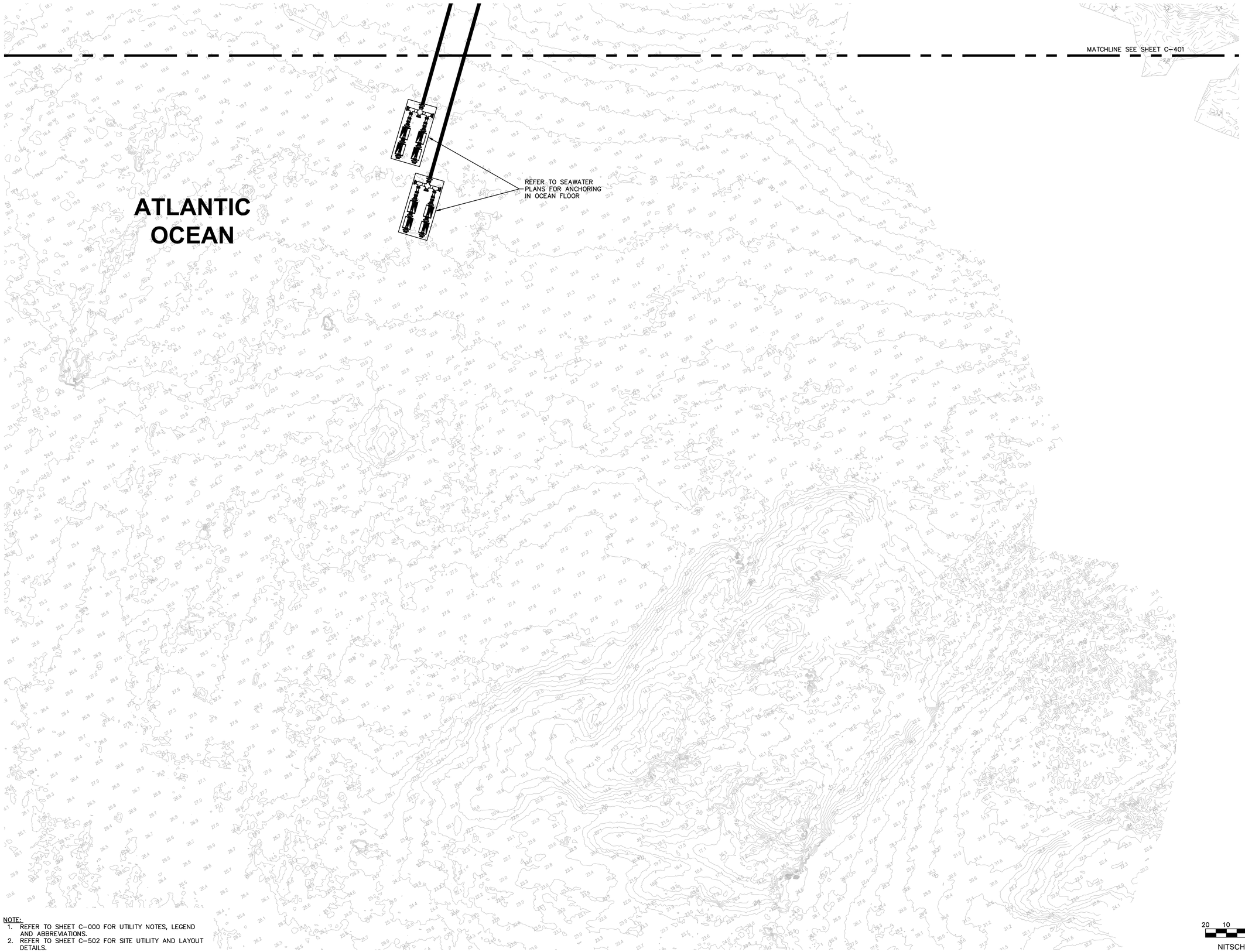
PROJECT NUMBER: 1227.89

SCALE: 1"=20'

DRAWING TITLE:

SITE UTILITY PLAN II

C-401



NOTE:
1. REFER TO SHEET C-000 FOR UTILITY NOTES, LEGEND AND ABBREVIATIONS.
2. REFER TO SHEET C-502 FOR SITE UTILITY AND LAYOUT DETAILS.

SCALE:
1" = 20'
20 10 0 20 40

NITSCH PROJECT NO. 12125

PROJECT:

Nahant Sea Water Pump House

430 NAHANT RD
NAHANT, MA 01908

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DATE:
08/10/2018

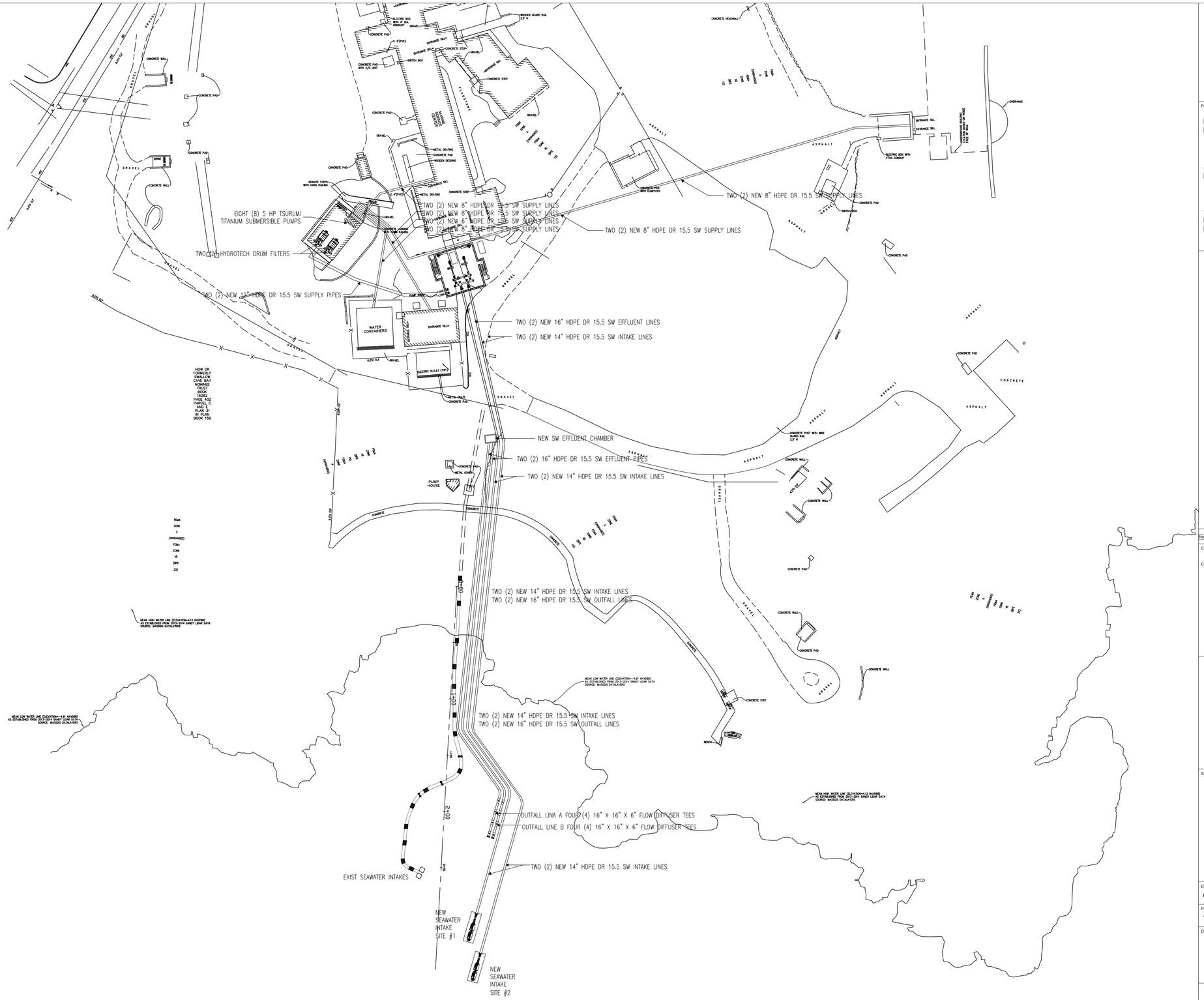
PROJECT NUMBER: 1227.89

SCALE: 1"=20'

DRAWING TITLE:

SITE UTILITY PLAN III

C-402



PROJECT:

Nahant Sea Water Pump House

430 NAHANT RD
NAHANT, MA 01908

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CONSULTANT:

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www.jonesarch.com

STAMP:

DATE:
04/22/2019

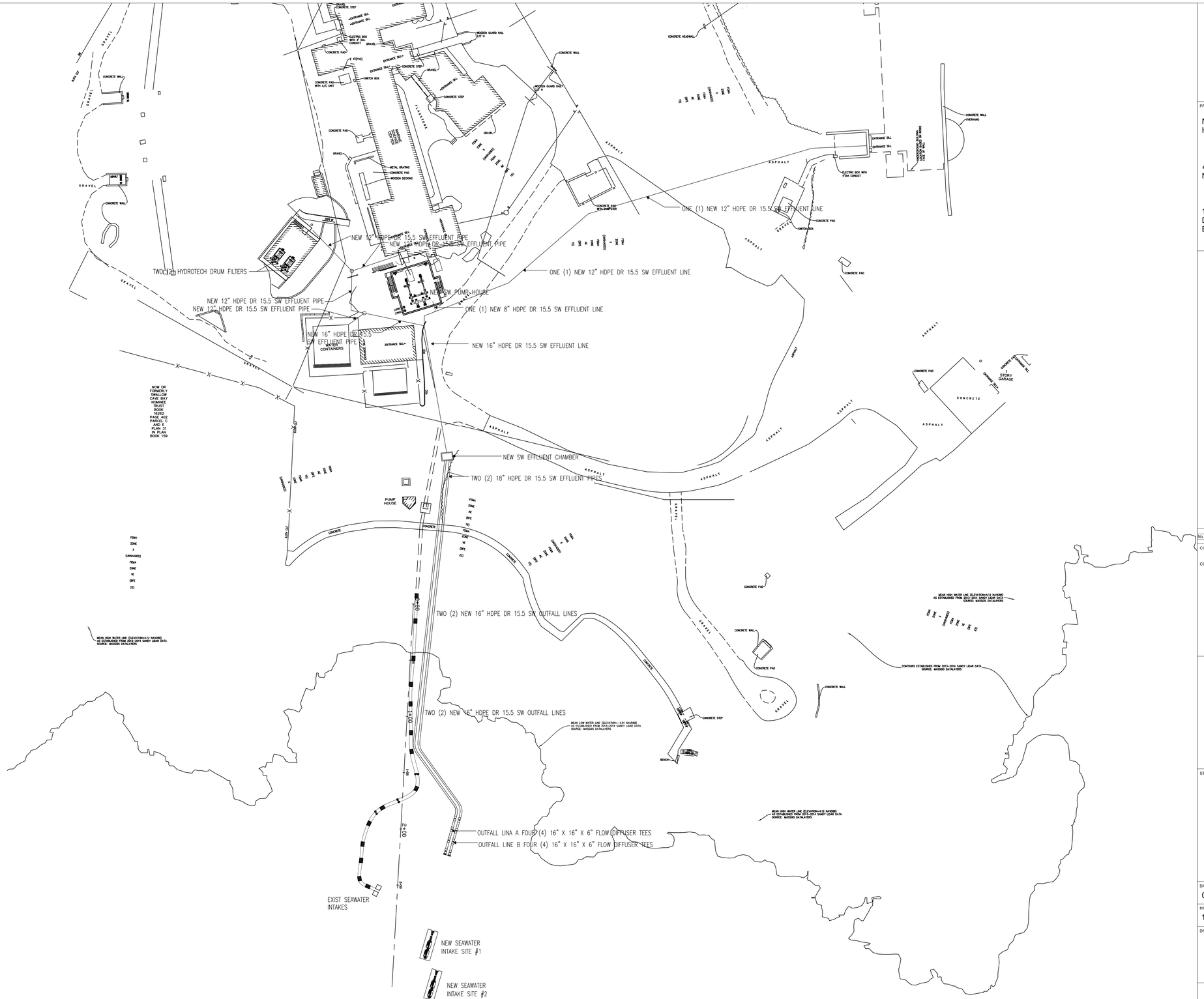
PROJECT NUMBER: 1227.89

SCALE: 1" = 40'-0"

DRAWING TITLE:

SEAWATER INTAKE SITE PIPING PLAN

SW-01



PROJECT:

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STAMP:

DATE:
04/22/2019

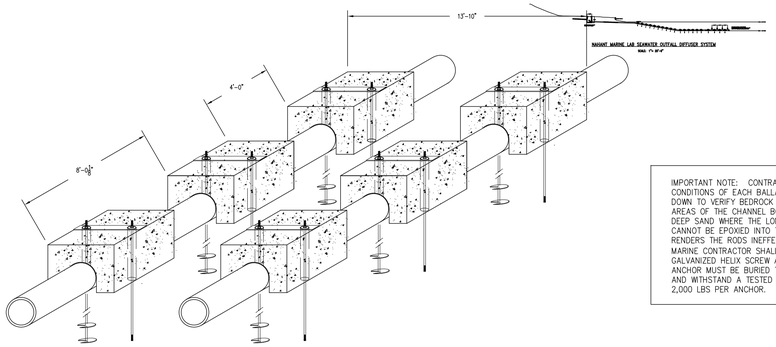
PROJECT NUMBER:
1227.89

SCALE:
1" = 40'-0"

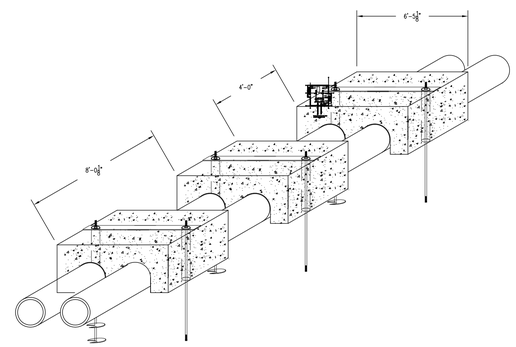
DRAWING TITLE:

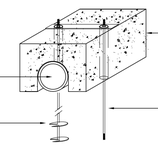
SEAWATER OUTFALL SITE PIPING PLAN

SW-02



IMPORTANT NOTE: CONTRACTOR SHALL VERIFY SPECIFIC SOIL CONDITIONS OF EACH BALLAST LOCATION BY WATER JETTING DOWN TO VERIFY BEDROCK OR SAND BOTTOM CONDITIONS. AREAS OF THE CHANNEL BOTTOM, MAY HAVE POCKETS OF DEEP SAND WHERE THE LONG GALVANIZED THREADED ROD CANNOT BE EPOXIED INTO THE BEDROCK AND THEREFORE RENDERS THE RODS INEFFECTIVE. IN THESE LOCATIONS THE MARINE CONTRACTOR SHALL INSTALL TWO (2) HOT DIPPED GALVANIZED HELIX SCREW ANCHORS PER BALLAST. THE HELIX ANCHOR MUST BE BURIED TO A MINIMUM DEPTH OF 5 FEET AND WITHSTAND A TESTED PULLOUT FORCE OF NOT LESS THAN 2,000 LBS PER ANCHOR.



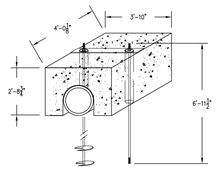


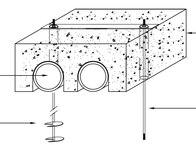
PRECAST CONCRETE HDPE PIPE BALLAST
DRY WEIGHT: 5,000 LBS
SUBMERGED WEIGHT: 2,920 LBS

ONE (1) 14" ø DR 15.5 HDPE PIPE

FOR SEDIMENT BOTTOM: INSTALL TWO (2) AB CHANCE HOT DIPPED GALVANIZED STEEL MODEL # SS5 HELICAL ANCHOR WITH 59" LONG TWIN HELIX LEAD SECTION AND 20" LONG THREADED ADAPTER FOR 1 1/2" SHAFT

BEDROCK BASE: TWO (2) 1 1/2"-7 X 84" LONG 316 STAINLESS STEEL THREADED RODS DRILLED AND SET INTO PLACE BY EPOXYING BOLTS INTO BEDROCK. SECURE CONCRETE BALLAST TO BEDROCK BOTTOM BY TIGHTENING 316 STAINLESS STEEL NUT AND CUSTOM 6" ø X 1/2" THICK 316 STAINLESS STEEL WASHER ONCE UNDERWATER EPOXY HAS CURED. EPOXIED THREAD ROD SHOULD HAVE A PULLOUT RESISTANCE GREATER THAN 2,000 LBS PER ROD. (SEE NOTE BELOW FOR SAND BOTTOM CONDITIONS)



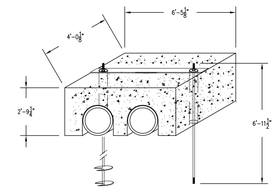


PRECAST CONCRETE HDPE PIPE BALLAST
DRY WEIGHT: 8,000 LBS
SUBMERGED WEIGHT: 4,670 LBS

TWO (2) 14" ø DR 15.5 HDPE PIPES

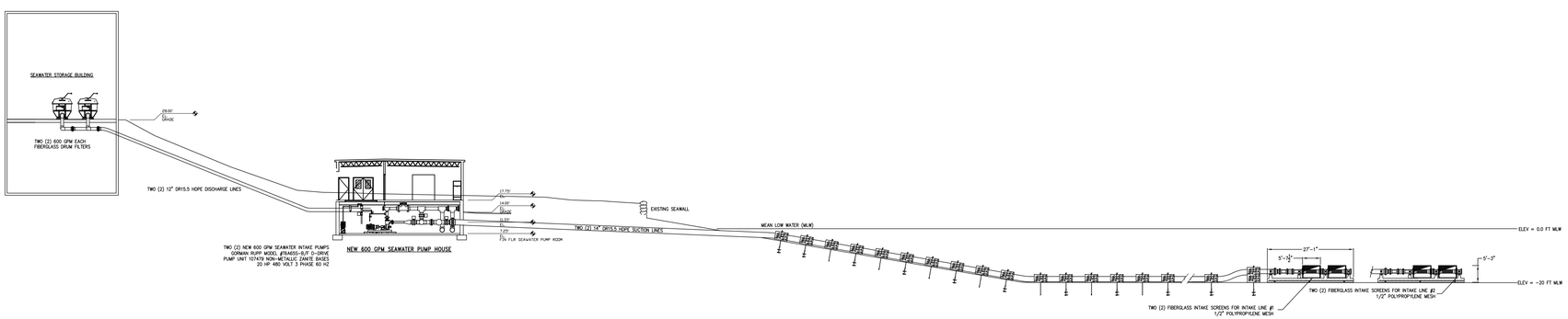
FOR SEDIMENT BOTTOM: INSTALL TWO (2) AB CHANCE HOT DIPPED GALVANIZED STEEL MODEL # SS5 HELICAL ANCHOR WITH 59" LONG TWIN HELIX LEAD SECTION AND 20" LONG THREADED ADAPTER FOR 1 1/2" SHAFT

BEDROCK BASE: TWO (2) 1 1/2"-7 X 84" LONG 316 STAINLESS STEEL THREADED RODS DRILLED AND SET INTO PLACE BY EPOXYING BOLTS INTO BEDROCK. SECURE CONCRETE BALLAST TO BEDROCK BOTTOM BY TIGHTENING 316 STAINLESS STEEL NUT AND CUSTOM 6" ø X 1/2" THICK 316 STAINLESS STEEL WASHER ONCE UNDERWATER EPOXY HAS CURED. EPOXIED THREAD ROD SHOULD HAVE A PULLOUT RESISTANCE GREATER THAN 2,000 LBS PER ROD. (SEE NOTE BELOW FOR SAND BOTTOM CONDITIONS)



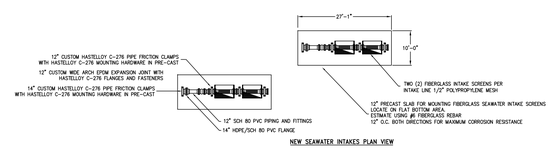
NAHANT MARINE LAB HDPE PIPE BALLASTS

SCALE: 1/4" = 1' - 0"



NAHANT MARINE LAB SEAWATER INTAKE SYSTEM SCHEME

SCALE: 1"= 20'-0"



NEW SEAWATER INTAKES PLAN VIEW

PROJECT:

Nahant Sea Water Pump House

430 NAHANT RD
NAHANT, MA 01908

100% SCHEMATIC DESIGN - FOR ESTIMATE

No.	Date	Revision

CONSULTANT:

CONSULTANT:

TAG Engineering LLC
Seawater Systems Consultant
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508 362-0561

Jones Architecture, INC
10 Derby Square
Salem, MA 01970

978.744.5200
www.jonesarch.com

STAMP:

DATE:
04/22/2019

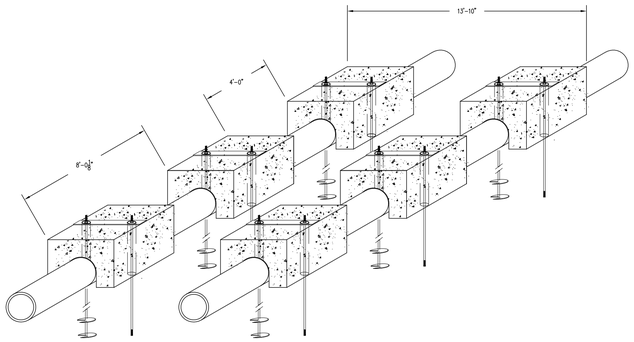
PROJECT NUMBER: 1227.89

SCALE: AS SHOWN

DRAWING TITLE:

SEAWATER INTAKE SYSTEM SCHEME

SW-03



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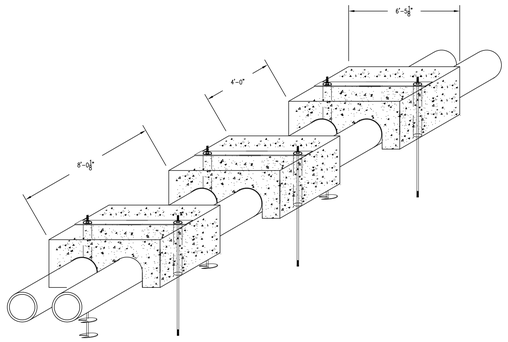
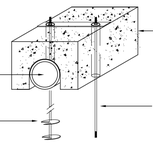


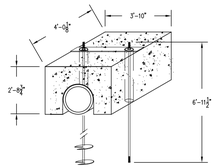


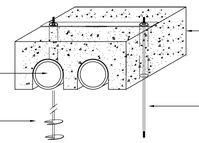
PRECAST CONCRETE HDPE PIPE BALLAST
DRY WEIGHT: 5,000 LBS
SUBMERGED WEIGHT: 2,920 LBS

ONE (1) 20" ø DR 15.5 HDPE PIPE

FOR SEDIMENT BOTTOM: INSTALL TWO (2) AB CHANCE HOT DIPPED GALVANIZED STEEL MODEL # SS5 HELICAL ANCHOR WITH 59" LONG TWIN HELIX LEAD SECTION AND 20" LONG THREADED ADAPTER FOR 1 1/2" SHAFT

BEDROCK BASE: TWO (2) 1 1/2"-7 X 84" LONG 316 STAINLESS STEEL THREADED RODS DRILLED AND SET INTO PLACE BY EPOXYING BOLTS INTO BEDROCK. SECURE CONCRETE BALLAST TO BEDROCK BOTTOM BY TIGHTENING 316 STAINLESS STEEL NUT AND CUSTOM 6" ø X 1/2" THICK 316 STAINLESS STEEL WASHER ONCE UNDERWATER EPOXY HAS CURED. EPOXIED THREAD ROD SHOULD HAVE A PULLOUT RESISTANCE GREATER THAN 2,000 LBS PER ROD. (SEE NOTE BELOW FOR SAND BOTTOM CONDITIONS)



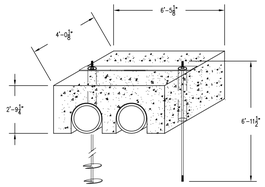


PRECAST CONCRETE HDPE PIPE BALLAST
DRY WEIGHT: 8,000 LBS
SUBMERGED WEIGHT: 4,670 LBS

TWO (2) 20" ø DR 15.5 HDPE PIPES

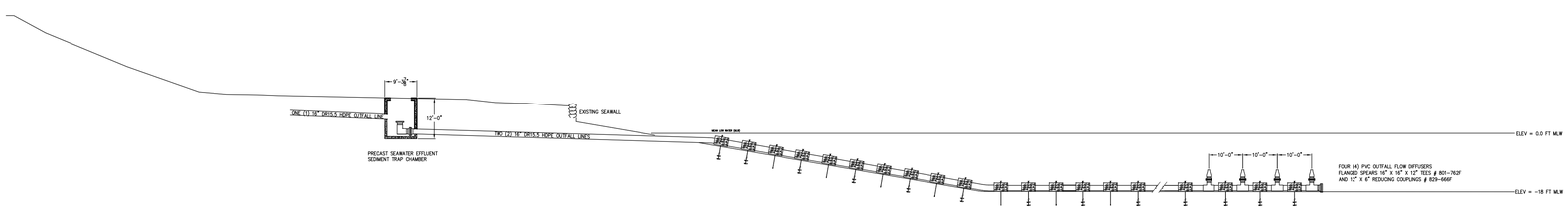
FOR SEDIMENT BOTTOM: INSTALL TWO (2) AB CHANCE HOT DIPPED GALVANIZED STEEL MODEL # SS5 HELICAL ANCHOR WITH 59" LONG TWIN HELIX LEAD SECTION AND 20" LONG THREADED ADAPTER FOR 1 1/2" SHAFT

BEDROCK BASE: TWO (2) 1 1/2"-7 X 84" LONG 316 STAINLESS STEEL THREADED RODS DRILLED AND SET INTO PLACE BY EPOXYING BOLTS INTO BEDROCK. SECURE CONCRETE BALLAST TO BEDROCK BOTTOM BY TIGHTENING 316 STAINLESS STEEL NUT AND CUSTOM 6" ø X 1/2" THICK 316 STAINLESS STEEL WASHER ONCE UNDERWATER EPOXY HAS CURED. EPOXIED THREAD ROD SHOULD HAVE A PULLOUT RESISTANCE GREATER THAN 2,000 LBS PER ROD. (SEE NOTE BELOW FOR SAND BOTTOM CONDITIONS)



NAHANT MARINE LAB HDPE PIPE BALLASTS

SCALE: 1/4" = 1' - 0"



NAHANT MARINE LAB SEAWATER OUTFALL DIFFUSER SYSTEM

SCALE: 1"= 20'-0"

PROJECT:

Nahant Sea Water Pump House

430 NAHANT RD
NAHANT, MA 01908

100% SCHEMATIC DESIGN - FOR ESTIMATE

No.	Date	Revision

CONSULTANT:

CONSULTANT:

TAG Engineering LLC
Seawater Systems Consultant
P.O. Box 558
Woods Hole, MA 02543
508 362-0561

Jones Architecture, INC
10 Derby Square
Salem, MA 01970

978.744.5200
www.jonesarch.com

STAMP:

DATE:
04/22/2019

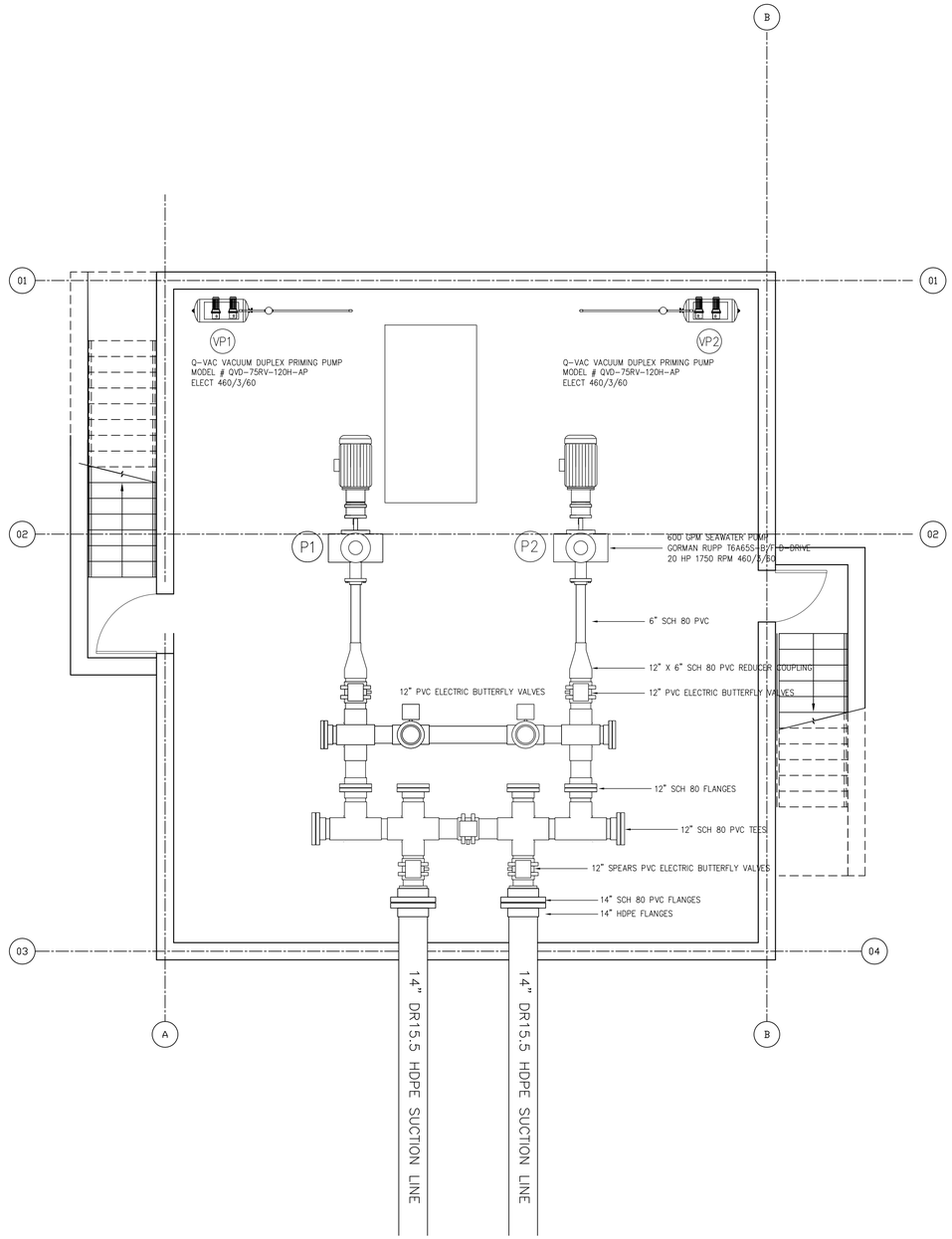
PROJECT NUMBER: 1227.89

SCALE: AS SHOWN

DRAWING TITLE:

SEAWATER OUTFALL PIPING SCHEME

SW-04



NEW 600 GPM SEAWATER PUMP HOUSE

SEAWATER SUCTION PIPING PLAN

PROJECT:

Nahant Sea Water Pump House

430 NAHANT RD
NAHANT, MA 01908

100% SCHEMATIC DESIGN - FOR ESTIMATE

No.	Date	Revision

CONSULTANT:

CONSULTANT:

TAG Engineering LLC
Seawater Systems Consultant
P.O. Box 558
Woods Hole, MA 02543
508 362-0561

Jones Architecture, INC
10 Derby Square
Salem, MA 01970

978.744.5200
www.jonesarch.com

STAMP:

DATE:
04/22/2019

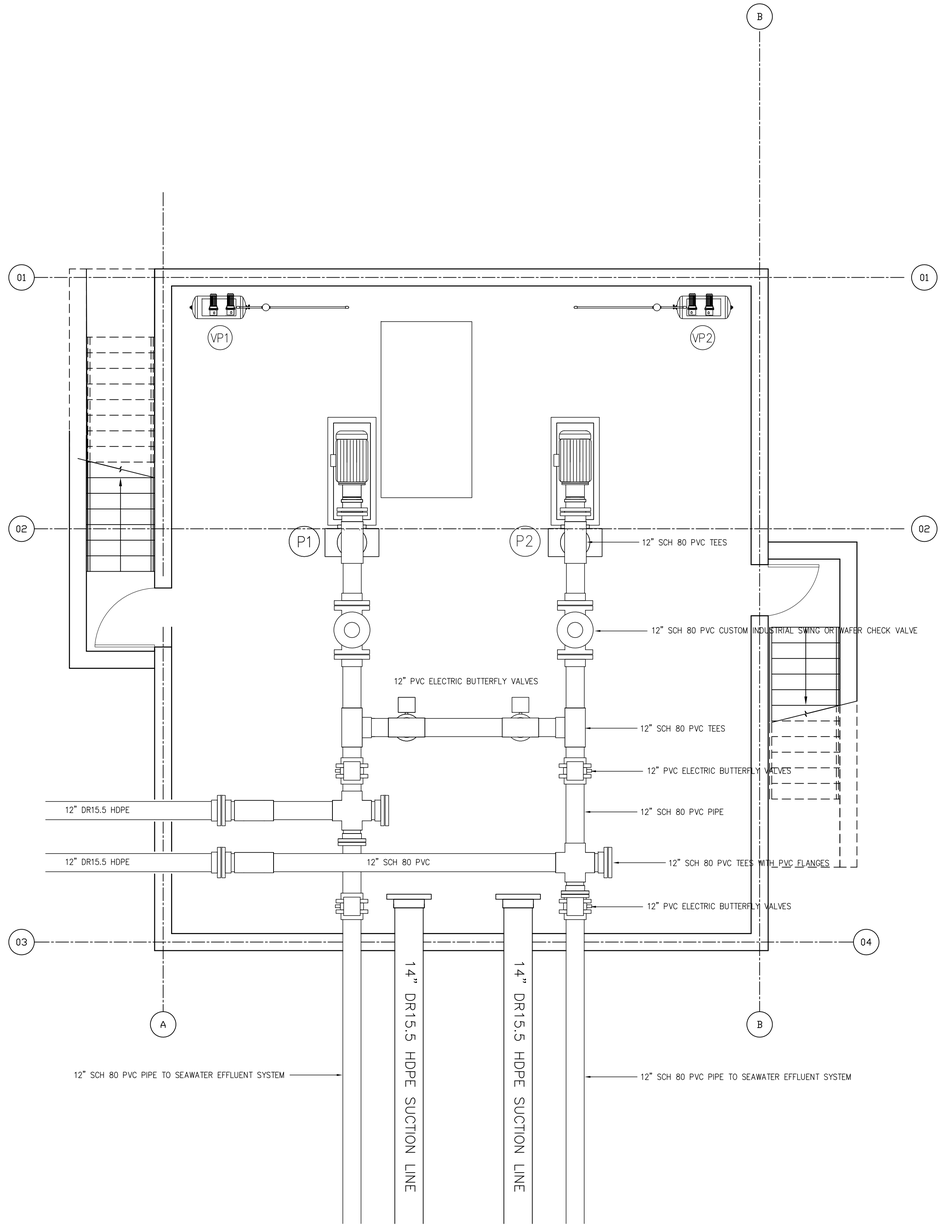
PROJECT NUMBER: 1227.89

SCALE: 1/4" = 1'-0"

DRAWING TITLE:

SEAWATER PUMP HOUSE
SUCTION PIPING PLAN

SW-05



NEW 600 GPM SEAWATER PUMP HOUSE

SEAWATER DISCHARGE PIPING

PROJECT:

Nahant Sea Water Pump House

430 NAHANT RD
NAHANT, MA 01908

100% SCHEMATIC DESIGN - FOR ESTIMATE

No.	Date	Revision

CONSULTANT:

CONSULTANT:

TAG Engineering LLC
Seawater Systems Consultant
P.O. Box 558
Woods Hole, MA 02543
508 362-0561

Jones Architecture, INC
10 Derby Square
Salem, MA 01970

978.744.5200
www.jonesarch.com

STAMP:

DATE:
04/22/2019

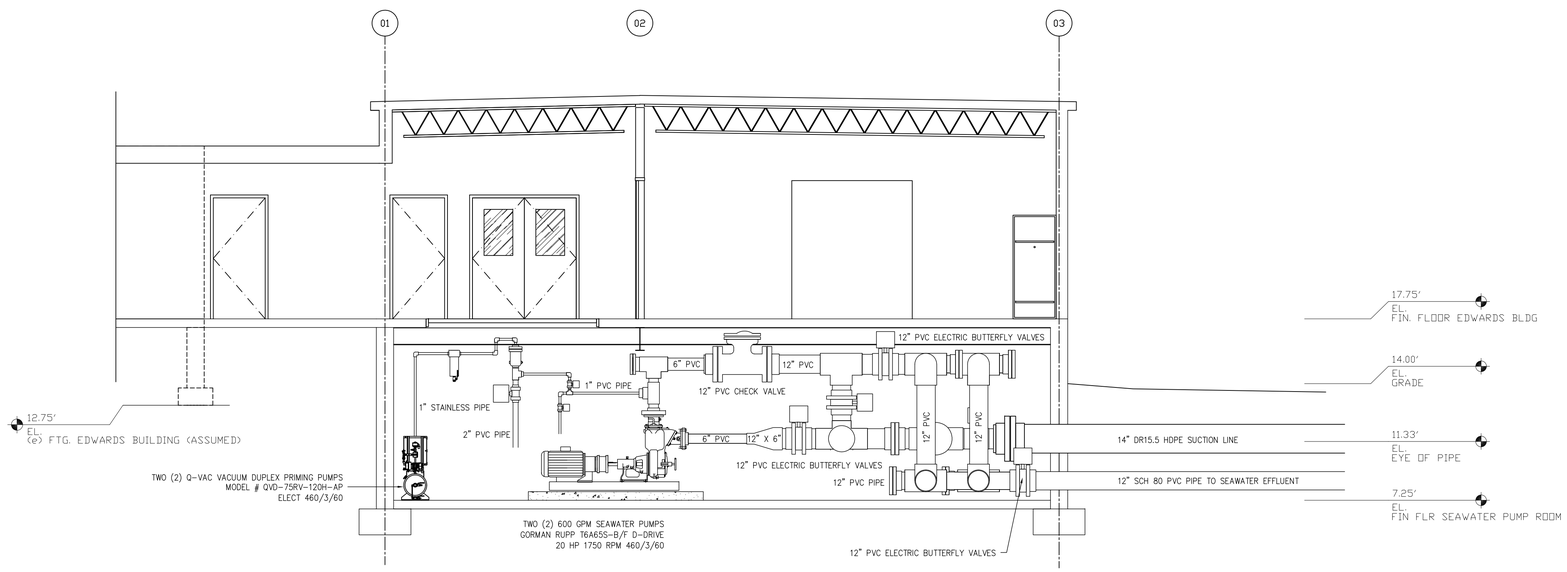
PROJECT NUMBER: 1227.89

SCALE: 1/4" = 1'-0"

DRAWING TITLE:

SEAWATER PUMP HOUSE
DISCHARGE PIPING PLAN

SW-06



NEW 600 GPM SEAWATER PUMP HOUSE

SEAWATER PIPING SYSTEM SECTION

PROJECT:

Nahant Sea Water Pump House

430 NAHANT RD
NAHANT, MA 01908

100% SCHEMATIC DESIGN - FOR ESTIMATE

No.	Date	Revision

CONSULTANT:

CONSULTANT:

TAG Engineering LLC
Seawater Systems Consultant
P.O. Box 558
Woods Hole, MA 02543
508 362-0561

Jones Architecture, INC
10 Derby Square
Salem, MA 01970

978.744.5200
www.jonesarch.com

STAMP:

DATE:
04/22/2019

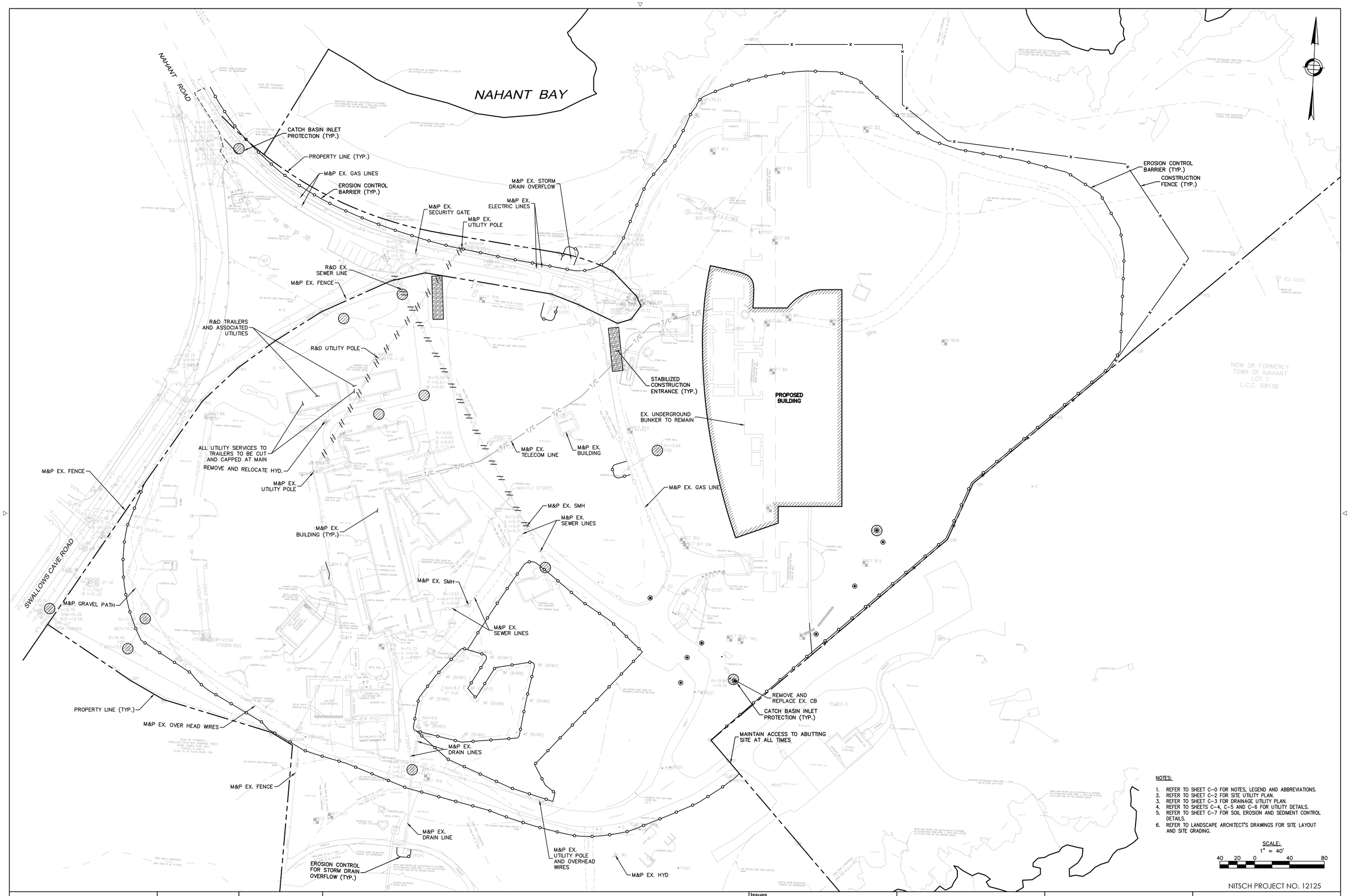
PROJECT NUMBER: 1227.89

SCALE: 1/4" = 1'-0"

DRAWING TITLE:

SEAWATER PUMP HOUSE PIPING SECTION

SW-07



NOTES:

1. REFER TO SHEET C-0 FOR NOTES, LEGEND AND ABBREVIATIONS.
2. REFER TO SHEET C-2 FOR SITE UTILITY PLAN.
3. REFER TO SHEET C-3 FOR DRAINAGE UTILITY PLAN.
4. REFER TO SHEETS C-4, C-5 AND C-6 FOR UTILITY DETAILS.
5. REFER TO SHEET C-7 FOR SOIL EROSION AND SEDIMENT CONTROL DETAILS.
6. REFER TO LANDSCAPE ARCHITECT'S DRAWINGS FOR SITE LAYOUT AND SITE GRADING.

SCALE:
1" = 40'
40 20 0 40 80

NITSCH PROJECT NO. 12125

Architect

Payette Associates Inc.
290 Congress Street, Fifth Floor
Boston, MA 02210-1005
Tel: 617-895-1000
Fax: 617-895-1002

PAYETTE

Landscape Architect

Stephen Stimson Associates
288 Norfolk St, #5
Cambridge, MA 02139
Tel: 617-876-8960

Civil Engineer

Nitsch Engineering
2 Center Plaza, #430
Boston, MA 02108
Tel: 617-338-0063

MEP Engineer

Bard, Rao + Athanas Consulting Engineers, LLC
10 Guest St
Boston, MA 02135
Tel: 617-254-0016

Structural Engineer

Simpson Gumpertz & Heger
41 Seyon Street
Bldg. 1, Suite 500
Waltham, MA 02453
Tel: 781-907-9000

Issues

Number	Date	Description
01	04/29/19	WPA Notice of Intent Submission

Revisions

Number	Date	Description

DRAFT

NORTHEASTERN UNIVERSITY COASTAL SUSTAINABILITY INSTITUTE

SOIL EROSION AND SEDIMENT CONTROL AND DEMOLITION PLAN

Drawing Scale
1"=40

Project Number
45270.00

Date Issued
APRIL 29, 2019

C-1

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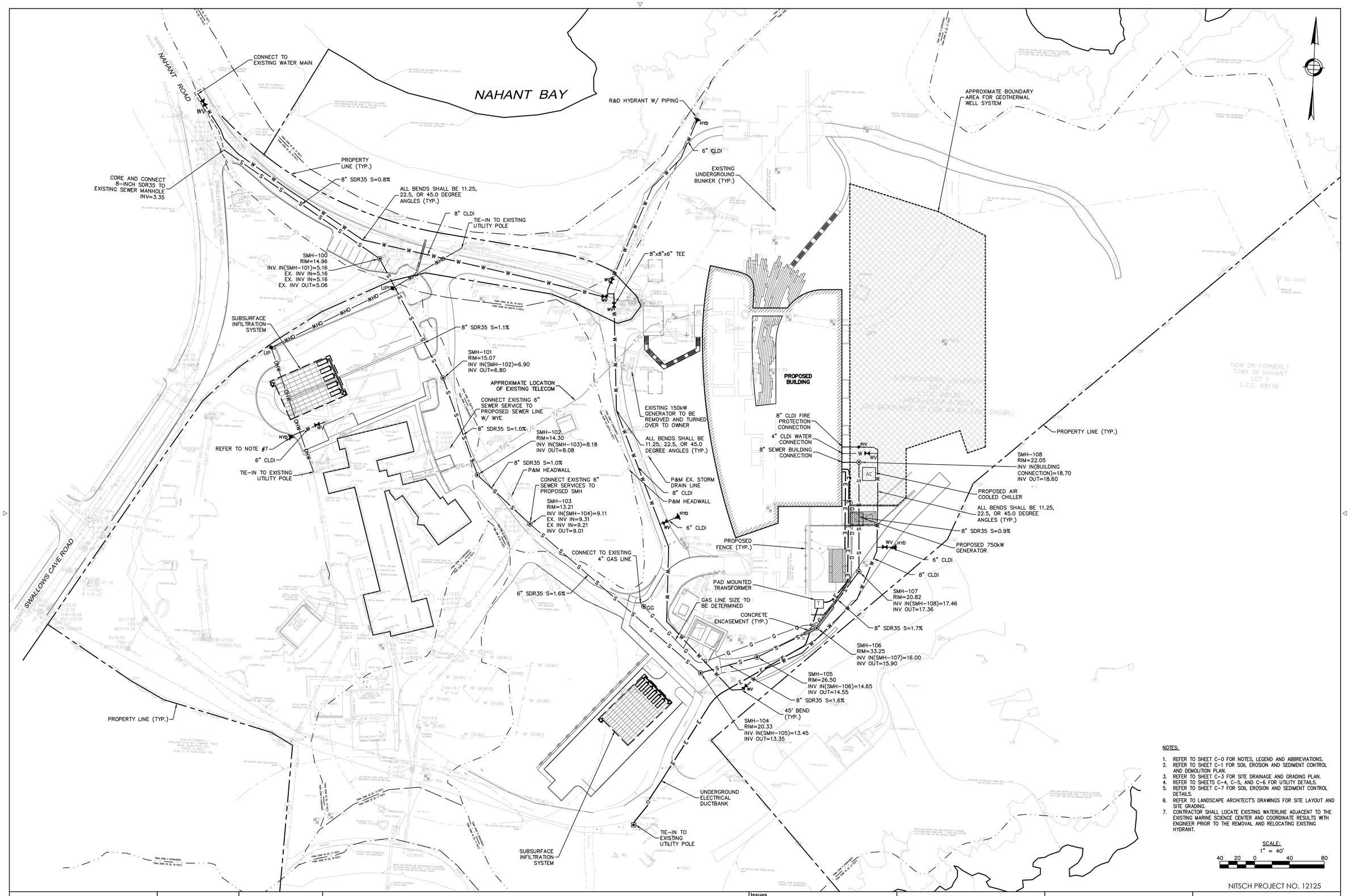

NOTES:

1. REFER TO SHEET C-0 FOR NOTES, LEGEND AND ABBREVIATIONS.
2. REFER TO SHEET C-1 FOR SOIL EROSION AND SEDIMENT CONTROL AND DEMOLITION PLAN.
3. REFER TO SHEET C-3 FOR SITE DRAINAGE AND GRADING PLAN.
4. REFER TO SHEETS C-4, C-5, AND C-6 FOR UTILITY DETAILS.
5. REFER TO SHEET C-7 FOR SOIL EROSION AND SEDIMENT CONTROL DETAILS.
6. REFER TO LANDSCAPE ARCHITECT'S DRAWINGS FOR SITE LAYOUT AND SITE GRADING.
7. CONTRACTOR SHALL LOCATE EXISTING WATERLINE ADJACENT TO THE EXISTING MARINE SCIENCE CENTER AND COORDINATE RESULTS WITH ENGINEER PRIOR TO THE REMOVAL AND RELOCATING EXISTING HYDRANT.

SCALE:
1" = 40'
40 20 0 40 80

NITSCH PROJECT NO. 12125

Architect

Payette Associates Inc.
290 Congress Street, Fifth Floor
Boston, MA 02210-1005
Tel: 617-895-1000
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01	04/29/19	WPA Notice of Intent Submission

Revisions

Number	Date	Description

DRAFT

NORTHEASTERN UNIVERSITY COASTAL SUSTAINABILITY INSTITUTE

SITE UTILITY PLAN

Drawing Scale
AS NOTED

Project Number
45270.00

Date Issued
APRIL 29, 2019

C-2

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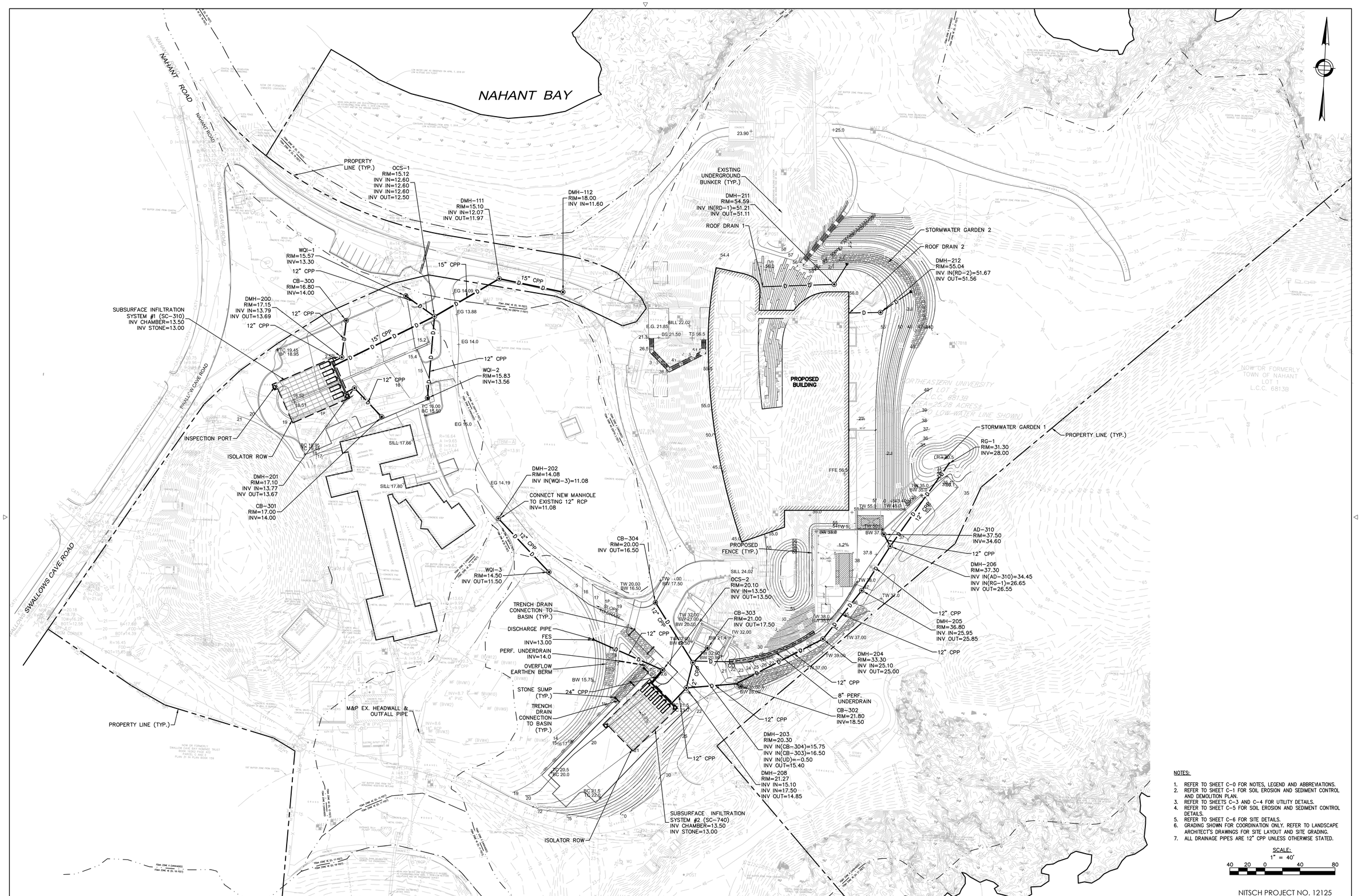

NOTES:

1. REFER TO SHEET C-0 FOR NOTES, LEGEND AND ABBREVIATIONS.
2. REFER TO SHEET C-1 FOR SOIL EROSION AND SEDIMENT CONTROL AND DEMOLITION PLAN;
3. REFER TO SHEETS C-3 AND C-4 FOR UTILITY DETAILS.
4. REFER TO SHEET C-5 FOR SOIL EROSION AND SEDIMENT CONTROL DETAILS.
5. REFER TO SHEET C-6 FOR SITE DETAILS.
6. GRADING SHOWN FOR COORDINATION ONLY. REFER TO LANDSCAPE ARCHITECT'S DRAWINGS FOR SITE LAYOUT AND SITE GRADING.
7. ALL DRAINAGE PIPES ARE 12" CPP UNLESS OTHERWSE STATED.

SCALE:
1" = 40'
40 20 0 40 80

NITSCH PROJECT NO. 12125

Architect

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PAYETTE

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Revisions

Number	Date	Description

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NORTHEASTERN UNIVERSITY COASTAL SUSTAINABILITY INSTITUTE

SITE DRAINAGE AND GRADING PLAN

Drawing Scale
AS NOTED

Project Number
45270.00

Date Issued
APRIL 29, 2019

C-3

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