Stormwater Report
Hingham Gas
19 & 27 Whiting Street
Hingham, Massachusetts

CHA Project Number: 60903

Applicant:
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LIST OF ACRONYMS & ABBREVIATIONS

BFE	Base Flood Elevation
BMP	Best Management Practice
BVW	Bordering Vegetated Wetland
FEMA	Federal Emergency Management Agency
FIRM	Flood Insurance Rate Map
HSG	Hydrologic Soil Group
IWPA	Interim Wellhead Protection Area
MAHW	Mean Annual High-Water
MassDEP	Massachusetts Department of Environmental Protection
NAVD	North American Vertical Datum
NRCS	Natural Resources Conservation Service
SHGW	Seasonal High Groundwater
SWMSH	Stormwater Management Standards Handbook
Tc	Time of Concentration
TSS	Total Suspended Solids
USGS	United States Geological Survey

1.0 NARRATIVE

1.1 EXECUTIVE SUMMARY

The Applicant, Merhej & Sons Realty, LLC (Merhej), proposes to develop a new retail building adjacent to the existing gas station to replace the aging kiosk located currently on the property at 19 Whiting Street in Hingham, MA. The site consists of two parcels 19 and 27 Whiting Street which will be combined into one parcel to support the development. The proposed building has an approximate footprint of 3,500 square-feet and will consist of an approximate 2,530 square feet of retail and an approximate 1,000 square feet of accessory storage with 500 square feet on the main level and 500 square-feet for maintenance (stepped foundation). All storage is complementary to use and accessible by employees only. The proposed building will be served by an onsite Title 5 septic system to be permitted with the Hingham Board of Health. The proposed development has been designed to be located mainly within areas that were previously disturbed; an existing gas station on 19 Whiting St and a residential house on the 27 Whiting St parcel.

The site is bounded by Whiting Street to the south by commercial development on the east and west. The site is located in the Business C zoning district with a small rear portion of the 27 Whiting St parcel designated Residence B. The parcels are located in the Hingham Aquifer Protection District and Accord Pond Watershed. Wetland areas exist on the 27 Whiting St parcel. The site is not located within a habitat area designated by the Natural Heritage and Endangered Species Program (NHESP) (see Figure 3).

The drainage systems on the site are comprised of closed-conveyance pipe system which will collect and convey stormwater runoff from paved surfaces and the roof area to two subsurface recharge/detention systems that ultimately discharges outside of the 50-foot buffer. Treatment of the stormwater runoff will be via deep sump catch basins, oil/water separators, and isolator rows prior to recharge/detention and then discharge. The subsurface systems will attenuate peak rates of runoff. The stormwater system provides the required treatment for stormwater runoff from impervious areas as required by the 2008 Massachusetts Stormwater Handbook. Refer to the attached site plans for additional information. The project will be serviced with water provided by the Weir River Water Company (Weir Rivre), and the wastewater is discharged via a proposed on-site Title 5 septic system. Electricity is supplied by the Hingham Municipal Lighting Plant.

1.2 OBJECTIVE OF CALCULATIONS

The purpose of this stormwater analysis is to assess and quantify the existing and proposed stormwater runoff conditions from the site based upon the Massachusetts Department of Environmental Protection (MassDEP) Stormwater Management Standards and the applicable provisions of the Town of Hingham Regulations.

The goals of the stormwater management system design for this project are to provide improved water quality, reduce post-development peak runoff rates as compared to pre-development peak runoff rates, maximize infiltration to the maximum extent practicable, and to protect the surrounding area from any potential flooding and/or environmental impacts. The following stormwater routing calculations were performed using the 2-year, 10-year, 25-year, and 100-year frequency. Type III, 24-hour SCS design storms and were compared for both pre-development and post-development conditions.

1.3 METHODOLOGY

The HydroCAD Stormwater Modeling System computer program, version 10.0, by Applied Microcomputer Systems, Inc. is used to develop stormwater runoff rates and volumes for the existing and proposed conditions at the project site. The HydroCAD software is a hydrograph generation and routing program similar to TR-20. The software uses Soil Conservation Service (SCS) Unit Hydrograph Methodology. This drainage analysis was developed utilizing a Type III, 24-hour storm as developed by the Soil Conservation Service (SCS). Information regarding the equations and calculation procedures utilized in HydroCAD will be made available upon request. The following basic steps are employed in the procedure:

1. A rainfall distribution is selected which indicates how the storm depth will be distributed over time. This is the standardized Type III SCS distribution based upon the project’s location.
2. The design storm depth is determined from rainfall frequency atlas based upon the return period being modeled. Combined with the distribution of rainfall will yield the cumulative depth at each period during the storm.
3. Based upon the Time of Concentration (Tc), the storm is divided into bursts of equal duration. For each burst, the SCS runoff equation and the average Curve Number are used to determine the portion of that burst that will appear as runoff.
4. A unit hydrograph representing the runoff resulting from one inch of precipitation excess generated uniformly over the watershed in conduction with the Time of Concentration is used to determine how the runoff from a burst is distributed over time. The result is a runoff hydrograph for a single burst.

5. Individual hydrographs are added together for all bursts in the storm yielding the complete runoff hydrograph for each storm.

The SCS rainfall distributions are derived from observations that were used to develop the Intensity-Duration-Frequency relationship or IDF curve. By studying the Weather Bureau's Rainfall Frequency Atlases, the SCS developed four "mass curves" that could be used to represent the characteristics of the rainfall distribution throughout the continental United States. The mass curve is a dimensionless distribution of rainfall over time, which indicates the fraction of the rainfall event that occurs at a given time within a 24-hour precipitation event. This synthetic distribution develops peak rates for storms of varying durations and intensities. The SCS distribution provides a cumulative rainfall at any point in time and allows volume dependent routing runoff calculations to occur.

The HydroCAD software has the additional capability to describe shallow concentrated flow. The "NEH-4 Upland Method" included in the HydroCAD software is applicable for conditions which occur in the headwaters of a watershed up to 2000 acres. The NEH-4 Upland Method allows the Time of Concentration (T_c) to reflect ground conditions such as overland flow, grassed waterways, paved areas and upland gullies. This results in a model that more accurately reflects the ground surface for shallow concentrated flow conditions, than TR-20, which is limited to distinguishing only paved and unpaved surfaces. T_c is the time required for water to flow from the most distant point on a runoff area to the measurement or collection point. In instances where the watersheds are small and impervious, Tc has been directly entered as a 5-minute minimum. This is consistent with standard engineering practice and Technical Release (TR-55) Urban Hydrology for Small Watersheds graphical method. A lower boundary of 5 minutes will yield a conservative, yet practical measure of stormwater runoff flow for small watersheds contained within the development.

The curve number or CN is a land sensitive coefficient that dictates the relationship between total rainfall depth and direct stormwater runoff. Based upon the cover in each sub-watershed a weighted average CN value was determined. The area, CN values, and time of concentration were entered into HydroCAD to develop hydrographs for the pre and post developed conditions.

1.4 SITE HYDROLOGY

Hydrologic soil groups (HSG) are used primarily to estimate runoff from precipitation in engineering calculations. HSG designations vary from "A" to "D" with "A" having the highest infiltration rate and "D" the slowest. Test pits were performed by a licensed soil evaluator in locations proximate to the proposed stormwater systems to confirm the infiltration rates and groundwater data used in the design and were witnessed by a peer review consultant of the Town.

Soils on the site consist soils from hydrologic soil groups (HSG) "A" through "D" based on the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS), Soil Survey of Plymouth County. Soils within the property are classified as: Urban Land towards Whiting Street, Hinckley gravely sandy loam and Newfields fine sandy loam within the interior of the parcel, and Scarboro muck within the wetland areas.

Test pits and site visits indicate permeable soils located on the south and east side of the 27 Whiting St. parcel with less permeable soils to the west and north towards the wetland resource area. HSG "A" was used for areas as presented on the hydrology plans (portion of 27 Whiting and all of 19 Whiting) and a HSG "C" was utilized for all other areas for all areas on the site. Refer to the watershed plans in Section 3.3 of this report for more information.

Two distinct design points (DP-1 and DP-2) were chosen at down gradient points in the drainage area to compare development conditions for each of the following SCS Type III 24-hour design storm events. The design storm frequencies and corresponding rainfall depths were compiled from the "Atlas of Precipitation Extremes for the Northeastern United States and Southeastern Canada" and Technical Paper No. 40, Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and 1 to 100 Years" and have been estimated as follows for Plymouth County:

Storm Frequency (Years)	Rainfall Depth (Inches)
2	3.4
10	4.7
25	5.6
100	7.0

Drainage watershed plans for both pre- and post-development conditions have been included in Section 3.3 of this report.

1.4.1 ESTIMATED SEASONAL HIGH GROUNDWATER

Seasonal high groundwater represents the highest groundwater elevation. Depth to seasonal high groundwater may be identified based on Redoximorphic (Redox) Features in the soil.

Field test pits (TP-1 through TP-6) were conducted onsite on March 6, 2020 and field test pits (TP-7 through TP10) were conducted on August 28, 2020 to identify the soils texture and determine the probable seasonal high groundwater elevation based on redox features if any were present. Redox features were observed in TP-1 through TP-6. The estimated seasonal high groundwater from TP-4 (elevation 134.2') and TP-2 (elevation 133.8) is used for UG-1. As noted and detailed in Section 4 of this report, only a portion of the bottom of the system greater than 2' from SHGW is utilized in the recharge calculation. UG-2 is located between TP-5 (SHGW elevation 131.4') and TP6 (SHGW elevation 133.6'), and a SHGW elevation of 132.6 was estimated and utilized in the hydrology model and recharge calculations.

1.4.2 PRE-DEVELOPMENT HYDROLOGY

The total project site consists of two lots which will be combined as part of the proposed development. One lot consists of an existing gas station and the other consists of an existing non-conforming residential house with driveway in a commercial district. The site predominately drains in two directions, to the south towards Whiting Street and to the North to the existing wetland. The site has been analyzed and divided into sub-watershed areas that are tributary to the design points. Times of concentration for developed areas were modeled as 5 minutes unless otherwise noted in the HydroCAD model. The sub-watershed areas are depicted on the Existing Conditions Hydrology Plan (DR-1) which is included in Section 3.3.1 of this report. The section below provides a brief description of the existing subcatchment areas. Refer to the attached HydroCAD model for additional information.

Existing Conditions Subcatchment 1

Subcatchment 1 consists of the portion of the site which drains to the South towards Whiting Street. The majority of the surface is paved with areas of woods and grass. A 5-minute direct entry Tc was utilized.

Existing Conditions Subcatchment 2

Subcatchment 2 is tributary to the existing wetland located on the 27 Whiting St parcel. The subcatchment area consists woods, impervious roof and driveway, and grass areas. A Tc of 15.7 minutes was utilized.

1.4.3 POST-DEVELOPMENT HYDROLOGY

As explained previously, the proposed project includes the proposed retail building as part of an upgrade to the existing gas station. The subcatchment areas were delineated based on the proposed drainage infrastructure for collection, treatment, and discharge. The sub-watershed areas are depicted on the Proposed Conditions Hydrology Plan (DR-2) which is included in Section 3.3.1 of this report. Refer to the attached HydroCAD model for additional information.

Post Development Subcatchment 1

Subcatchment 1 consists of the portion of the site which drains to the South towards Whiting Street. The majority of the surface is paved with areas of landscape and gravel. A 5-minute direct entry Tc was utilized.

Post Development Subcatchment 2a

Subcatchment 2a consists of the grassed and wooded areas which flow directly to the existing wetland. A 15.7-minute Tc which is the same as the existing Tc was utilized.

Post Development Subcatchment 2b

Subcatchment 2b consists of the portion of the site which is tributary to UG-1 the underground recharge/detention system. The area consists predominantly of impervious area including the roof and parking lot but includes some woods and lawn areas as well. A 5-minute direct entry Tc was utilized.

Post Development Subcatchment 2c

Subcatchment 2c consists of the portion of the site which is tributary to UG-2 the underground recharge/detention system. The area consists predominantly of impervious area but includes lawn/landscape areas as well. A 5-minute direct entry Tc was utilized.

1.5 STORMWATER MANAGEMENT

This project includes a Stormwater Management System that has been designed to satisfy and comply with the requirements of the MassDEP Stormwater Standards (2008).

The following is an explanation on how the proposed project will address the 2008 MassDEP Stormwater Management Policy.

<u>Standard 1: No New Untreated Discharges</u> **–** *No new stormwater system conveyances will discharge untreated runoff or cause erosion in wetlands or waters of the Commonwealth.*

All new stormwater system conveyances will be treated prior to discharge and will not cause erosion in wetlands or waters of the Commonwealth. Stormwater will be directed to various structural and non-structural Best Management Practices.

<u>Standard 2: Peak Rate Attenuation</u> **–** *Stormwater management systems shall be designed so that post-development peak discharge rates do not exceed pre-development peak discharge rates.*

The peak discharge rates are calculated with the aid of a hydrograph routing program using TR-20 methodology called HydroCAD. The HydroCAD calculations of the Pre- and Post-Development runoff peak rates have been performed. The proposed stormwater system reduces post-development peak rates of runoff below that of pre-development levels at each Design Point.

<u>Standard 3: Recharge</u> **–** *Loss of annual recharge to groundwater shall be eliminated or minimized using infiltration measures including environmentally sensitive site design, low impact development techniques, stormwater best management practices, and good operation and maintenance. At a minimum, the annual recharge from the post-development site shall approximate the annual recharge from pre-development conditions based on soil type. This standard is met when the stormwater management system is designed to infiltrate the required recharge volume as determined in accordance with the Massachusetts Stormwater Handbook.*

Recharge to groundwater will be provided through volume within the stone below the underground recharge/detention system UG-1. The recharge provided satisfies Standard 3 and exceeds the recharge requirement. Please see the calculations provided in this report in Section 4.3.

<u>Standard 4: Water Quality</u> **–** *Stormwater management systems shall be designed to remove 80% of the average annual post-construction load of Total Suspended Solids (TSS).*
This Standard is met when:

a. Suitable practices for source control and pollution prevention are identified in a long-term pollution prevention plan, and thereafter are implemented and maintained;
b. Structural stormwater best management practices are sized to capture the required water quality volume determined in accordance with the Massachusetts Stormwater Handbook; and

c. *Pretreatment is provided in accordance with the Massachusetts Stormwater Handbook.*

The project proposes the use of deep sump hooded catch basins, oil/water separators, Isolator Rows, and underground recharge systems to remove the required post-construction load of TSS to the extent practicable per the Massachusetts DEP Stormwater Management Standards. The TSS removal worksheets are located within Section 4.2 of this report. The Long-Term Pollution Prevention Plan is included in conjunction with the Operation and Maintenance Plan required by Standard 9 (see Section 2 of this report).

Standard 5: Land Uses with Higher Potential Pollutant Loads **–** *For land uses with higher potential pollutant loads, source control and pollution prevention shall be implemented in accordance with the Massachusetts Stormwater Handbook to eliminate or reduce the discharge of stormwater runoff from such land uses to the maximum extent practicable. If through source control and/or pollution prevention all land uses with higher potential pollutant loads cannot be completely protected from exposure to rain, snow, snow melt, and stormwater runoff, the proponent shall use the specific structural stormwater BMPs determined by the Department to be suitable for such uses as provided in the Massachusetts Stormwater Handbook. Stormwater discharges from land uses with higher potential pollutant loads shall also comply with the requirements of the Massachusetts Clean Waters Act, M.G.L. c. 21, §§ 26-53 and the regulations promulgated there under at 314 CMR 3.00, 314 CMR 4.00 and 314 CMR 5.00.*

The site is considered a LUHPL (Land Use with Higher Potential Pollutant Load). Note that the existing gas station is a LUHPL and utilizes a canopy to limit exposure to rain, snow, snow melt, and runoff as suggested in the Massachusetts Stormwater Handbook Volume 2 Appendix pages 4 and 5. The project provides the required TSS removal (44% or higher) prior to discharging to the recharge systems through the use of a deep sump hooded catch basin, oil/water separators, and Isolator Row. Overall, the project provides the required TSS removal of 80% or higher. Refer to the attached TSS removal worksheets located within Section 4.2 of this report.

Standard 6: Critical Areas **–** *Critical areas are Outstanding Resource Waters as designated in 314 CMR 4.00, Special Resource Waters as designated in 314 CMR 4.00, recharge areas for public water supplies as defined in 310 CMR 22.02 (Zone Is, Zone IIs, and Interim Wellhead Protection Areas for groundwater sources and Zone (A)s for surface water sources.)*

There will be no untreated stormwater discharge to a "Critical Area," however, the proposed recharge systems (UG-1, UG-2) are located in the Town of Hingham Aquifer Protection

District. Overall, the project provides the required TSS removal of 80% or higher. Refer to the attached TSS removal worksheets located within Section 4.2 of this report.

<u>Standard 7: Redevelopment Projects</u> – A redevelopment project is required to meet the following Stormwater Management Standards only to the maximum extent practicable: Standard 2, Standard 3, and the pretreatment and structural best management practice requirements of Standards 4, 5, and 6. Existing stormwater discharges shall comply with Standard 1 only to the maximum extent practicable. A redevelopment project shall also comply with all other requirements of the Stormwater Management Standards and improve existing conditions.

This project is a mix of new and redevelopment under the Stormwater Management Standards. The project has been designed to meet and provide full compliance with the Stormwater Management Standards for the new proposed areas and to the extent practicable for the existing impervious areas.

<u>Standard 8: Construction Period Pollution Prevention Plan and Erosion and Sedimentation Control</u> – A plan to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities (construction period erosion, sedimentation, and pollution prevention plan) shall be developed and implemented.

A Construction Pollution Prevention Plan has been prepared for the project (see Section 2). Provisions to maintain runoff control devices have been assured through non-structural, structural, and construction management approaches.

<u>Standard 9: Operation and Maintenance Plan</u> – A long-term operation and maintenance plan shall be developed and implemented to ensure that stormwater management systems function as designed.

A Long-Term Operation and Maintenance Plan has been prepared for the project (see Section 2). Provisions to maintain runoff control devices have been assured through non-structural, structural, and construction management approaches.

<u>Standard 10: Prohibition of Illicit Discharges</u> – All illicit discharges to the stormwater management system are prohibited.

The Operation and Maintenance plan required by Standard 9 includes measures to prevent

illicit discharges (see Section 2). An Illicit Discharge Compliance Statement is included in Section 4.5.

1.6 BEST MANAGEMENT PRACTICES (BMPs)

A treatment train of deep sump catch basins, oil/water separators, StormTech Isolator Rows, and subsurface infiltration chamber systems are proposed to treat stormwater runoff on the site. See Section 4 for the Total Suspended Solids (TSS) Calculations. A description of the devices incorporated is indicated below.

1.6.1 PROPOSED STRUCTURAL AND TREATMENT BMPs

1. DEEP SUMP HOODED CATCH BASINS

Deep sump catch basins are modified versions of inlet structures installed to collect and convey stormwater on the site. The deep sumps, typically a 4-ft dimension below the outlet pipe invert, are most effective if placed “off-line” which means that they do not have inlet pipes. The catch basins contain traps or hoods on the outlet pipes and serve as pretreatment for other downstream BMPs. Deep sump catch basins will be installed throughout the site to remove trash, debris, sediment and a limited amount of oil and grease from stormwater runoff. To ensure maximum capacity and efficiency, the catch basins shall be inspected monthly and cleaned, in dry weather, when half of the sump capacity is filled or at a minimum quarterly or as required and at the end of construction.

2. OIL/WATER SEPARATORS

Oil/Water separators are used to manage runoff from land uses with higher potential pollutant loads where there is a risk that the stormwater is contaminated with oil or grease. Oil/water separators require regular maintenance with inspection monthly and cleaning at least twice per year. Cleaning included removal of accumulated oil and grease and sediment using a vacuum truck. Polluted water or sediments removed should be disposed in accordance with all applicable local, state, and federal laws and regulations.

3. ISOLATOR ROWS

The Isolator Row is a series of ADS StormTech® chambers surrounded with filter fabric and connected to one or more manholes for access. The chambers are wrapped in fabric and provide settling and filtration. Stormwater runoff is first directed to the Isolator Row where sediments are captured, thereby protecting the rest of the underground system consisting of standard chambers in a stone bed. This technology will be used as a part of a treatment train consisting of other structural and non-structural approaches such as street sweeping and reduced road salt alternatives. Isolator Rows will be inspected routinely and cleaned in accordance with manufacturer's recommendations.

4. SUBSURFACE RECHARGE/ DETENTION SYSTEMS (UG-1, UG-2)

A subsurface drainage system consisting of high-density polyethylene plastic chambers (ADS StormTech®) set in a stone bed that is proposed to retain, recharge, and infiltrate storm runoff. The chamber system aims to provide peak flow reduction, stormwater runoff volume reduction, and TSS removal for various storm events. The proposed system drains down completely between storm events as required by the Massachusetts Stormwater Policy. Manhole risers or manufacturer recommended inspection ports are proposed at the ground surface to allow inspection and maintenance access. Once the system goes online, inspections should occur after each storm event for the first few months to ensure proper stabilization, function, and to ensure that the outlets remain free of obstructions. Preventative maintenance shall be performed at least twice per year and after every major storm event (> 1.5" of rainfall) and shall include removal of accumulated sediment, inspection of the undergound structure, and monitoring of groundwater to ensure proper operation of the system. Important items to check for include differential settlement, cracking, breakout, clogging of outlets and vents, and root infestation. Water levels should be checked and recorded against rainfall amounts to verify that the drainage system is working properly and draining within 72 hours. If they do not drain within 72 hours, corrective action should be taken.

5. OUTLET CONTROL STRUCTURES

The outlet control structures (OCS) detain the water utilizing orifices to control the outlet flow and are below grade with access via covers to grade. Although the outlet control structures should not have much debris, they should be inspected to make sure there are not concrete issues or residual debris. Sand accumulation within the OCS is a sign there is an issue with the upstream stormwater treatment device. The OCS shall be inspected once per year. It may be necessary to clean the structure and the use of a vacuum truck may be necessary.

6. LEVEL SPREADER/PLUNGE POOL / ENERGY DISSIPATER AND DOWNSTREAM SLOPES

The level spreader/plunge pool/energy dissipaters are utilized at the outlet pipes prior to discharge to the wetland to prevent erosions. The level spreader/plunge pool/energy dissipaters should be inspected at least once a year for sand accumulation and debris which may impact their effectiveness to slow water. Cleaning should take place during the early spring, although, additional inspections and cleaning may be needed.

In order to ensure that the level spreader systems are working, the outlets as well as slopes downstream for the first three years of operation, should be inspected after every storm of 1” or greater to assure no erosion of the slope. After the first three years, we recommend inspections after any large storm (25+ year event) for erosion. If no erosion is evident, then the stone size and level spreader design is adequate. Should there be erosion evident at the outlet, stone size should be increased, or additional large stones added to enhance energy dissipation of water. If downstream slopes exhibit signs of erosion, repairs to soils and slope should be made and then a treatment such as an erosion control matting should be instituted to reinforce soils until vegetative cover can be restored. We recommend that the aprons and downstream slopes be inspected and cleaned annually as part of the outlet maintenance to ensure future adequacy.

1.7 HYDRAULICS AND PIPE SIZING

The closed-conveyance storm drain collection system was analyzed using the Rational Method. **Q = CiA,** for estimating runoff where “C” is a coefficient dependent on land cover, “i” is storm intensity in in/hr based upon published I-D-F curves, and “A” is area in acres. “Q” is flow in cubic feet per second.

The project site and access road were subdivided by catch basin or inlets based upon drainage areas tributary to each. A “C” value for each area was assigned based upon overall character of land. “C” values ranged from 0.9 in paved/impervious conditions to 0.3 for grass and landscaped areas. IDF curves from Quincy, Massachusetts are used to establish the rainfall rate for the 100-year event. Pipe hydraulic design was completed using Manning’s full flow capacity equation for circular pipe with an n-value of 0.013

$\mathbf{Q = 1.49/n\ AR^{2/3}\ S^{1/2}}$**,** where, n is coefficient depending on channel roughness, A is area of flow, R is the hydraulic radius, and S is the channel slope.

1.8 SUMMARY OF HYDROLOGY & STORMWATER CALCULATIONS

The results of the pre and post-development hydrology calculations provided in Section 3 are summarized in the following tables. The table corresponds to the design points as indicated on the drainage area maps and hydrograph routing calculations.

- **<u>Summary of Design Point 1 (DP-1):</u>**

TOTAL RUNOFF PEAK FLOW RATE (CFS) - DESIGN POINT 1 (DP-1)

STORM SCS 24-HR	EXISTING	PROPOSED	DIFFERENCE
2-YEAR	0.98	0.74	-0.24
10-YEAR	1.67	1.15	-0.52
25-YEAR	2.17	1.43	-0.74
100-YEAR	2.97	1.87	-1.10

TOTAL RUNOFF VOL. (AC-FT) - DESIGN POINT 1 (DP-1)

STORM SCS 24-HR	EXISTING	PROPOSED	DIFFERENCE
2-YEAR	0.070	0.053	-0.017
10-YEAR	0.119	0.083	-0.036
25-YEAR	0.154	0.104	-0.050
100-YEAR	0.212	0.138	-0.074

The project design reduces the peak flow rates and volumes in the post-developed condition at the DP-1 in all storms.

- **<u>Summary of Design Point 2 (DP-2):</u>**

TOTAL RUNOFF PEAK FLOW RATE (CFS) - DESIGN POINT 2 (DP-2)

STORM SCS 24-HR	EXISTING	PROPOSED	DIFFERENCE
2-YEAR	0.84	0.79	-0.05
10-YEAR	1.87	1.64	-0.23
25-YEAR	2.68	2.30	-0.38
100-YEAR	4.06	3.40	-0.66

TOTAL RUNOFF VOL. (AC-FT) - DESIGN POINT 2 (DP-2)

STORM SCS 24-HR	EXISTING	PROPOSED	DIFFERENCE
2-YEAR	0.094	0.178	0.084
10-YEAR	0.190	0.306	0.116
25-YEAR	0.265	0.402	0.137
100-YEAR	0.392	0.566	0.174

The project design meets or reduces the peak flow rates in the post-developed condition at the DP-2 in all storm events. There is a slight increase in volume to DP2 in all storms. This is the result of the additional impervious as well as collecting additional stormwater runoff off existing impervious area not currently collected on the site. There is an extensive wetland system behind the 27 Whiting St parcel. An approximate area of 6 acres of wetlands are located behind the site prior to a stream indicated on Oliver (MassGIS). The 100-year volume of 0.174 acre-feet spread over an area of 6 acres is approximately 0.029 feet or 0.348 inches. Therefore, it is our professional opinion that the additional volume provides a significant flooding concern.

1.9 CONCLUSION

In conclusion, the project incorporates a series of structural and nonstructural Best Management Practices (BMPs) that are designed to reduce stormwater runoff rates and increase the detention time for the site and enhance the stormwater runoff quality by providing the required TSS removal.

The stormwater system has been designed to control peak discharge rates up to and including the 100-yr design storm event. The proposed stormwater system has been designed to meet Massachusetts Stormwater Management Standards for TSS removal and water quality treatment.

It is our professional opinion that the proposed development project does not adversely affect the surrounding drainage patterns. The following routing calculations, Best Management Practices design, and associated documentation within this report have been prepared to illustrate that runoff discharge rates from the project has been mitigated and that the design provides the required recharge for the increase in proposed impervious area.

REFERENCES

1. Commonwealth of Massachusetts, Department of Environmental Protection, Stormwater Management Standards Handbook. Volumes 1-3 February 2008 (DEP Stormwater Management Policy 2008).

2. Commonwealth of Massachusetts, Department of Environmental Protection. 310 CMR 10.00: Massachusetts Wetlands Protection Act Regulations. 2008.

3. Commonwealth of Massachusetts, Department of Environmental Protection. 314 CMR 4.00: Massachusetts Surface Water Quality Standards. 2007.

4. Commonwealth of Massachusetts, Department of Environmental Protection. 314 CMR 9.00: Massachusetts Water Quality Regulations. 2008.

5. United States Department of Agriculture, Natural Resources Conservation Services Urban Hydrology for Small Watersheds, Technical Release 55 (TR-55). June 1986.

6. United States Department of Agriculture, Natural Resources Conservation Services Project Formulation Hydrology Program System, Technical Release 20 (TR-20). Oct. 2004.

1.10 GENERAL CONSTRUCTION SEQUENCING

The following section provides construction details and highlights the construction sequence and timing of earthmoving activities. The overall project will be broken down into the following phases:

- Establish Erosion and Sediment Controls around the project site
- Demolition (ex. building, structures, driveways, septic systems)
- Site clearing and grading, drainage, utility, and roadway installation
- Building construction
- Final utility connections, and permanent stabilization

A. Pre-construction Meeting

An on-site meeting will be conducted by the Owner's Representative prior to the start of construction activity.

B. Installation of Erosion Controls

Erosion and sedimentation controls (i.e. silt fence, filter sock, and inlet protection) will be installed at the limits of work and within the existing catch basins, as applicable. Tree protection will be installed around trees specified to remain within the limit of work. Structures to remain shall also be visibly flagged/protected.

C. Installation of Construction Entrance

A construction entrance will be installed in the location as shown on the Erosion Control Plan in accordance with the construction detail provided in the plan set. Existing pavement will be removed within the limits of the proposed construction entrance to accommodate the crushed stone entrance.

D. Installation of Temporary Sediment Basins

Temporary sediment basins will be installed as shown on the plans with vertical 12” perforated pipe wrapped with filter fabric and screen on top for overflow. Side slopes of the temporary sediment basins shall be 3 foot horizontal to 1 foot vertical. Sediment to be removed when accumulation is within 6” of the outlet elevation.

E. Demolition

Any existing building, utilities services, and pavement within the project area will be demolished in accordance with the Construction Plans. Those utilities effected by construction activates shall be coordinated with the utility purveyors and Dig Safe procedures taken prior to implementation of agreed upon connections/disconnections/abandonment of services. Materials that are to be removed from the site will be transported to an appropriate facility or will be disposed of elsewhere according to Federal, State, and Local guidelines. Inactive stockpiles or areas of granular material or topsoil shall be temporarily secured in order to control sediment laden runoff.

F. Site Clearing and Rough Grading

The site will be cleared and rough graded in accordance with the proposed grading as shown on the plans. If suitable topsoil is found, it will be removed and stockpiled within the project limits. Areas which have been cleared (outside of the right-of-way) will be stabilized.

G. Building Construction

This phase of construction will involve the installation of the building including the proposed foundation and vertical construction of the building. All building waste is to be properly disposed of in dumpsters. While this phase commences, other site construction activities will be taking place.

H. Installation of Drainage and Utilities

Utility relocations and modifications, including water, gas, and electric, are anticipated to occur in conjunction with the drainage work. Temporary sediment basins will be constructed at this time on an as-needed basis to collect stormwater runoff during construction. Stockpiles will be established in designated areas as shown on project plans. All temporary/inactive stockpile areas will be encompassed by filter sock and silt fence or other approved erosion control devices to control sediment laden runoff as necessary and will be temporarily seeded, mulched or covered with plastic, as necessary.

I. Fine Grading, Paving, Etc.

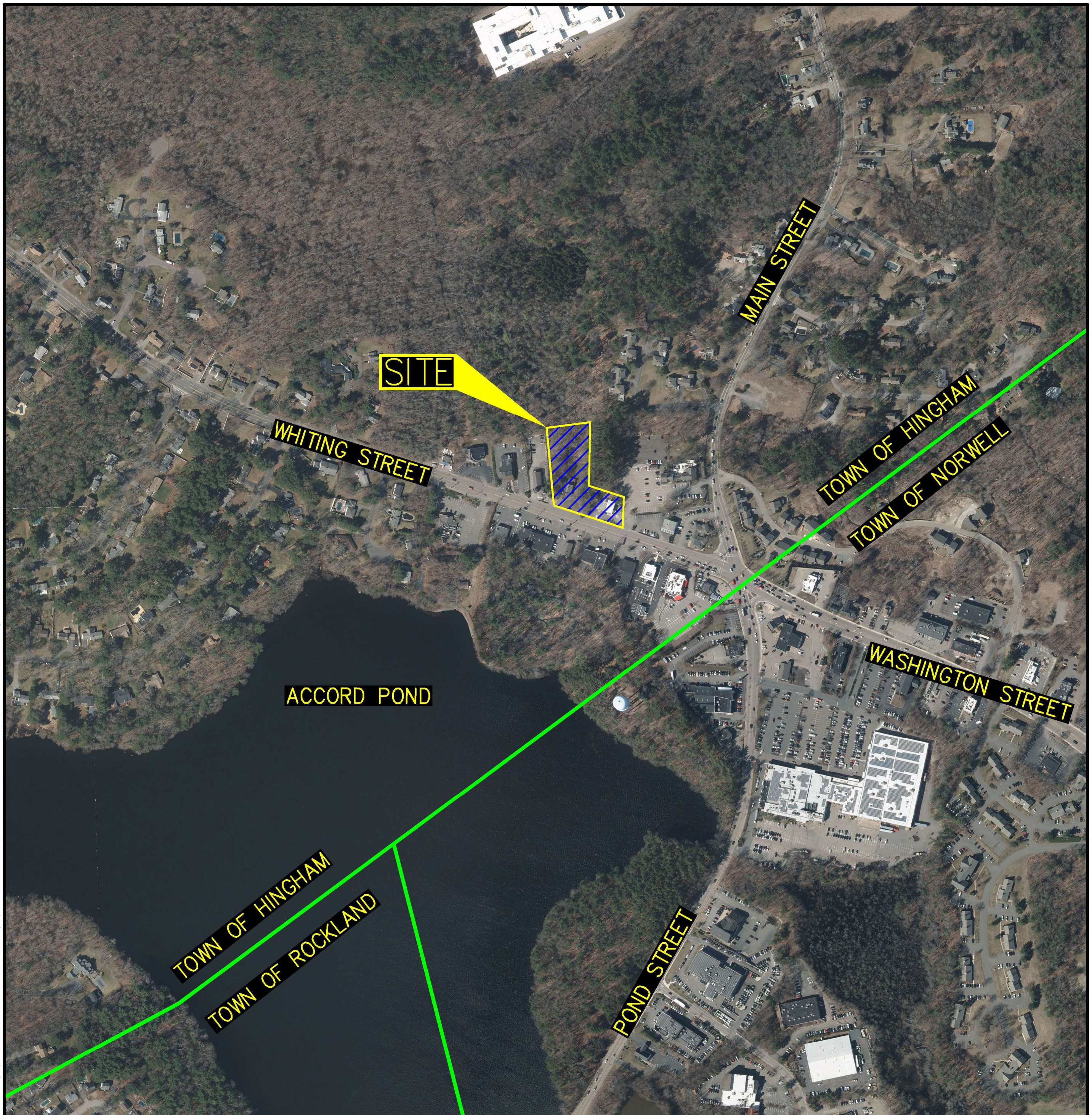
The fine grading and shaping will commence along with the installation of curbing to prepare for paving operations. Areas outside of the parking lot will be shaped and prepped for loam, seed, or other treatments. Paving operations will begin with the installation of both binder and finish course layers.

J. Permanent / Final Site Stabilization

The final phase of the project consists of landscaping and restoration and stabilization of all exposed surfaces. Final landscaping will be performed upon completion of earthwork and completion of all curbing and sidewalk construction. Disturbed areas will be landscaped, mulched or seeded in accordance with the landscape requirements. Permanent restoration and revegetation measures serve to control erosion and sedimentation by establishing a vegetative cover. In the event that weather conditions prevent final restoration, temporary erosion and sedimentation measures will be employed until the weather is suitable for final cleanup. A final inspection will ensure that the project site is cleared of all project debris and that erosion and sedimentation controls are functioning properly. Once the site has been stabilized, newly installed catch basins and the subsurface infiltration and detention systems will be inspected for sediment deposits and cleaned if necessary.

Section 1.12

Figures



LEGEND:

APPROXIMATE PROPERTY LINE

N

0 600 1200

Scale in feet

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ORTHOPHOTO PLAN
19 AND 27 WHITING STREET
HINGHAM, MA 02043

PROJECT NO. 060903

DATE: 04/06/20

FIGURE 1

LEGEND:

APPROXIMATE PROPERTY LINE

N

0 600 1200

Scale in feet

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USGS PLAN
19 AND 27 WHITING STREET
HINGHAM, MA 02043

PROJECT NO.
060903

DATE: 04/06/20

FIGURE 2

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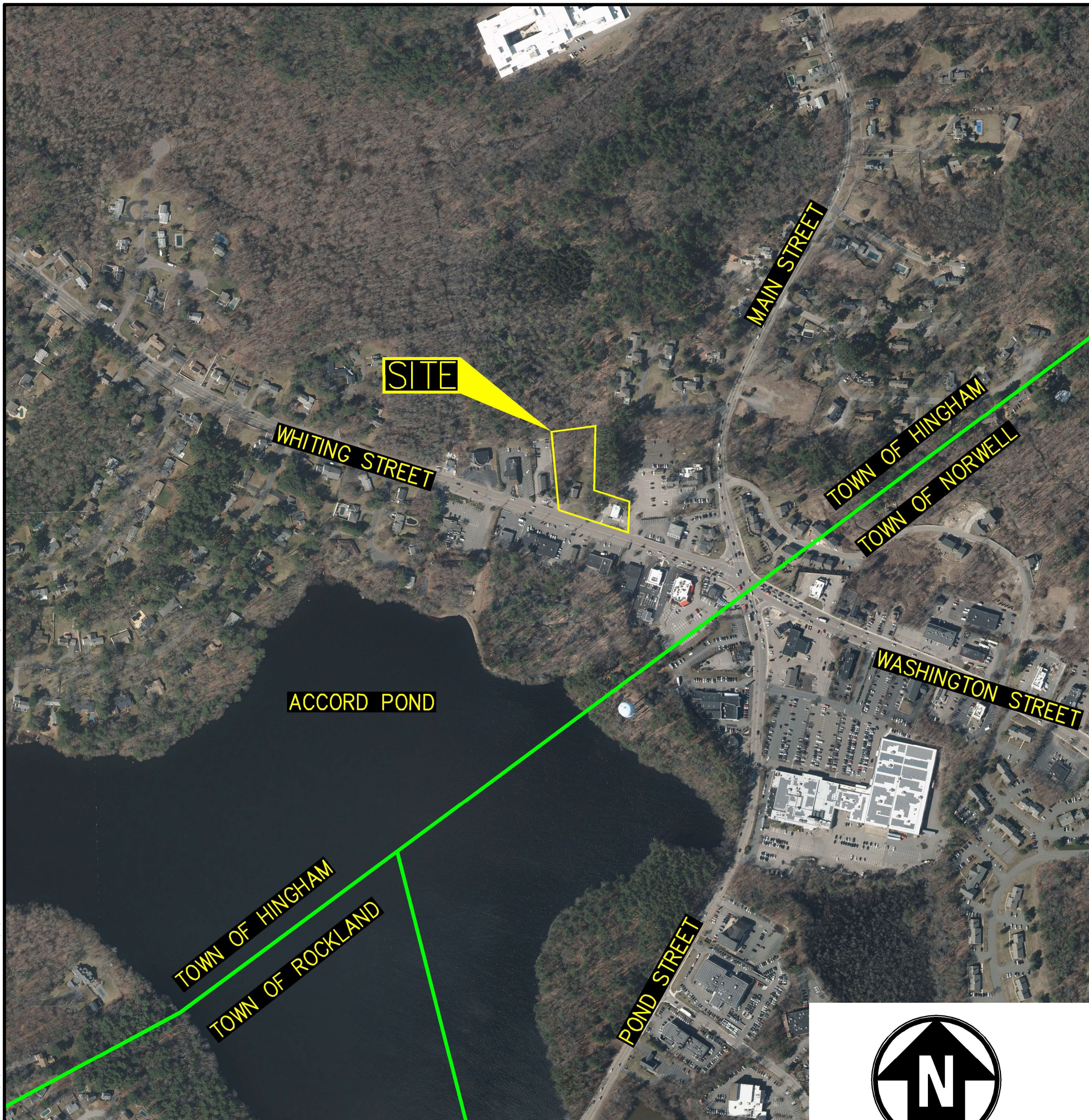

LEGEND:

- APPROXIMATE PROPERTY LINE
- NHESP ESTIMATED HABITATS OF RARE WILDLIFE
- POTENTIAL VERNAL POOL
- CERTIFIED VERNAL POOL
- NHESP PRIORITY HABITATS OF RARE SPECIES

0 600 1200
Scale in feet

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NHESP HABITAT MAP
19 AND 27 WHITING STREET
HINGHAM, MA 02043

PROJECT NO. 060903

DATE: 04/06/20

FIGURE 3

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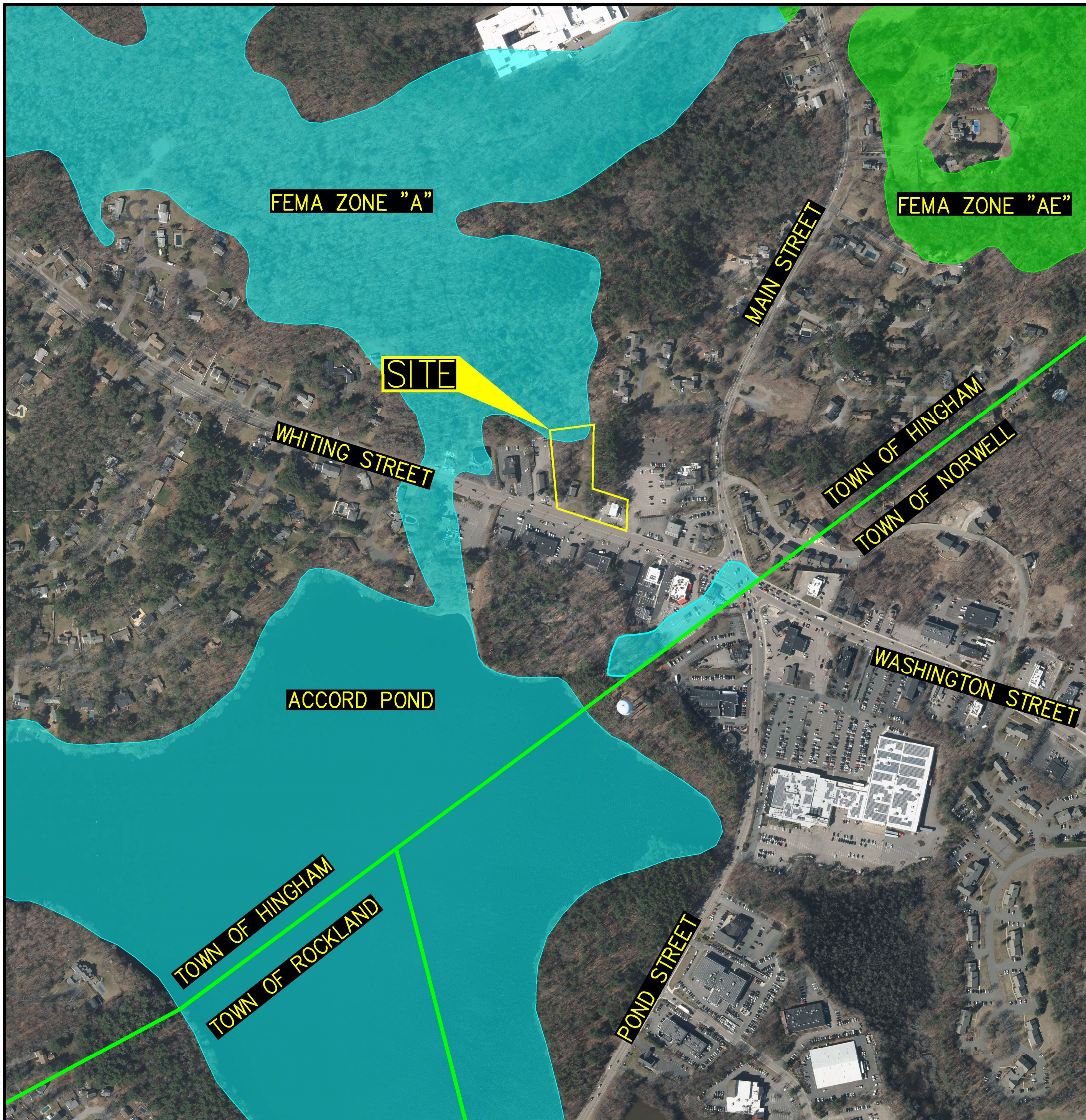

LEGEND:

APPROXIMATE PROPERTY LINE

FEMA ZONE "A" 1% CHANCE OF FLOODING

FEMA ZONE "AE" 1% CHANCE OF FLOODING

N

0 600 1200

Scale in feet

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FEMA FLOOD MAP
19 AND 27 WHITING STREET
HINGHAM, MA 02043

PROJECT NO. 060903

DATE: 04/06/20

FIGURE 4

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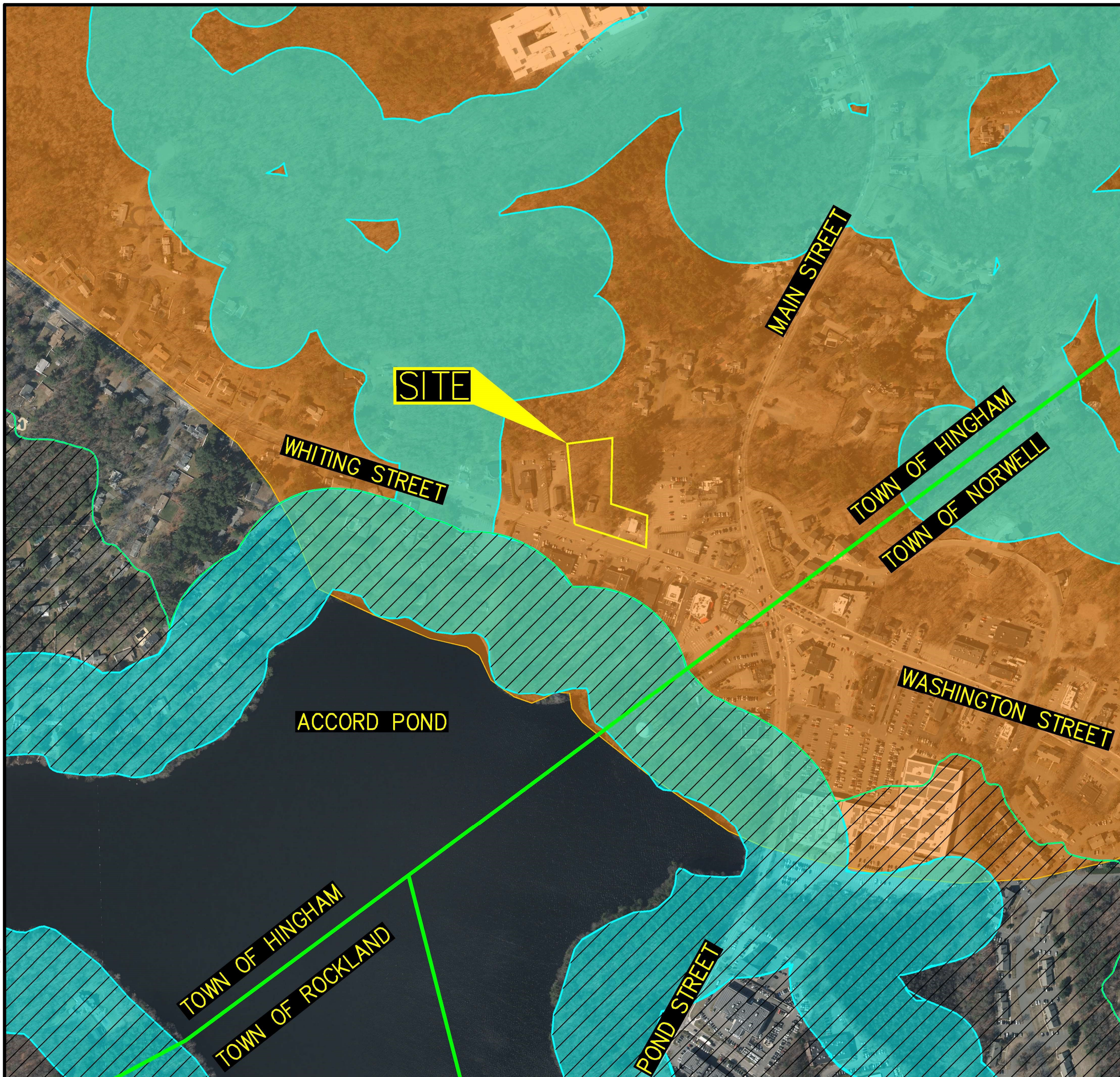

LEGEND:

APPROXIMATE PROPERTY LINE

ZONE A SURFACE WATER SUPPLY

ZONE B SURFACE WATER SUPPLY

ZONE 1 WELLHEAD PROTECTION AREA

ZONE 2 WELLHEAD PROTECTION AREA

INTERIM WELLHEAD PROTECTION AREA

N

0 600 1200

Scale in feet

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WATER SUPPLY PLAN
19 AND 27 WHITING STREET
HINGHAM, MA 02043

PROJECT NO. 060903

DATE: 04/06/20

FIGURE 5

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Section 2.0

Long-Term Pollution Prevention and Operation and Maintenance Plan

Construction Period Operation and Maintenance Plan

LONG-TERM STORMWATER POLLUTION PREVENTION AND OPERATION & MAINTENANCE PLAN TO COMPLY WITH STORMWATER STANDARDS 4, 6, & 9

APPLICABILITY

This document identifies constituents of concern that have the potential to contaminate stormwater from the proposed Hingham Gas project located at 19 and 27 Whiting Street and provides a framework of Best Management Practices (BMPs) for handling stormwater runoff. It also outlines an inspection and maintenance program to ensure continued effectiveness of the proposed stormwater management system. The proposed BMP's are shown on the plans prepared by CHA, 141 Longwater Drive, Suite 104, Norwell, Massachusetts.

PROJECT OVERVIEW:

The proposed project located on Whiting Street in Hingham includes a new commercial building to service an existing gas station and associated parking and utilities. The project is a redevelopment of a residential site. The project has been designed to meet State standards for TSS removal through the use of BMPs. Runoff from the roof and other impervious surfaces will be collected and treated by deep sump hooded catch basin, oil/water separators, isolator rows of underground drainage chamber systems, and detained within the underground drainage chamber systems using outlet controls structures.

Appended to this document is a sample maintenance form and a chart describing the anticipated frequency of tasks.

OWNER AND RESPONSIBLE PARTY:

Owner:

Merhej & Sons Realty, LLC
87 Derby Street
Hingham, MA 02043

Day-to-day Operation and Maintenance:

Merhej & Sons Realty, LLC
87 Derby Street
Hingham, MA 02043

ON-GOING MAINTENANCE CONTRACT

The non-structural and structural approaches recommended below, as well as the required BMP maintenance, will be completed by an appropriate contractor. Adequate personnel with appropriate training and access to proper equipment will be available to complete the tasks. Future responsible parties must be notified of their responsibility to operate and maintain the system in perpetuity.

LIVING DOCUMENT PROVISIONS

Due to the difficulty of identifying all sources of potential stormwater contamination and maintenance activities, this document should be updated as necessary to reflect new procedures, technologies or requirements.

MAINTENANCE LOG

The Responsible Party shall develop and maintain a log of inspections, maintenance, repairs, and disposal (including location of disposal) during the life of the project. Records will be maintained for at least 3 years and be made available to the Massachusetts Department of Environmental Protection or the Town of Hingham in accordance with the provisions of the Massachusetts Stormwater Handbook.

MINIMIZING EXPOSURE

The Responsible Party shall minimize exposure of potential pollutant sources, including debris from coming into contact with precipitation and being picked up by stormwater and carried into drains and surface waters using the following steps:

- Storing all containerized materials in a protected, secure location away from drains and plainly labeled.
- Containing all activities that can generate sources of contaminants from reaching the receiving water or the stormwater management system.
- Securing any equipment or supplies so that they are not transported during storm events into receiving waters or stormwater management system.

BEST MANAGEMENT PRACTICES (BMP) MAINTENANCE

The proposed stormwater management system has been designed with appropriate BMPs aimed at reducing the pollutants discharge based upon the intended use of the proposed development. All BMPs require regular maintenance to function as intended. Some management measures have simple maintenance requirements; others are more involved. The Responsible Party must have all BMPs regularly inspected to ensure they are operating properly on an as-needed basis, including during runoff events exceeding 0.5 inches of rainfall.

A description of the non-structural and structural approaches to be incorporated is indicated below. The following Best Management Practices are proposed to be incorporated into the stormwater management design to reduce source runoff and improve stormwater runoff discharge quality. The Responsible Party will regularly inspect all BMPs to ensure they are operating properly. If any deficiencies are identified during these inspections, action to resolve it will be initiated and documented on the maintenance log.

NON-STRUCTURAL BEST MANAGEMENT PRACTICES (BMPs)

STREET/PARKING LOT SWEEPING

This practice, considered by MassDEP to be a non-structural BMP, provides effective removal of Total Suspended Solids (TSS) in a comprehensive stormwater management program. A maintenance program of roadway/driveway sweeping with a High Efficiency Vacuum Sweeper or a Regenerative Air Sweeper to reduce sediment accumulation in the deep sump catch basins and subsurface systems shall be implemented based on the owner discretion. Sweeping can be conducted on a quarterly basis (primarily in the spring and fall) to keep low impact BMPs operating effectively.

GRADING

The impervious areas of the site shall be graded as gently as possible, generally not more than 6% slopes, to reduce runoff velocities. Steep slopes will be permanently vegetated to dissipate energy and reduce potential erosion. No constructed vegetated slopes shall exceed 3H:1V without providing additional reinforcement. Steep slopes may require soil reinforcement and additional vegetation.

SNOW STORAGE AND DEICING

Snow storage will be located adjacent to parking area as indicated on the plan. In the event of a large snow event that exceeds snow storage on the site, snow will be removed and hauled off-site.

In the interest of reducing the volume of dissolved salt that enters the watershed, the operator of the development will rely on sand alone where traction on snowy surfaces is the primary objective. However, parking areas, driveways, and sidewalks which require deicing for safety during winter months will typically be treated with calcium magnesium acetate or another alternative as approved by the Hingham Conservation Commission.

FERTILIZER:

Due to the project's location within an environmentally sensitive area, any use of fertilizers will be limited to those as approved by the Hingham Conservation Commission.

WASTE MANAGEMENT:

Solid waste will be contained within dumpsters. Waste deposition in these receptacles will be consistent with state and local permits. The covers and doors of the dumpsters will be kept closed to limit rainwater/wildlife intrusion.

STRUCTURAL BEST MANAGEMENT PRACTICES:

Prior to final completion and full occupancy of the development, it is recommended that a representative of the Contractor, Manufacturer, and/or Engineer either designing or building the facility for the Owner properly instruct the Responsible Party as to the maintenance practices required to responsibly maintain the effectiveness of the drainage system. These frequencies and requirements are recommendations to maintain minimum effectiveness in most typical environments. Ultimately, the Responsible Party will implement the procedures and frequencies as they see fit under their current plan and inspect the systems as needed to maintain minimum effectiveness as recommended by the manufacturer. The following maintenance of structural BMPs will be implemented:

ROOF DRAIN GUTTERS AND DOWNSPOUTS

Roof drain gutters and downspouts should be inspected and cleaned twice a year, once in the fall after leaf drop and in the spring after snow melt. Cleaning will take place at the completion of construction and in early spring after snow melt. Any obstructions, sediment, and debris that could potentially cause clogging shall be removed within the roof drain gutter and downspout system as necessary.

DEEP SUMP CATCH BASINS AND MANHOLE STRUCTURES

Catch basins shall be cleaned, in dry weather, when half of the sump capacity is filled or at a minimum quarterly or as required through periodic inspection. Cleaning will take place at the completion of construction and in early spring after sanding of roadways has ceased or as needed depending on the frequency of major storm events (greater than 1-inch of rainfall). All manholes shall be inspected at least once annually. Any obstructions, sediment, and debris that could potentially cause clogging shall be removed within the conveyance system as necessary. Inverts, grates, and hoods shall be checked and replaced as necessary to maintain hydraulic effectiveness.

OIL/WATER SEPARATORS

Oil/Water separators are used to manage runoff from land uses with higher potential pollutant loads where there is a risk that the stormwater is contaminated with oil or grease. Oil/water separators require regular maintenance with inspection monthly and cleaning at least twice per year. Cleaning included removal of accumulated oil and grease and sediment using a vacuum truck. Polluted water or sediments removed should be disposed in accordance with all applicable local, state, and federal laws and regulations.

ISOLATOR ROW

The Isolator Rows in the underground chamber systems shall be inspected twice per year and cleaned at least once per year and in accordance with the manufacturer's recommendations. Periodic inspections performed by the responsible party may dictate cleaning on a more frequent basis depending on the suspended solids loading. Conduct jetting and vactoring annually or when inspection shows that maintenance is necessary. See attached maintenance documentation from the manufacturer.

SUBSURFACE STORMTECH CHAMBERS SYSTEM

Subsurface system consisting of high-density polyethylene plastic chambers (ADS StormTech®) set in a stone bed are proposed to remove TSS. The chamber system can provide TSS removal for various storm events for the stormwater runoff. The proposed system drains down completely between storm events due to the large footprint of the stone beds. Manhole risers and manufacturer recommended inspection ports are proposed at the ground surface to allow inspection and maintenance access. Once the system goes online, inspections should occur after each storm event for the first few months to ensure proper stabilization, function, and to ensure that the outlets remain free of obstructions.

Preventative maintenance shall be performed at least twice per year and after every major storm event (> 1.5” of rainfall) and shall include removal of accumulated sediment, inspection of the detention structure, and monitoring of groundwater to ensure proper operation of the system.

Important items to check for include differential settlement, cracking, breakout, clogging of outlets and vents, and root infestation. Water levels should be checked and recorded against rainfall amounts to verify that the drainage system is working properly and draining within 72 hours. If they do not drain within 72 hours, corrective action should be taken.

OUTLET CONTROL STRUCTURES

The outlet control structures (OCS) detain the water utilizing orifices to control the outlet flow and are below grade with access via covers to grade. Although the outlet control structures should not have much debris, they should be inspected to make sure there are not concrete issues or residual debris. Sand accumulation within the OCS is a sign there is an issue with the upstream stormwater treatment device. The OCS shall be inspected once per year. It may be necessary to clean the structure and the use of a vacuum truck may be necessary.

PLUNGE POOL/ENERGY DISSIPATER AND DOWNSTREAM SLOPES

The level spreader/plunge pool/energy dissipaters are utilized at the outlet pipes prior to discharge to the wetland to prevent erosions. The level spreader/plunge pool/energy dissipaters should be inspected at least once a year for sand accumulation and debris which may impact its effectiveness to slow water. Cleaning should take place during the early spring, although, additional inspections and cleaning may be needed.

In order to ensure that the level spreader systems are working, the outlets as well as slopes downstream for the first three years of operation, should be inspected after every storm of 1” or greater to assure no erosion of the slope. After the first three years, we recommend inspections after any large storm (25+ year event) for erosion. If no erosion is evident, then the stone size and level spreader design is adequate. Should there be erosion of the level spreader, stone size should be increased, or additional large stones added to enhance energy dissipation of water. If downstream slopes exhibit signs of erosion, repairs to soils and slope should be made and then a treatment such as an erosion control matting should be instituted to reinforce soils until vegetative cover can be restored. We recommend that the aprons and downstream slopes be inspected and cleaned annually as part of the outlet maintenance to ensure future adequacy.

SPILL CONTROL:

The development consists of a gas station and associated commercial building. It is recommended that if there is no existing contingency plan to address the spillage/release of petroleum products and any hazardous material be implemented for the development the one be fully developed. The recommendation includes that the Owner have all MassDEP emergency spill response information posted onsite at all times. It is also recommended an emergency spill response kit including absorbent pillows be stored on-site along with instructions for the kit, a copy of applicable regulations regarding spills, and a list of individuals to contact (local and state officials) in the event of a spill.

Spills or leaks will be treated properly according to material type, volume of spillage, and location of the spill. Mitigation will include preventing further spillage, containing the spilled material in the smallest practical area, removing spilled material in a safe and environmentally friendly manner, and remediating any damage to the environment.

LONG-TERM OPERATION AND MAINTENANCE BUDGET:

Consistent with Standard 9 of the Massachusetts Department of Environmental Protection Stormwater Handbook (February 2008) the approximate cost of inspections and maintenance based on the abovementioned post-construction activities and frequencies is as follows:

- Pavement Sweeping - $3,000 per year based on annual sweepings.
- Deep Sump Catch Basins - inspection/cleaning - $1,000 per year/per catch basin based on quarterly inspections and sediment removal of both single and double grate deep sump catch basins.
- Oil/Water Separator - inspection - $1,000 per year based on semi-annual inspections. Cleaning/debris removal/maintenance - $1,000 per year for accumulated sediment and trash removal.
- Underground Infiltration/Detention System - inspection - $1,000 per year based on semi-annual inspections. Cleaning/debris removal - $1,000 per year for accumulated sediment and trash removal.

Additional costs may be incurred if it is determined during routine inspections of the BMP's that further corrective actions are necessary.

LONG TERM STRUCTURAL BEST MANAGEMENT PRACTICE INSPECTION & MAINTENANCE MATRIX AFTER CONSTRUCTION

Note: BMP's shall be visually inspected and repaired by a qualified party in accordance with the following chart. Note these are minimum inspection criteria/frequencies and should be adjusted throughout the project lifespan as required to maintain effectiveness. Refer to maintenance standards for drainage facilities and structural best management practices in the "Recommended Long-Term Stormwater Pollution Prevention Plan."

Conventional & LID Best Management Practices	Recommended Minimum Inspection & Maintenance Frequency	Erosion/Scouring	Tree Growth Hazards	Differential Settlement/Seepage	Structural Damage/Obstructions	Trash & Debris	Removal of Accumulated Sediment	Slope Integrity	*Mow Vegetation/Poor Vegetation Coverage	Remove/Reset Filter Fabric & Stone As Required	Remove & Replace Hardwood mulch/media	Vac Truck Sediment & Contaminants	Remove/Reset Riprap as Required
Catch Basin and OCS	*Quarterly*		☑	☑	☑	☑	☑					☑	
Oil/Water Sepator	*Monthly/ Semi-Annual*		☑	☑	☑	☑	☑					☑	
Roof Drain Gutters and Downspouts	*Semi-Annual*		☑	☑	☑	☑	☑					☑	
Isolator Row	*Semi-Annual / Per Manufacturer*			☑	☑	☑	☑					☑	
Detention/Recharge	*Semi-Annual*	☑	☑	☑	☑	☑	☑					☑	
Flared End	*Semi-Annual*	☑	☑	☑	☑	☑	☑	☑		☑			☑

Stormwater BMP Inspection and Maintenance Log

Facility Name	
Address	
Begin Date	End Date

Date	**BMP ID#**	**BMP Description**	**Inspected by:**	**Cause for Inspection**	**Exceptions Noted**	**Comments and Actions Taken**

Instructions: Record all inspections and maintenance for all treatment BMPs on this form. Use additional log sheets and/or attach extended comments or documentation as necessary.

- BMP ID# — Always use ID# from the Operation and Maintenance Manual or Approved Plans.
- Inspected by — Note all inspections and maintenance on this form, including the required independent annual inspection.
- Cause for inspection — Note if the inspection is routine, pre-rainy-season, post-storm, annual, or in response to a noted problem or complaint.
- Exceptions noted — Note any condition that requires correction or indicates a need for maintenance.
- Comments and actions taken — Describe any maintenance done and need for follow-up.

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A division of ADS

Isolator® Row O&M Manual

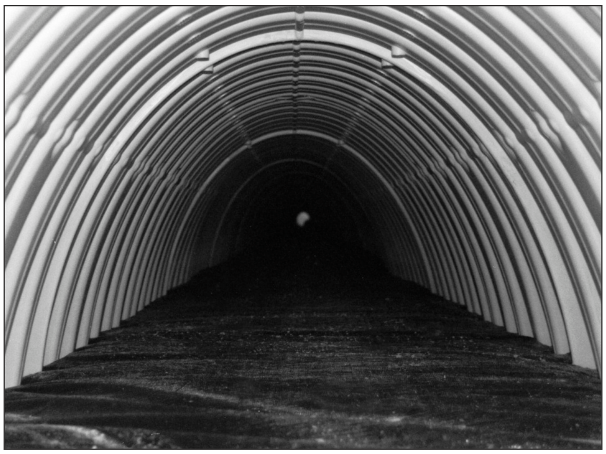
StormTech® Chamber System for Stormwater Management

U.S. Green Building Council Member

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.

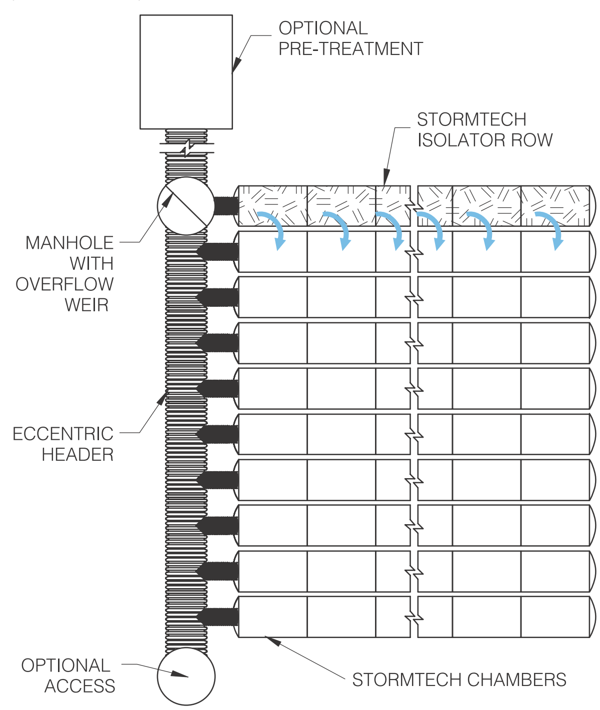
Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for storm water filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of 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.

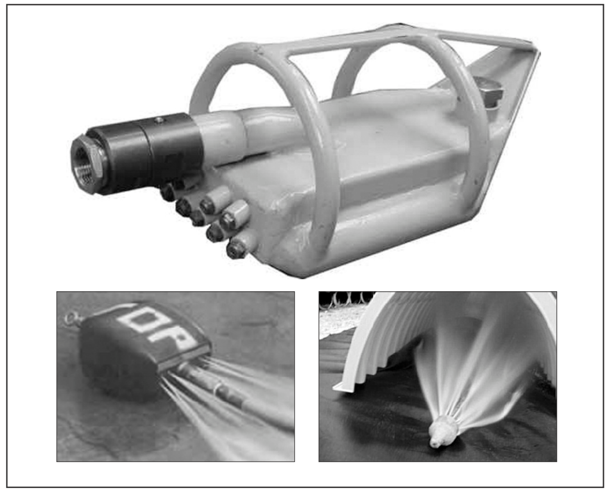
At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

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

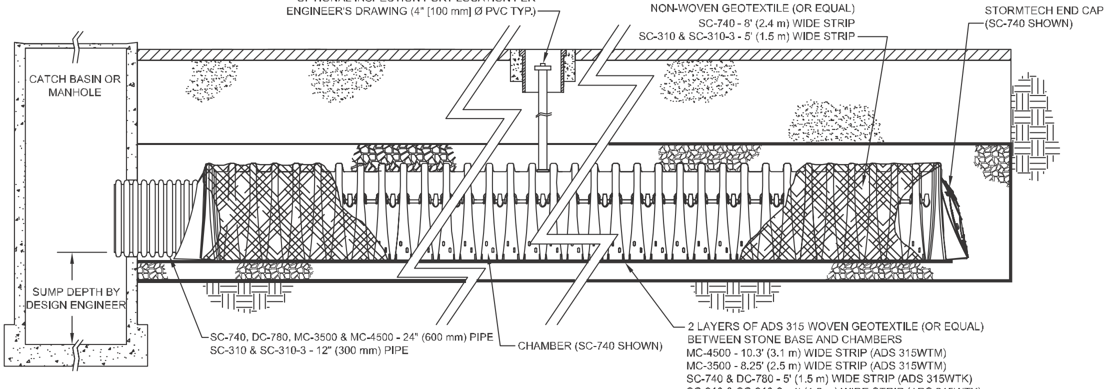
The Isolator Row was designed to reduce the cost of periodic maintenance. By "isolating" sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via 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)

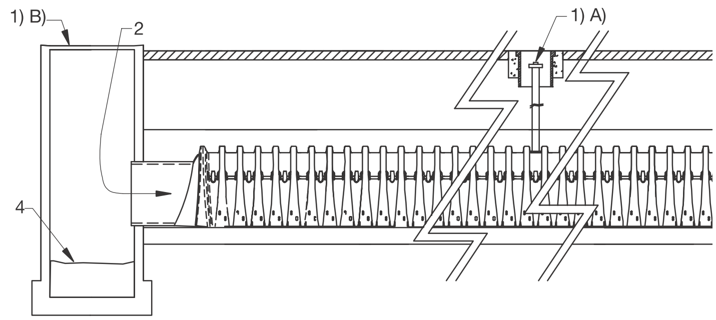


NOTE: NON-WOVEN FABRIC IS ONLY REQUIRED OVER THE INLET PIPE CONNECTION INTO THE END CAP FOR DC-780, MC-3500 AND MC-4500 CHAMBER MODELS AND IS NOT REQUIRED OVER THE ENTIRE ISOLATOR ROW.

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

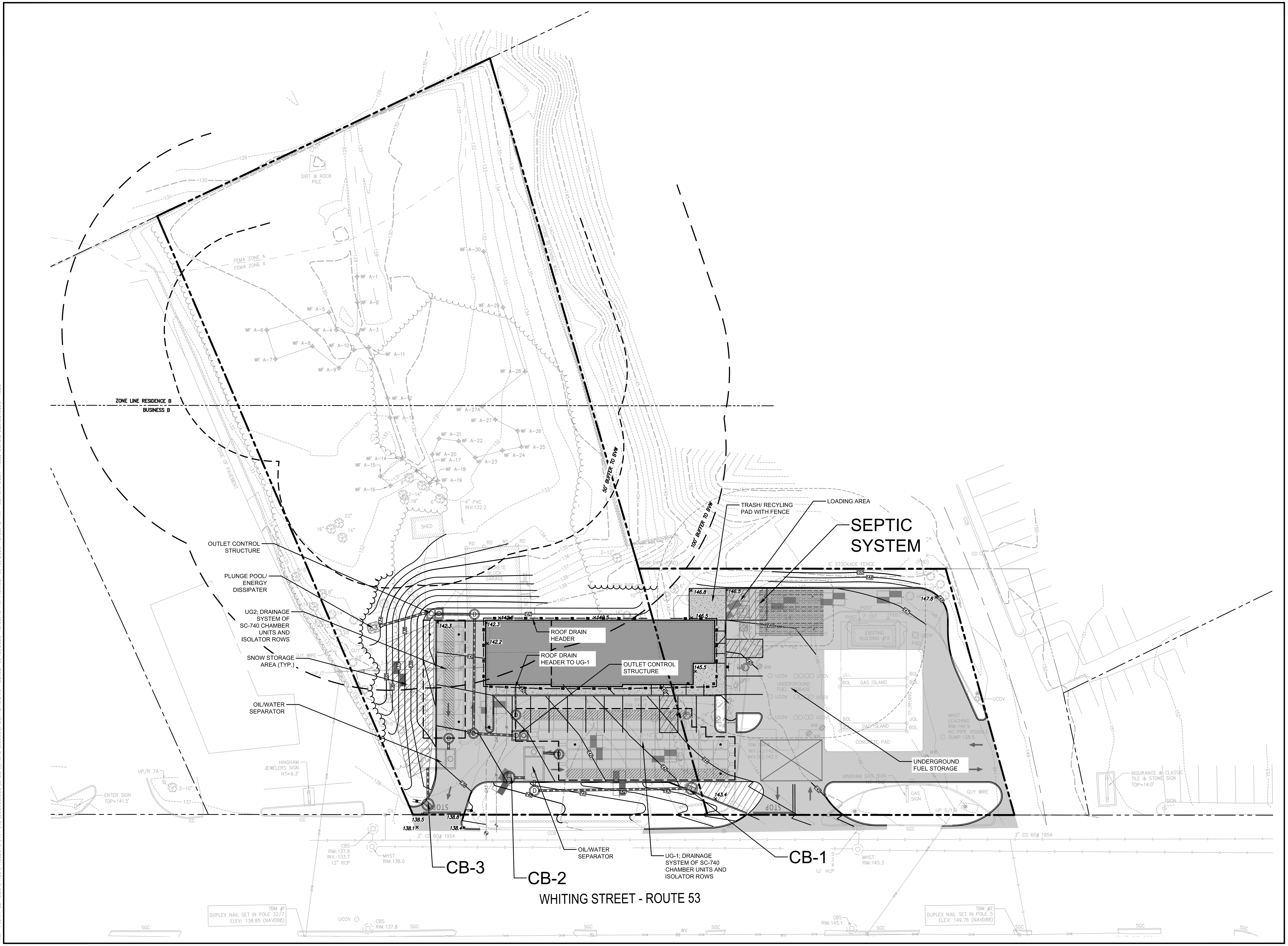
Step 4) Inspect & clean catch basins and manholes upstream of the StormTech system

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



CHA
141 Longwater Drive - Suite 104
Norwell, MA 02061
781.982.5400 • www.chacompanies.com

0 20 40
Scale in feet

OWNER/APPLICANT:

MERHEJ & SONS REALTY, LLC
87 DERBY STREET
HINGHAM, MA 02043

HINGHAM GAS
#19 & 27 WHITING STREET
HINGHAM, MA 02043

No.	Submittal / Revision	App'd.	By	Date
2	PERMIT SET	KK	JM	9/11/2020
1	PERMIT SET	KK	JM	5/1/2020

OPERATION AND MAINTENANCE PLAN

Designed By:	Drawn By:	Checked By:
DR/BN	DR/BN	KK
Issue Date:	Project No:	Scale:
05/01/2020	060903	1" = 20'

Drawing No.:
O&M

File: \\CHA-LLP.COM\PROJ\PROJECTS\ANY\K5\060903.000\CADD_ACAD\060903_PC_HYDRO.DWG Saved: 9/10/2020 10:00:18 AM Plotted: 9/10/2020 10:08:12 AM Current User: Rose, Donald LastSavedBy: 4323

CONSTRUCTION PERIOD POLLUTION PREVENTION AND EROSION AND SEDIMENTATION CONTROL PLAN
STORMWATER STANDARD 8

INTRODUCTION:

This Construction Period Pollution Prevention Operation and Maintenance Plan has been created for the Hingham Gas commercial project located at 19 & 27 Whiting Street in Hingham, MA. The goals of this CPOM (Construction Period O&M) are to detail the structural and non-structural practices selected to control erosion associated with surface stormwater discharges during construction and increase pollution attenuation after construction has been completed. Stormwater Best Management Practices (BMPs) have been incorporated into the design and will be implemented during construction to attenuate potential pollutants, dampen peak flow velocities, and prevent erosion. The format of this Plan follows the framework detailed as required by Standard 8 of the Stormwater Handbook.

NARRATIVE:

The Applicant, Merhej & Sons Realty, LLC (Merhej), proposes to develop a new retail building adjacent to the existing gas station to replace the aging kiosk located currently on the property at 19 Whiting Street in Hingham, MA. The site consists of two parcels 19 and 27 Whiting Street which will be combined into one parcel to support the development. The proposed building has an approximate footprint of 3,500 square-feet and will consist of an approximate 2,530 square feet of retail and an approximate 1,000 square feet of accessory storage with approximately 500 square foot storage associated with the retail and 500 square feet for maintenance. The proposed building will be served by an onsite Title 5 septic system to be permitted with the Hingham Board of Health. The proposed development has been designed to be located mainly within areas that were previously disturbed; an existing gas station on 19 Whiting St and a residential house on the 27 Whiting St parcel.

The site is bounded by Whiting Street to the south by commercial development on the east and west. The site is located in the Business C zoning district with a small rear portion of the 27 Whiting St parcel designated Residence B. The parcels are located in the Hingham Aquifer Protection District and Accord Pond Watershed. Wetland areas exist on the 27 Whiting St parcel. The site is not located within a habitat area designated by the Natural Heritage and Endangered Species Program (NHESP) (see Figure 3).

The drainage systems on the site are comprised of closed-conveyance pipe system which will collect and convey stormwater runoff from paved surfaces and the roof area to two subsurface recharge/detention systems that discharges outside of the 50-foot buffer. Treatment of the stormwater runoff will be via deep sump catch basins, oil/water separators, and isolator rows prior to recharge/detention and then discharge. The subsurface systems will attenuate peak rates of runoff. The stormwater system provides the required treatment for stormwater runoff from impervious areas as required by the 2008 Massachusetts Stormwater Handbook. Refer to the attached site plans for additional information. The project will be serviced with water provided by the Aquarion Water Company (Aquarion), and the wastewater is discharged via a proposed on-site Title 5 septic system.

Electricity is supplied by the Hingham Municipal Lighting Plant.

PARTIES RESPONSIBLE FOR COMPLIANCE

Owner:

Merhej & Sons Realty, LLC
87 Derby Street
Hingham, MA 02043

Area of Control: Merhej & Sons Realty, LLC has operational control over the construction plans and specifications for the project and has the ability to make modifications to the plans and specifications.

Construction Manager or Site Supervisor:

TO BE DETERMINED

Area of Control: A construction manager with adequate knowledge and experience on projects of similar size and scope shall be employed to oversee all site construction. The contractor shall incorporate the appropriate techniques to control sediment and erosion pollution during construction in accordance with the Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas and any conditions of approval from the local conservation commission.

The design incorporates measures to control construction-related impacts including erosion, sedimentation and other pollutant sources during construction and land disturbance activities. The information contained herein and within the engineering drawings identifies construction period pollution prevention measures, responsible parties, erosion control measures (filter socks and silt fence, etc.), BMPs for collecting and treating runoff and groundwater during construction[1], site stabilization measures (i.e. gravel, seed, pavement, etc.), an operations and maintenance plan & long-term pollution prevention plan contained herein.

Care should be taken when constructing stormwater control structures. Light earth-moving equipment shall be used when operating over top of buried utilities or drain or chambers.

GOOD HOUSEKEEPING PRACTICES DURING CONSTRUCTION

The Construction Manager shall maintain good housekeeping practices by maintaining a clean and orderly facility to prevent potential pollution sources, including debris, from coming into contact

[1] Should the need for de-watering arise during construction at the site, groundwater will be pumped directly from the work area into geotextile filter bags, temporary settling basins, or portable fractionation tanks (depending on the nature and volume of water encountered) which will act as sediment traps during construction. Discharge points will be set outside of all resource areas and buffers monitored by qualified personnel (wetland scientist, licensed site professional, civil engineer, etc.) to ensure no impacts to resource areas and compliance with applicable Federal and state regulations. All discharges will be free from visible floating, suspended, and settleable solids that would impair the functions of the nearby drainage systems, wetlands, or downstream rivers. Refer to the details provided on the drawing set for additional information.

with stormwater and degrading water quality. This includes establishing protocols to reduce the possibility of mishandling materials or equipment and training employees in good housekeeping techniques. Common areas where good housekeeping practices should be followed includes: material storage areas, vehicle and equipment maintenance areas, and loading areas. Good housekeeping practices must include a designated and secure location for garbage. A schedule for regular pickup and disposal of garbage and waste materials and routine inspections of containers for leaks and structural integrity shall be developed.

Specific good housekeeping practices that will be implemented include routine removal of trash. items including scrap, metal, wood, plastic, miscellaneous trash, paper, glass, insulation, misc. building materials, and packaging. Additional practices include securing and covering any containers, supplies, or equipment that could become sources of stormwater pollution.

MINIMIZING EXPOSURE DURING CONSTRUCTION

The Responsible Party shall minimize exposure of potential pollutant sources, including debris from coming into contact with precipitation and being picked up by stormwater and carried into drains and surface waters using the following steps:

- Storing all containerized materials in a protected, secure location away from drains and plainly labeled.
- Containing all activities that can generate sources of contaminants from reaching the receiving water or the stormwater management system.
- Securing any equipment or supplies so that they are not transported during storm events into receiving waters or stormwater management system.

BEST MANAGEMENT PRACTICES (BMP) MAINTENANCE

The proposed stormwater management system has been designed with appropriate BMPs aimed at reducing the pollutants discharge based upon the intended use of the proposed development. All BMPs require regular maintenance to function as intended. Some management measures have simple maintenance requirements; others are more involved. The Construction Manager must have all BMPs regularly inspected to ensure they are operating properly on an as-needed basis, including during runoff events exceeding 0.25 inches of rainfall.

The Construction Manager shall develop and maintain a log of inspections, maintenance, repairs, and disposal (including location of disposal) during the life of the project. Records will be maintained for at least 3 years and be made available to the Massachusetts Department of Environmental Protection or the Town of Hingham in accordance with the provisions of the Massachusetts Stormwater Handbook.

A description of the non-structural and structural approaches to be incorporated is indicated below. The following Best Management Practices are proposed to be incorporated into the stormwater management design to reduce source runoff and improve stormwater runoff discharge quality. The Responsible Party will regularly inspect all BMPs to ensure they are operating properly. If any deficiencies are identified during these inspections, action to resolve it will be initiated and documented on the maintenance log.

EROSION AND SEDIMENT CONTROLS:

Erosion and sedimentation (ESC) measures will be installed as indicated on the site plans prior to the commencement of any construction activities and will be maintained throughout construction until the site is stabilized. ESC controls, in the form of 12-inch compost filter socks, temporary soil and stockpile areas, temporary sediment basins and drain inlet protection will be installed in accordance with project plans and details, as well as any other current State, and Local requirements. ESC measures will be incorporated into the project as needed by the contractor to control runoff and prevent impact to areas which are to remain undisturbed.

ESC measures will be maintained and/or replaced as inspection deems necessary and or as directed by the Engineer, Architect, or Environmental Inspector. Sediment accumulations along ESC measures to a depth of 6-inches or more shall be removed and re-distributed to an area in manner that does not contribute to additional sediment migration. Contractors who disturb ESC measures will be required to repair/replace them and should inform the engineer or environmental inspector of deficiencies with ESC measures observed in the field.

Generally, the 50-foot natural buffer to wetland resources will be maintained during construction. Any encroachments into the 50-foot buffer will receive treatment of a double-row of 12” compost tube socks. The outlet for a proposed temporary sediment basin will be approximately 33 feet with approximately 21 feet to the edge of the wetland boundary. Note that the location of the proposed outlet is in an area where the buffer has already been reduced, therefore, the addition of the double-row compost tube socks enhances the existing buffer to provide protection against the existing case.

See Site Plans for locations of sediment controls.

PERIMETER CONTROLS

Perimeter sediment and stormwater controls consist of silt fence or compost filter socks which must be installed prior to commencement of earth disturbing activities at the site. Perimeter controls must be installed along the contour in the flattest area possible at a distance from the toe of slope; ends shall be placed up slope from the rest of the control. Perimeter controls must also be used around soil stockpiles as a sediment control measure.

Perimeter measures will be maintained and/or replaced as inspection deems necessary and or as directed by the Engineer, Architect, or Environmental Inspector. Sediment accumulations along the perimeter measures to a depth of 6-inches or more shall be removed and re-distributed to an area in manner that does not contribute to additional sediment migration. Contractors who disturb ESC measures will be required to repair/replace them and should inform the engineer or environmental inspector of deficiencies with ESC measures observed in the field.

See the Site Plans in Appendix A for additional details on the Perimeter Controls.

SEDIMENT TRACK OUT

Construction vehicles are anticipated to utilize the designated access drives, and construction entrances will be established at various points of entry into the construction zone. Construction entrance locations may be relocated as needed during different phases of the construction. Property entrance/exit locations will be maintained in a condition that will prevent tracking or flowing of sediment onto public roadways. The construction entrances will be inspected daily by the Site Supervisor. Fines imposed for tracking sediment onto public roads will be paid by the culpable Contractor.

All materials spilled, tracked or otherwise transported onto public road rights-of-way will be immediately removed. Remove the track-out by sweeping, shoveling, or vacuuming these surfaces, or by using other similarly effective means of sediment removal. It is prohibited from hosing or sweeping tracked-out sediment into any stormwater conveyance, storm drain inlet, or water of the U.S.

STREET SWEEPING

During the construction period, streets will be swept on an as-needed basis after all significant earth moving activities to remove pollutants and sediments that have accumulated.

STOCKPILED SEDIMENT OR SOIL

All inactive/temporary soil stockpiles will be protected with erosion controls and temporarily seeded, mulched or covered with plastic if not reused within 14 days. Long-term stockpiles may be compacted and hydro-seeded/mulched prior to the onset of wet weather. Temporary soil stockpiles shall be located within the active construction work area and be surrounded by an approved siltation barrier.

Any exposed soils/disturbed areas where construction activity ceases for 14 or more calendar days will be temporarily stabilized with seed, mulch or a bonded-fiber mix or other approved erosion control material unless the area is covered with snow or unless work in the area is expected to resume within 21 days. This will be done on all slopes as well as exposed flat surfaces as deemed necessary. Straw material will be applied uniformly across disturbed areas to minimize erosion. Routine inspection and maintenance of stabilization practices will reduce soil erosion and minimize project runoff.

For any stockpiled or land clearing debris composed, in whole or in part, of sediment or soil, the following measures must be followed:

Locate the piles outside of any natural buffers established and physically separated from other stormwater controls implemented and as noted on the Plans;

- Protect from contact with stormwater (including run-on) using a temporary perimeter sediment barrier;
- Provide cover or appropriate temporary stabilization to avoid direct contact with precipitation or to minimize sediment discharge;

- Do not hose down or sweep soil or sediment accumulated on pavement or other impervious surfaces into any stormwater conveyance (unless connected to a sediment basin, sediment trap, or similarly effective control), storm drain inlet, or surface water; and
- Unless infeasible, contain and securely protect from wind.

MINIMIZE DUST

Dust control is important for controlling air quality on and off site during various phases of construction. Dust control will be provided on an as-needed basic during construction. Sprinkle irrigation using tanker trucks is effective to control dust from gravel/dirt haul roads and during earth-moving/grading phases of site preparation. On exposed soils where vehicular traffic is not expected and/or completed, vegetative cover and/or mulching can be used to stabilize soils. Stone graded out over exposed areas where vegetation cannot be established can be effective along high traffic areas. Dust shall be monitored regularly onsite and treated as necessary.

The following dust suppression methods may be used at the project:

- Watering/Irrigation: Sprinkling the ground surface with water until it is moist.
- Soil Stabilization: Vegetative cover, mulch, riprap or any method that covers the soil surface reduces the potential for soil particles to become airborne.
- Wind Breaks: Wind breaks are barriers (either natural or constructed) that reduce wind velocity across exposed soil surfaces and reduces the potential for soil particles become airborne. Wind breaks can be trees or shrubs left in place during site clearing or constructed barriers such as a wind fence.

If additional dust control measures are required, the situation will be assessed and addressed.

TOPSOIL

Where disturbance to native topsoil will occur at the site, unless infeasible, it must be preserved and reused. Existing and new vegetation will be maintained to the maximum extent practicable to prevent the contamination of storm water with sediment. Vegetated areas beginning to show signs of erosion or soil transport will be mulched or covered with jute netting or a comparable erosion control fabric to filter stormwater runoff prior to conveyance into the stormwater drainage system.

SOIL COMPACTION

In areas where final vegetative stabilization will occur or where infiltration practices (post development stormwater management system) and septic system will be installed either of the following measures must be followed by the Contractor:

- Restrict vehicle and equipment use and stockpile of materials in these locations to avoid soil compaction
- Prior to seeding or planting areas of exposed soil that have been compacted, use techniques that condition the soils to support vegetative growth, if necessary.

STORM DRAIN INLETS

Catch basins and area drains associated with the existing and/or proposed stormwater management system located within the project limits and the adjacent Right-of-Ways may collect and convey sediment and sediment-laden stormwater runoff. Therefore, all catch basins and area drains, existing and proposed, within construction zones, will be protected with silt sacks during construction and until final site stabilization is complete.

SEDIMENT BASINS

The removal and disposal of collected water from construction areas is a potential source of sediment and can lead to erosion during construction activities. Temporary sedimentation basins shall be constructed according to the site plans and EPA regulations. The temporary sedimentation basins shall be monitored daily. Stormwater shall be directed towards the existing pipe conveyance system to help prevent overflow from leaving the construction work area.

Temporary sediment basins/traps are instrumental in controlling sediment-laden stormwater runoff during initial phases of construction involving earthmoving activities before permanent stormwater management systems are in place. Sediment basins and traps will be constructed in accordance with Environmental Protection Agency (EPA) guidelines (See Project Plans – Appendix A). Sediment traps should have a minimum volume, based on 0.5-inch of storage for each acre of drainage area. Temporary sedimentation basins/traps shall be monitored daily. Stormwater shall be directed towards the existing conveyance system to help prevent overflow from leaving the construction work area.

ROOF DRAIN GUTTERS AND DOWNSPOUTS

Roof drain gutters and downspouts should be inspected and cleaned twice a year, once in the fall after leaf drop and in the spring after snow melt. Cleaning will take place at the completion of construction and in early spring after snow melt. Any obstructions, sediment, and debris that could potentially cause clogging shall be removed within the roof drain gutter and downspout system as necessary.

DEEP SUMP CATCH BASINS AND MANHOLE STRUCTURES

Catch basins shall be cleaned, in dry weather, when half of the sump capacity is filled or at a minimum quarterly or as required through periodic inspection. Cleaning will take place at the completion of construction and in early spring after sanding of roadways has ceased or as needed depending on the frequency of major storm events (greater than 1-inch of rainfall). All manholes shall be inspected at least once annually or as dictated by the Responsible Party. Any obstructions, sediment, and debris that could potentially cause clogging shall be removed within the conveyance system as necessary. Inverts, grates, and hoods shall be checked and replaced as necessary to maintain hydraulic effectiveness.

OIL/WATER SEPARATORS

Oil/Water separators are used to manage runoff from land uses with higher potential pollutant loads where there is a risk that the stormwater is contaminated with oil or grease. Oil/water separators require regular maintenance with inspection monthly and cleaning at least twice per year. Cleaning included removal of accumulated oil and grease and sediment using a vacuum truck. Polluted water or sediments removed should be disposed in accordance with all applicable local, state, and federal laws and regulations.

ISOLATOR ROW

The Isolator Rows in the underground chamber systems shall be inspected twice per year and cleaned at least once per year and in accordance with the manufacturer's recommendations. Periodic inspections performed by the responsible party may dictate cleaning on a more frequent basis depending on the suspended solids loading. During construction accumulated sediment may need to be removed more frequently. Conduct jetting and vactoring annually or when inspection shows that maintenance is necessary. See attached maintenance documentation from the manufacturer.

SUBSURFACE STORMTECH CHAMBERS SYSTEM

Subsurface system consisting of high-density polyethylene plastic chambers (ADS StormTech®) set in a stone bed are proposed to remove TSS. The chamber system can provide TSS removal for various storm events for the stormwater runoff. The proposed system drains down completely between storm events due to the large footprint of the stone beds. Manhole risers and manufacturer recommended inspection ports are proposed at the ground surface to allow inspection and maintenance access. Once the system goes online, inspections should occur after each storm event for the first few months to ensure proper stabilization, function, and to ensure that the outlets remain free of obstructions. Preventative maintenance shall be performed at least twice per year and after every major storm event (> 1.5" of rainfall) and shall include removal of accumulated sediment, inspection of the detention structure, and monitoring of groundwater to ensure proper operation of the system.

Important items to check for include differential settlement, cracking, breakout, clogging of outlets and vents, and root infestation. Water levels should be checked and recorded against rainfall amounts to verify that the drainage system is working properly and draining within 72 hours. If they do not drain within 72 hours, corrective action should be taken.

OUTLET CONTROL STRUCTURES

The outlet control structures (OCS) detain the water utilizing orifices to control the outlet flow and are below grade with access via covers to grade. Although the outlet control structures should not have much debris, they should be inspected to make sure there are not concrete issues or residual debris. Sand accumulation within the OCS is a sign there is an issue with the upstream stormwater treatment device. The OCS shall be inspected once per year. It may be necessary to clean the structure and the use of a vacuum truck may be necessary.

PLUNGE POOL/ENERGY DISSIPATER AND DOWNSTREAM SLOPES

The level spreader/plunge pool/energy dissipaters are utilized at the outlet pipes prior to discharge to the wetland to prevent erosions. The level spreader/plunge pool/energy dissipaters should be inspected at least once a year for sand accumulation and debris which may impact its effectiveness to slow water. Cleaning should take place during the early spring, although, additional inspections and cleaning may be needed.

In order to ensure that the level spreader systems are working, the outlets as well as slopes downstream for the first three years of operation, should be inspected after every storm of 1” or greater to assure no erosion of the slope. After the first three years, we recommend inspections after any large storm (25+ year event) for erosion. If no erosion is evident, then the stone size and level spreader design is adequate. Should there be erosion of the level spreader, stone size should be increased, or additional large stones added to enhance energy dissipation of water. If downstream slopes exhibit signs of erosion, repairs to soils and slope should be made and then a treatment such as an erosion control matting should be instituted to reinforce soils until vegetative cover can be restored. We recommend that the aprons and downstream slopes be inspected and cleaned annually as part of the outlet maintenance to ensure future adequacy.

INSPECTION AND MAINTENANCE SCHEDULE

At a minimum, the Contractor must conduct a site inspection at least once every 7 calendar days.
OR
Once every 14 calendar days and within 24 hours of the occurrence of a storm event of 0.25 inches or greater. To determine if a storm event of 0.25 inches or greater has occurred on the site, either keep a properly maintained rain gauge on the site or obtain the storm event information from a weather station that is representative of your location.

VEGETATIVE PLANNING

The Contractor must immediately initiate soil stabilization measures whenever earth-disturbing activities have permanently or temporarily ceased on any portion of the site. Earth-disturbing activities have temporarily or permanently ceased when clearing, grading and excavating within any area of the site that will not include permanent structures, will not resume for a period of 14 or more calendar days, but will resume in the future.

Deadline to complete stabilization. As soon as practicable, but no later than 14 calendar days after the initiation of soil stabilization measures the following must be completed:

- For vegetative stabilization, all activities necessary to initially seed or plant the area to be stabilized; and/or
- For non-vegetative stabilization, the installation or application of all such non-vegetative measures.

Seed shall be sown from April 1 to June 15, or from August 15 to September 30 unless otherwise approved by the Engineer. Deciduous planting season is April 1 to May 20 and October 1 to November 15th unless otherwise approved by the Engineer. Evergreen planting season is April 1 to May 20 unless otherwise approved by the Engineer.

SPILL CONTROL:

The development consists of a gas station and associated commercial building. It is recommended that if there is no existing contingency plan to address the spillage/release of petroleum products and any hazardous material be implemented for the development the one be fully developed. The

Contractor shall have the MassDEP emergency spill response information posted onsite at all times. It is also recommended an emergency spill response kit including absorbent pillows be stored on-site along with instructions for the kit, a copy of applicable regulations regarding spills, and a list of individuals to contact (local and state officials) in the event of a spill.

Spills or leaks will be treated properly according to material type, volume of spillage and location of spill. Mitigation will include preventing further spillage, containing the spilled material in the smallest practical area, removing spilled material in a safe and environmentally friendly manner, and remediating any damage to the environment.

CONSTRUCTION SEQUENCING:

The following section provides construction details and highlights the construction sequence and timing of earthmoving activities. The overall project will be broken down into the following phases:

- Establish Erosion and Sediment Controls around the project site
- Demolition (ex. building, structures, driveways, septic systems)
- Site clearing and grading, drainage, utility, and roadway installation
- Building construction
- Final utility connections, and permanent stabilization

A. Pre-construction Meeting
An on-site meeting will be conducted by the Owner's Representative prior to the start of construction activity.

B. Installation of Erosion Controls
Erosion and sedimentation controls (i.e. silt fence, filter sock, and inlet protection) will be installed at the limits of work and within the existing catch basins, as applicable. Tree protection will be installed around trees specified to remain within the limit of work. Structures to remain shall also be visibly flagged/protected.

C. Installation of Construction Entrance
A construction entrance will be installed in the location as shown on the Erosion Control Plan in accordance with the construction detail provided in the plan set. Existing pavement will be removed within the limits of the proposed construction entrance to accommodate the crushed stone entrance.

D. Installation of Temporary Sediment Basins
Temporary sediment basins will be installed as shown on the plans with vertical 12" perforated pipe wrapped with filter fabric and screen on top for overflow. Side slopes of the temporary sediment basins shall be 3 foot horizontal to 1 foot vertical. Sediment to be removed when accumulation is within 6" of the outlet elevation.

E. Demolition
Any existing building, utilities services, and pavement within the project area will be demolished in accordance with the Construction Plans. Those utilities effected by construction activates shall be coordinated with the utility purveyors and Dig Safe procedures taken prior to implementation of agreed upon

connections/disconnections/abandonment of services. Materials that are to be removed from the site will be transported to an appropriate facility or will be disposed of elsewhere according to Federal, State, and Local guidelines. Inactive stockpiles or areas of granular material or topsoil shall be temporarily secured in order to control sediment laden runoff.

F. Site Clearing and Rough Grading
The site will be cleared and rough graded in accordance with the proposed grading as shown on the plans. If suitable topsoil is found, it will be removed and stockpiled within the project limits. Areas which have been cleared (outside of the right-of-way) will be stabilized.

G. Building Construction
This phase of construction will involve the installation of the building including the proposed foundation and vertical construction of the building. All building waste is to be properly disposed of in dumpsters. While this phase commences, other site construction activities will be taking place.

H. Installation of Drainage and Utilities
Utility relocations and modifications, including water, gas, and electric, are anticipated to occur in conjunction with the drainage work. Temporary sediment basins will be constructed at this time on an as-needed basis to collect stormwater runoff during construction. Stockpiles will be established in designated areas as shown on project plans. All temporary/inactive stockpile areas will be encompassed by filter sock and silt fence or other approved erosion control devices to control sediment laden runoff as necessary and will be temporarily seeded, mulched or covered with plastic, as necessary.

I. Fine Grading, Paving, Etc.
The fine grading and shaping will commence along with the installation of curbing to prepare for paving operations. Areas outside of the parking lot will be shaped and prepped for loam, seed, or other treatments. Paving operations will begin with the installation of both binder and finish course layers.

J. Permanent / Final Site Stabilization
The final phase of the project consists of landscaping and restoration and stabilization of all exposed surfaces. Final landscaping will be performed upon completion of earthwork and completion of all curbing and sidewalk construction. Disturbed areas will be landscaped, mulched or seeded in accordance with the landscape requirements. Permanent restoration and revegetation measures serve to control erosion and sedimentation by establishing a vegetative cover. In the event that weather conditions prevent final restoration, temporary erosion and sedimentation measures will be employed until the weather is suitable for final cleanup. A final inspection will ensure that the project site is cleared of all project debris and that erosion and sedimentation controls are functioning properly. Once the site has been stabilized, newly installed catch basins and the subsurface infiltration and detention systems will be inspected for sediment deposits and cleaned if necessary.

LONG TERM STRUCTURAL BEST MANAGEMENT PRACTICE INSPECTION & MAINTENANCE MATRIX AFTER CONSTRUCTION

Note: BMP's shall be visually inspected and repaired by a qualified party in accordance with the following chart. Note these are minimum inspection criteria/frequencies and should be adjusted throughout the project lifespan as required to maintain effectiveness. Refer to maintenance standards for drainage facilities and structural best management practices in the "Recommended Long-Term Stormwater Pollution Prevention Plan."

Conventional & LID Best Management Practices	Recommended Minimum Inspection & Maintenance Frequency	Erosion/Scouring	Tree Growth Hazards	Differential Settlement/Seepage	Structural Damage/Obstructions	Trash & Debris	Removal of Accumulated Sediment	Slope Integrity	*Mow Vegetation/Poor Vegetation Coverage	Remove/Reset Filter Fabric & Stone As Required	Remove & Replace Hardwood mulch/media	Vac Truck Sediment & Contaminants	Remove/Reset Riprap as Required
Catch Basin and OCS	*Quarterly*		☑	☑	☑	☑	☑					☑	
Oil/Water Sepator	*Monthly/ Semi-Annual*		☑	☑	☑	☑	☑					☑	
Roof Drain Gutters and Downspouts	*Semi-Annual*		☑	☑	☑	☑	☑					☑	
Isolator Row	*Semi-Annual / Per Manufacturer*			☑	☑	☑	☑					☑	
Detention/Recharge	*Semi-Annual*	☑	☑	☑	☑	☑	☑					☑	
Flared End	*Semi-Annual*	☑	☑	☑	☑	☑	☑	☑		☑			☑

CONSTRUCTION PERIOD POLLUTION PREVENTION AND EROSION AND SEDIMENTATION CONTROL PLAN

CONSTRUCTION LOG FORM

Hingham Gas
Hingham, Massachusetts

RESPONSIBLE PARTY ____

AREA OF PROJECT WITH CONSTRUCTION	DATE(S) OF MAJOR GRADING ACTVITY	DATE(S) WHEN CONSTRUCTION TEMPORARILY OR PERMANENTLY CEASED	DATE(S) WHEN STABILIZING MEASURES WERE INITIATED	DATE AND INITIAL

CONSTRUCTION PERIOD POLLUTION PREVENTION AND EROSION AND SEDIMENTATION CONTROL PLAN

INSPECTION AND MAINTENANCE REPORT

Hingham Gas
Hingham, Massachusetts

<table>
<tr><th colspan="4">General Information</th></tr>
<tr><td>Project Name</td><td colspan="3"></td></tr>
<tr><td>Location</td><td colspan="3"></td></tr>
<tr><td>Date of Inspection</td><td></td><td>Start/End Time</td><td></td></tr>
<tr><td>Inspector's Name(s)</td><td colspan="3"></td></tr>
<tr><td>Inspector's Title(s)</td><td colspan="3"></td></tr>
<tr><td>Inspector's Contact Information</td><td colspan="3"></td></tr>
<tr><td>Inspector's Qualifications</td><td colspan="3"></td></tr>
<tr><td>Describe present phase of construction</td><td colspan="3"></td></tr>
<tr><td colspan="4">Type of Inspection:
❑ Regular ❑ Pre-storm event ❑ During storm event ❑ Post-storm event</td></tr>
<tr><th colspan="4">Weather Information</th></tr>
<tr><td colspan="4">Has there been a storm event since the last inspection? ❑Yes ❑No
If yes, provide:
Storm Start Date & Time: Storm Duration (hrs): Approximate Amount of Precipitation (in):</td></tr>
<tr><td colspan="4">Weather at time of this inspection?
❑ Clear ❑Cloudy ❑ Rain ❑ Sleet ❑ Fog ❑ Snowing ❑ High Winds
❑ Other: Temperature:</td></tr>
<tr><td colspan="4">Have any discharges occurred since the last inspection? ❑Yes ❑No
If yes, describe:</td></tr>
<tr><td colspan="4">Are there any discharges at the time of inspection? ❑Yes ❑No
If yes, describe:</td></tr>
</table>

	BMP	BMP Installed?	BMP Maintenance Required?	Corrective Action Needed and Notes
1		❑Yes ❑No	❑Yes ❑No	
2		❑Yes ❑No	❑Yes ❑No	
3		❑Yes ❑No	❑Yes ❑No	
4		❑Yes ❑No	❑Yes ❑No	
5		❑Yes ❑No	❑Yes ❑No	
6		❑Yes ❑No	❑Yes ❑No	
7		❑Yes ❑No	❑Yes ❑No	
8		❑Yes ❑No	❑Yes ❑No	
9		❑Yes ❑No	❑Yes ❑No	
10		❑Yes ❑No	❑Yes ❑No	
11		❑Yes ❑No	❑Yes ❑No	
12		❑Yes ❑No	❑Yes ❑No	
13		❑Yes ❑No	❑Yes ❑No	
14		❑Yes ❑No	❑Yes ❑No	
15		❑Yes ❑No	❑Yes ❑No	
16		❑Yes ❑No	❑Yes ❑No	
17		❑Yes ❑No	❑Yes ❑No	
18		❑Yes ❑No	❑Yes ❑No	
19		❑Yes ❑No	❑Yes ❑No	
20		❑Yes ❑No	❑Yes ❑No	

	BMP/activity	Implemented?	Maintenance Required?	Corrective Action Needed and Notes
1	Are all slopes and disturbed areas not actively being worked properly stabilized?	❑Yes ❑No	❑Yes ❑No	
2	Are natural resource areas (e.g., streams, wetlands, mature trees, etc.) protected with barriers or similar BMPs?	❑Yes ❑No	❑Yes ❑No	
3	Are perimeter controls and sediment barriers adequately installed (keyed into substrate) and maintained?	❑Yes ❑No	❑Yes ❑No	
4	Are discharge points and receiving waters free of any sediment deposits?	❑Yes ❑No	❑Yes ❑No	
5	Are storm drain inlets properly protected?	❑Yes ❑No	❑Yes ❑No	
6	Is the construction exit preventing sediment from being tracked into the street?	❑Yes ❑No	❑Yes ❑No	
7	Is trash/litter from work areas collected and placed in covered dumpsters?	❑Yes ❑No	❑Yes ❑No	

	BMP/activity	Implemented?	Maintenance Required?	Corrective Action Needed and Notes
8	Are washout facilities (e.g., paint, stucco, concrete) available, clearly marked, and maintained?	❑Yes ❑No	❑Yes ❑No	
9	Are vehicle and equipment fueling, cleaning, and maintenance areas free of spills, leaks, or any other deleterious material?	❑Yes ❑No	❑Yes ❑No	
10	Are materials that are potential stormwater contaminants stored inside or under cover?	❑Yes ❑No	❑Yes ❑No	
11	Are non-stormwater discharges (e.g., wash water, dewatering) properly controlled?	❑Yes ❑No	❑Yes ❑No	
12	(Other)	❑Yes ❑No	❑Yes ❑No	

Non-Compliance

Describe any incidents of non-compliance not described above:

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Save Valuable Land and Protect Water Resources

Isolator® Row O&M Manual

StormTech® Chamber System for Stormwater Management

U.S. GREEN BUILDING COUNCIL MEMBER™

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.

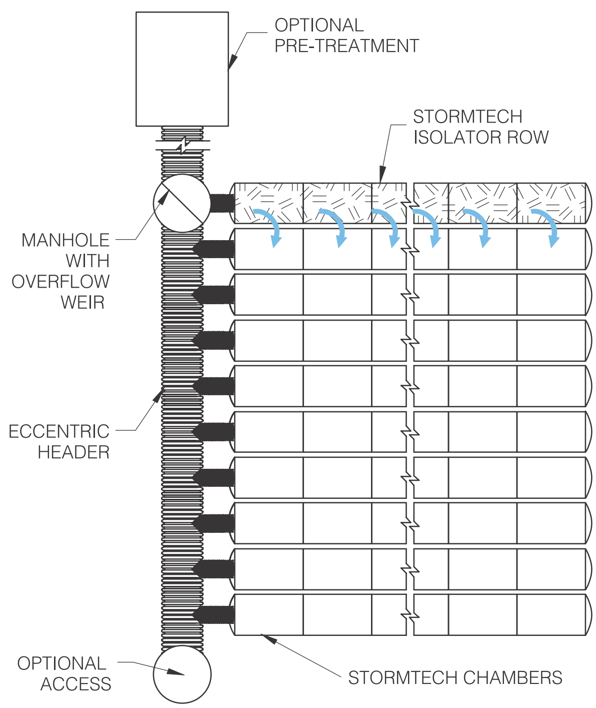
Two different fabrics are used for the Isolator Row. A woven geotextile fabric is placed between the stone and the Isolator Row chambers. The tough geotextile provides a media for storm water filtration and provides a durable surface for maintenance operations. It is also designed to prevent scour of 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

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.

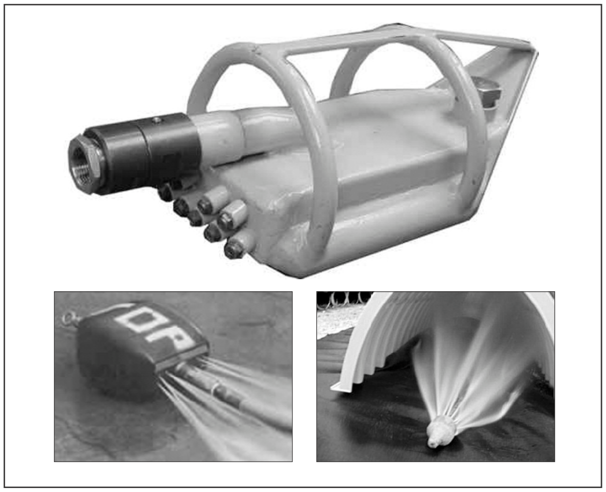
At a minimum, StormTech recommends annual inspections. Initially, the Isolator Row should be inspected every 6 months for the first year of operation. For subsequent years, the inspection should be adjusted based upon previous observation of sediment deposition.

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

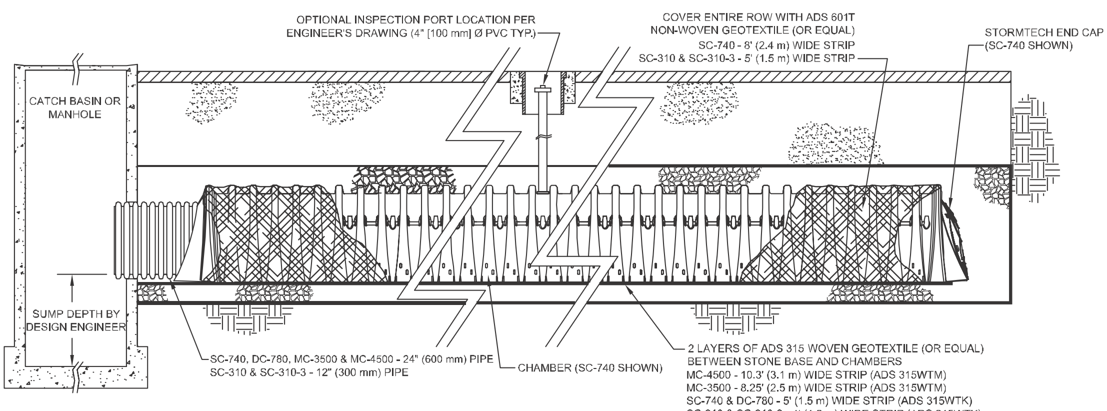
The Isolator Row was designed to reduce the cost of periodic maintenance. By “isolating” sediments to just one row, costs are dramatically reduced by eliminating the need to clean out each row of the entire storage bed. If inspection indicates the potential need for maintenance, access is provided via 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.**

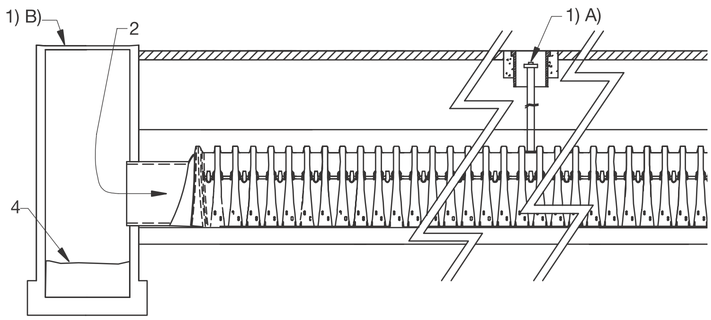
StormTech Isolator Row (not to scale)



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

StormTech Isolator Row (not to scale)



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.

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

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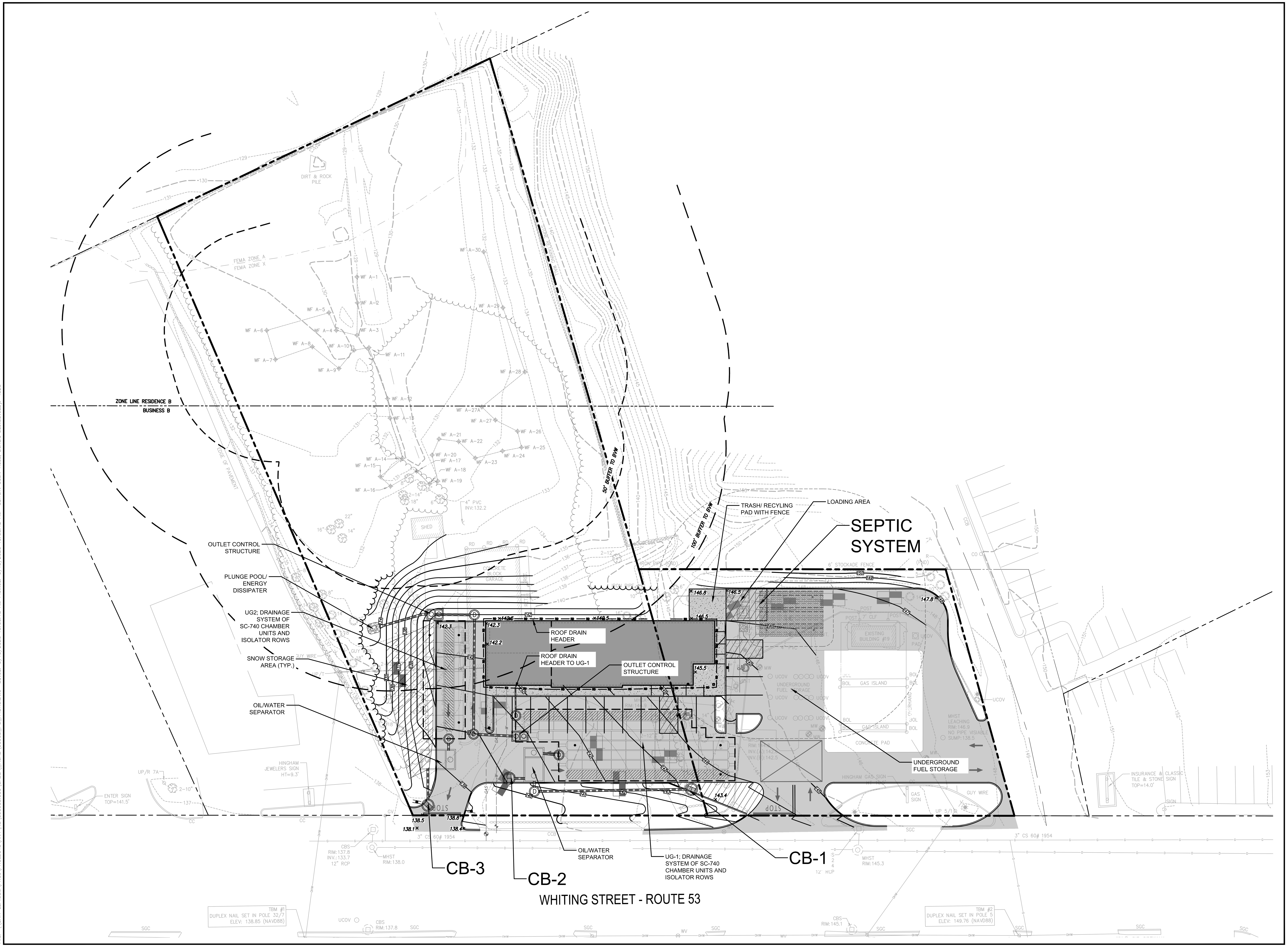
860.529.8188 | 888.892.2694 | fax 866.328.8401 | www.stormtech.com



CHA
141 Longwater Drive - Suite 104
Norwell, MA 02061
781.982.5400 • www.chacompanies.com

0 20 40
Scale in feet

OWNER/APPLICANT:

MERHEJ & SONS REALTY, LLC
87 DERBY STREET
HINGHAM, MA 02043

IT IS A VIOLATION OF LAW FOR ANY PERSON, UNLESS THEY ARE ACTING UNDER THE DIRECTION OF A LICENSED PROFESSIONAL ENGINEER, ARCHITECT, LANDSCAPE ARCHITECT OR LAND SURVEYOR TO ALTER AN ITEM IN ANY WAY. IF AN ITEM BEARING THE STAMP OF A LICENSED PROFESSIONAL IS ALTERED, THE ALTERING ENGINEER, ARCHITECT, LANDSCAPE ARCHITECT OR LAND SURVEYOR SHALL STAMP THE DOCUMENT AND INCLUDE THE NOTATION "ALTERED BY" FOLLOWED BY THEIR SIGNATURE, THE DATE OF SUCH ALTERATION, AND A SPECIFIC DESCRIPTION OF THE ALTERATION.

HINGHAM GAS
#19 & 27 WHITING STREET
HINGHAM, MA 02043

No.	Submittal / Revision	App'd.	By	Date
B	PERMIT SET	KK	JM	9/11/2020
A	PERMIT SET	KK	JM	5/1/2020

OPERATION AND MAINTENANCE PLAN

Designed By:	Drawn By:	Checked By:
DR/BN	DR/BN	KK
Issue Date:	Project No:	Scale:
05/01/2020	060903	1" = 20'

Drawing No.:

O&M

Section 3.0

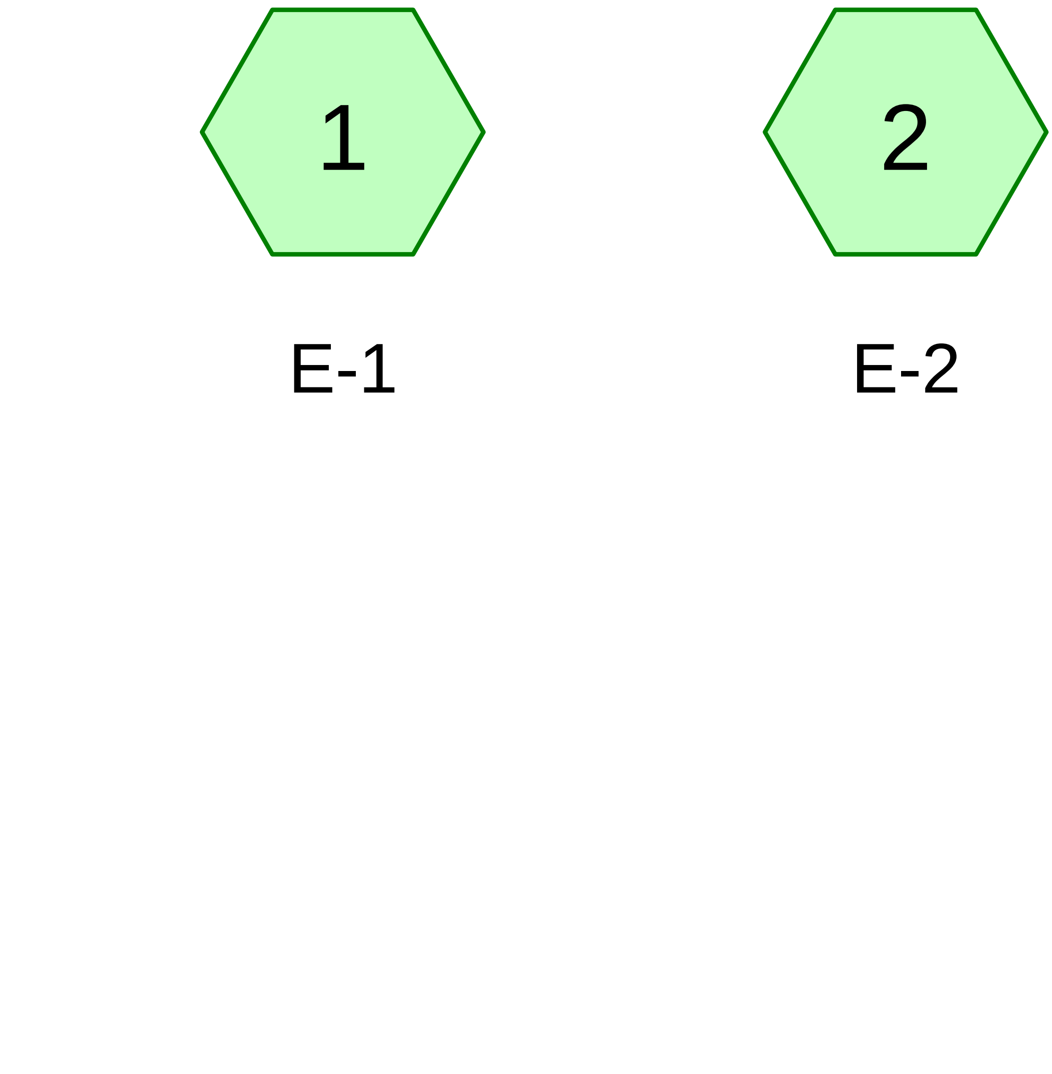
Hydrology and Hydraulic Modeling

Section 3.1

HydroCAD Site Hydrology Calculations

Section 3.1.1

Pre-Developed Stormwater Report Calculations



Routing Diagram for 27 Whiting Existing Hydrology
Prepared by CHA Companies, Inc., Printed 9/10/2020
HydroCAD® 10.00-25 s/n 01012 © 2019 HydroCAD Software Solutions LLC

Time span=0.00-60.00 hrs, dt=0.05 hrs, 1201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1: E-1 Runoff Area=23,595 sf 70.74% Impervious Runoff Depth=1.56"
Tc=5.0 min CN=80 Runoff=0.98 cfs 0.070 af

Subcatchment 2: E-2 Runoff Area=62,035 sf 8.95% Impervious Runoff Depth=0.79"
Flow Length=321' Tc=15.7 min CN=67 Runoff=0.84 cfs 0.094 af

Total Runoff Area = 1.966 ac Runoff Volume = 0.165 af Average Runoff Depth = 1.00"
74.02% Pervious = 1.455 ac 25.98% Impervious = 0.511 ac

Summary for Subcatchment 1: E-1

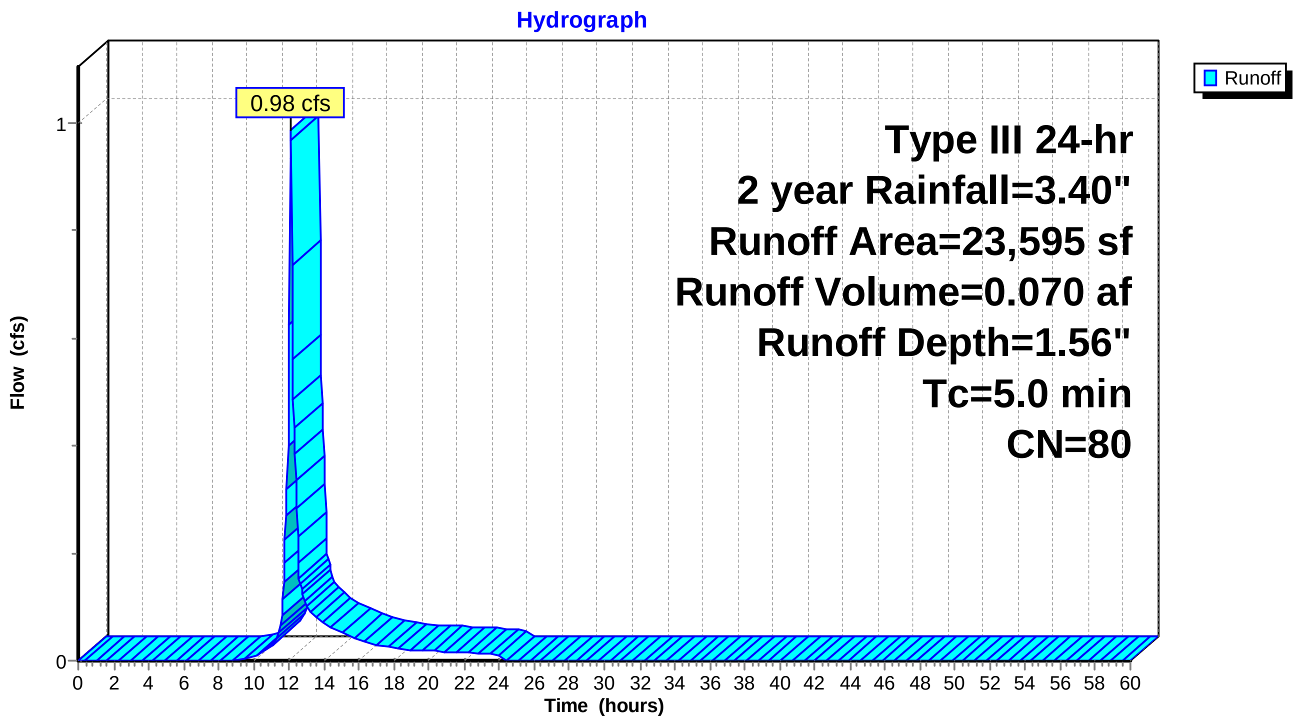
Runoff = 0.98 cfs @ 12.08 hrs, Volume= 0.070 af, Depth= 1.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.40"

	Area (sf)	CN	Description
*	16,692	98	Impervious
	1,257	30	Woods, Good, HSG A
*	5,646	39	>75% Grass Good/Landscape, HSG A
	23,595	80	Weighted Average
	6,903		29.26% Pervious Area
	16,692		70.74% Impervious Area

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

Subcatchment 1: E-1



Summary for Subcatchment 2: E-2

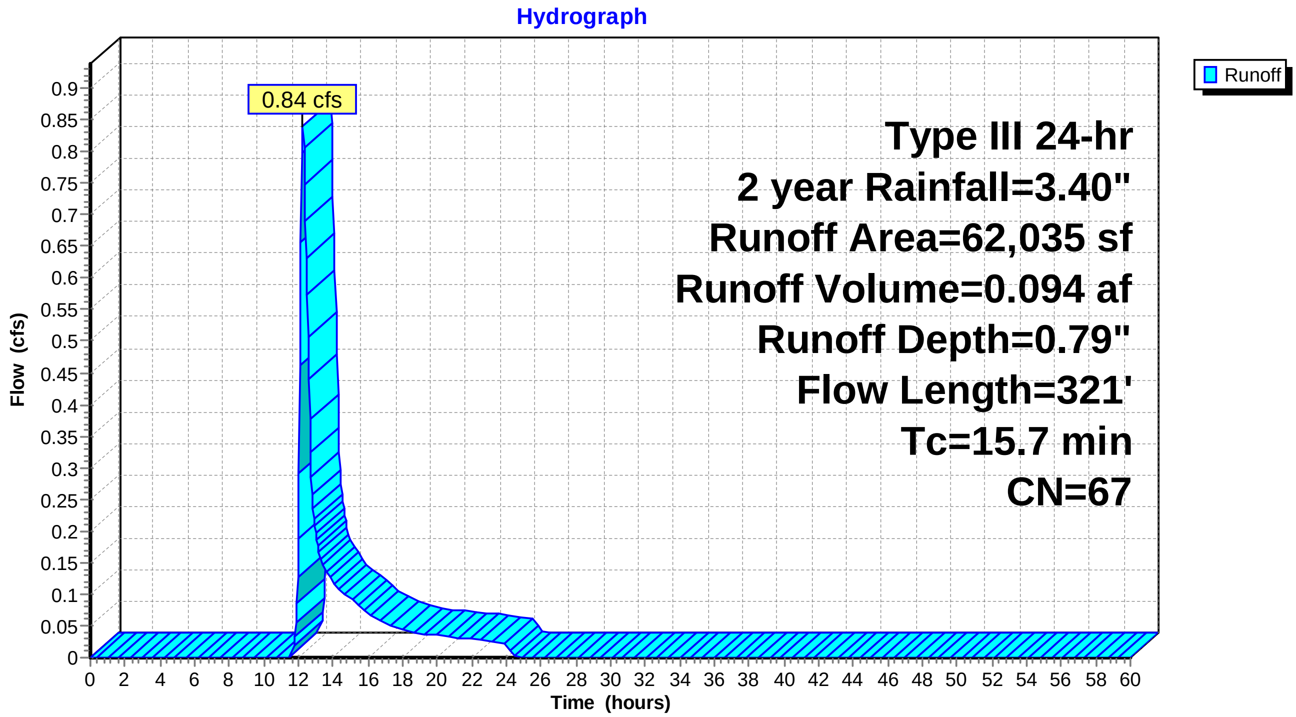
Runoff = 0.84 cfs @ 12.25 hrs, Volume= 0.094 af, Depth= 0.79"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.40"

	Area (sf)	CN	Description
	32,848	70	Woods, Good, HSG C
	2,312	30	Woods, Good, HSG A
	11,047	74	>75% Grass cover, Good, HSG C
	10,277	39	>75% Grass cover, Good, HSG A
*	5,551	98	Impervious
	62,035	67	Weighted Average
	56,484		91.05% Pervious Area
	5,551		8.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	50	0.1900	0.10		**Sheet Flow, AB** Woods: Dense underbrush n= 0.800 P2= 3.20"
0.3	40	0.1750	2.09		**Shallow Concentrated Flow, BC** Woodland Kv= 5.0 fps
1.6	123	0.0325	1.26		**Shallow Concentrated Flow, CD** Short Grass Pasture Kv= 7.0 fps
5.1	108	0.0050	0.35		**Shallow Concentrated Flow, DE** Woodland Kv= 5.0 fps
15.7	321	Total			

Subcatchment 2: E-2



Time span=0.00-60.00 hrs, dt=0.05 hrs, 1201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1: E-1 Runoff Area=23,595 sf 70.74% Impervious Runoff Depth=2.63"
Tc=5.0 min CN=80 Runoff=1.67 cfs 0.119 af

Subcatchment 2: E-2 Runoff Area=62,035 sf 8.95% Impervious Runoff Depth=1.60"
Flow Length=321' Tc=15.7 min CN=67 Runoff=1.87 cfs 0.190 af

Total Runoff Area = 1.966 ac Runoff Volume = 0.308 af Average Runoff Depth = 1.88"
74.02% Pervious = 1.455 ac 25.98% Impervious = 0.511 ac

Summary for Subcatchment 1: E-1

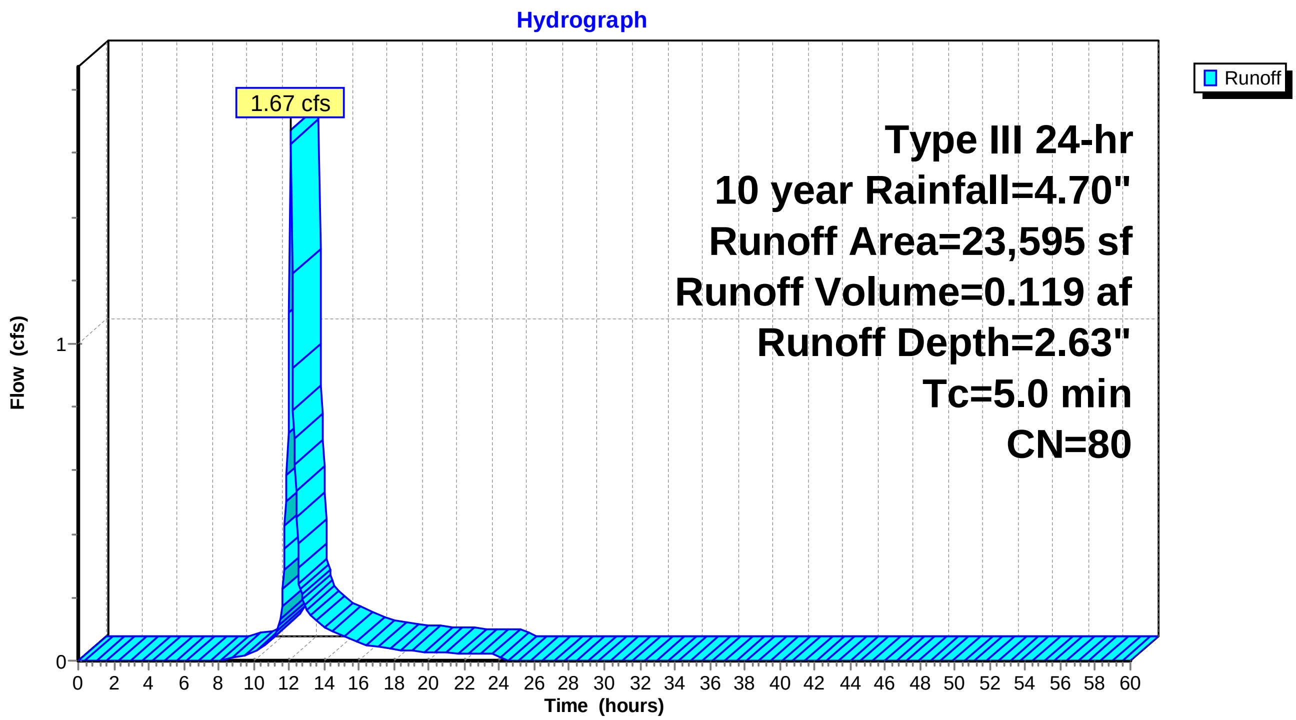
Runoff = 1.67 cfs @ 12.08 hrs, Volume= 0.119 af, Depth= 2.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.70"

	Area (sf)	CN	Description
*	16,692	98	Impervious
	1,257	30	Woods, Good, HSG A
*	5,646	39	>75% Grass Good/Landscape, HSG A
	23,595	80	Weighted Average
	6,903		29.26% Pervious Area
	16,692		70.74% Impervious Area

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

Subcatchment 1: E-1



Summary for Subcatchment 2: E-2

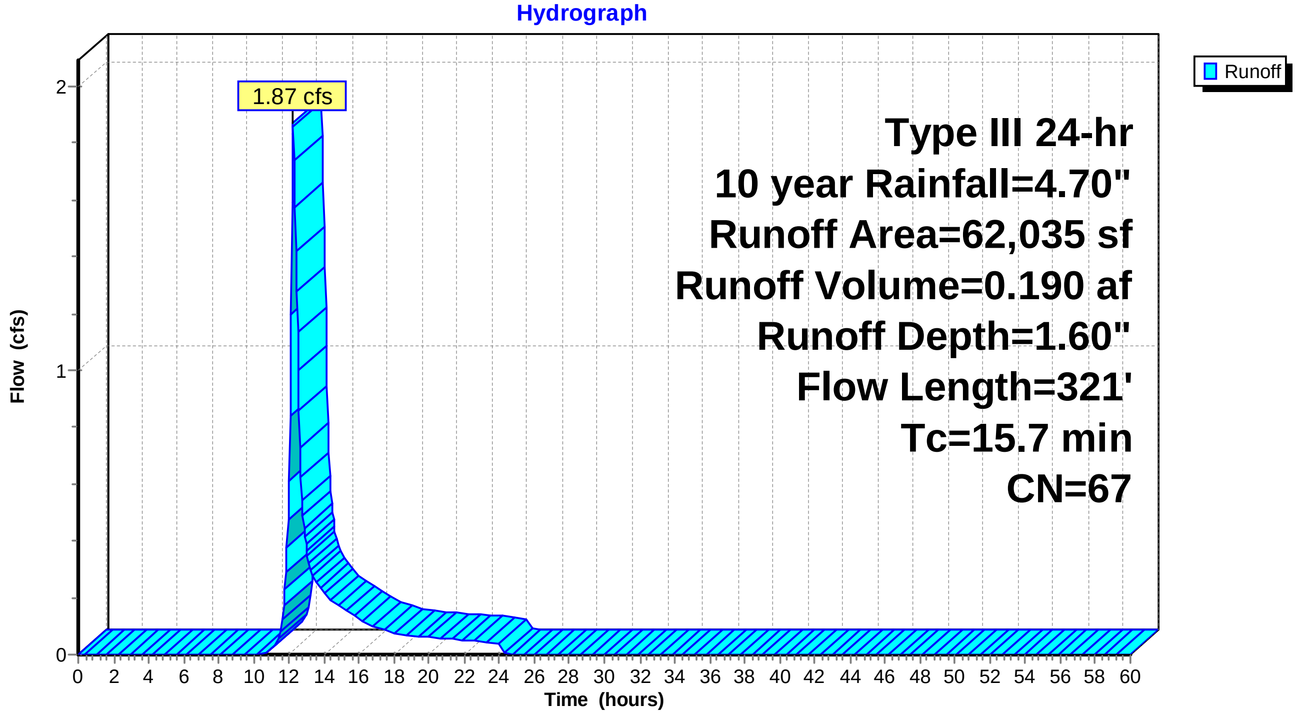
Runoff = 1.87 cfs @ 12.23 hrs, Volume= 0.190 af, Depth= 1.60"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.70"

	Area (sf)	CN	Description
	32,848	70	Woods, Good, HSG C
	2,312	30	Woods, Good, HSG A
	11,047	74	>75% Grass cover, Good, HSG C
	10,277	39	>75% Grass cover, Good, HSG A
*	5,551	98	Impervious
	62,035	67	Weighted Average
	56,484		91.05% Pervious Area
	5,551		8.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	50	0.1900	0.10		**Sheet Flow, AB** Woods: Dense underbrush n= 0.800 P2= 3.20"
0.3	40	0.1750	2.09		**Shallow Concentrated Flow, BC** Woodland Kv= 5.0 fps
1.6	123	0.0325	1.26		**Shallow Concentrated Flow, CD** Short Grass Pasture Kv= 7.0 fps
5.1	108	0.0050	0.35		**Shallow Concentrated Flow, DE** Woodland Kv= 5.0 fps
15.7	321	Total			

Subcatchment 2: E-2



Time span=0.00-60.00 hrs, dt=0.05 hrs, 1201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1: E-1 Runoff Area=23,595 sf 70.74% Impervious Runoff Depth=3.42"
Tc=5.0 min CN=80 Runoff=2.17 cfs 0.154 af

Subcatchment 2: E-2 Runoff Area=62,035 sf 8.95% Impervious Runoff Depth=2.23"
Flow Length=321' Tc=15.7 min CN=67 Runoff=2.68 cfs 0.265 af

Total Runoff Area = 1.966 ac Runoff Volume = 0.419 af Average Runoff Depth = 2.56"
74.02% Pervious = 1.455 ac 25.98% Impervious = 0.511 ac

Summary for Subcatchment 1: E-1

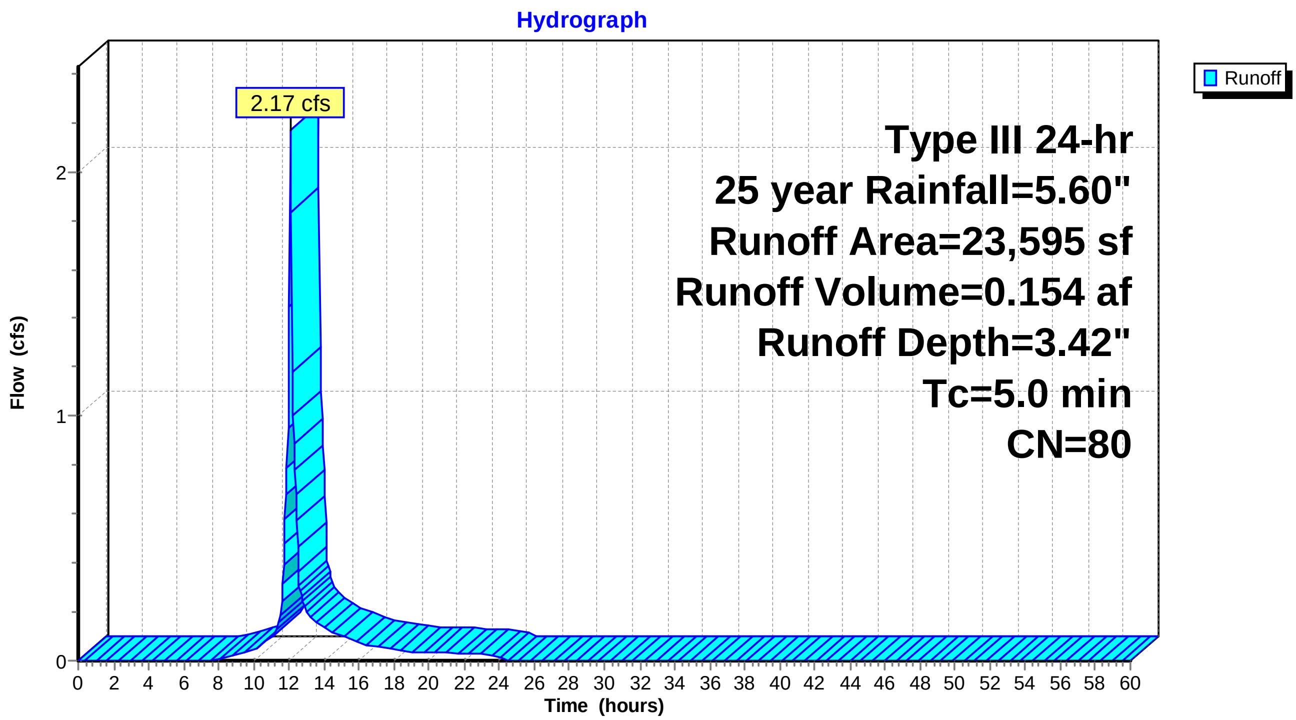
Runoff = 2.17 cfs @ 12.08 hrs, Volume= 0.154 af, Depth= 3.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 year Rainfall=5.60"

	Area (sf)	CN	Description
*	16,692	98	Impervious
	1,257	30	Woods, Good, HSG A
*	5,646	39	>75% Grass Good/Landscape, HSG A
	23,595	80	Weighted Average
	6,903		29.26% Pervious Area
	16,692		70.74% Impervious Area

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

Subcatchment 1: E-1



Summary for Subcatchment 2: E-2

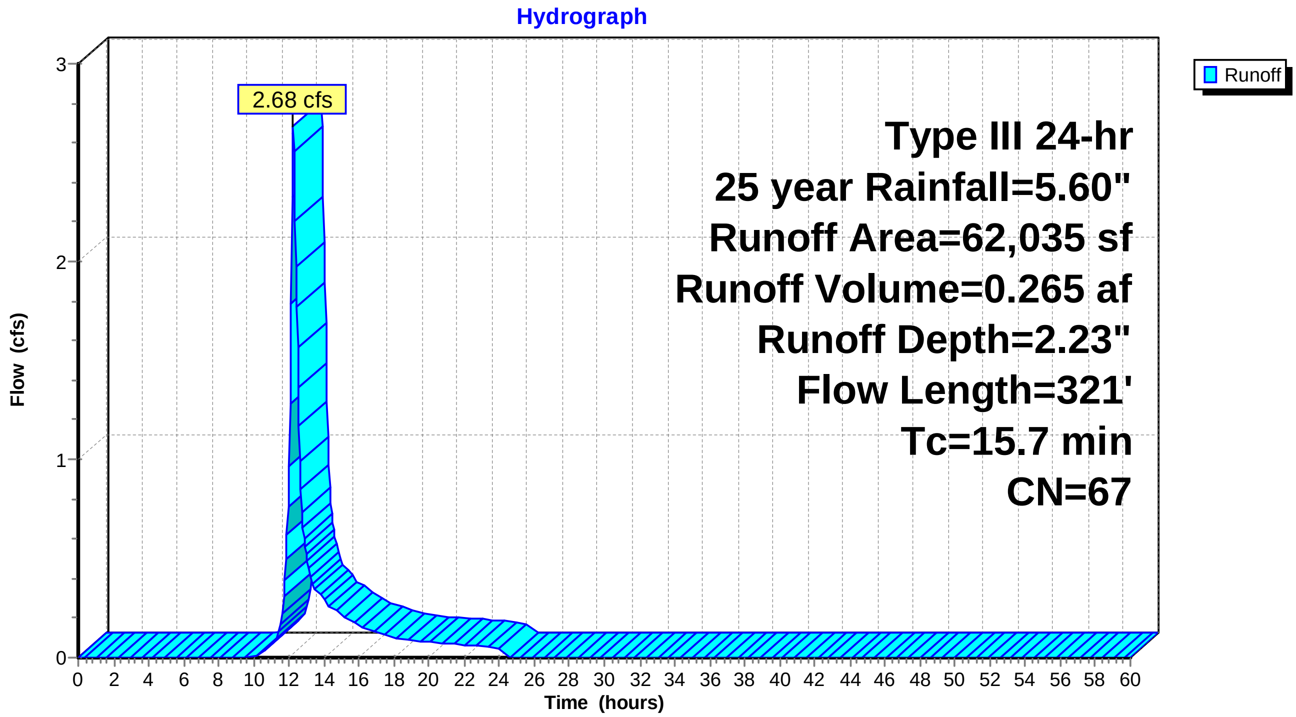
Runoff = 2.68 cfs @ 12.23 hrs, Volume= 0.265 af, Depth= 2.23"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 year Rainfall=5.60"

	Area (sf)	CN	Description
	32,848	70	Woods, Good, HSG C
	2,312	30	Woods, Good, HSG A
	11,047	74	>75% Grass cover, Good, HSG C
	10,277	39	>75% Grass cover, Good, HSG A
*	5,551	98	Impervious
	62,035	67	Weighted Average
	56,484		91.05% Pervious Area
	5,551		8.95% Impervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	50	0.1900	0.10		**Sheet Flow, AB** Woods: Dense underbrush n= 0.800 P2= 3.20"
0.3	40	0.1750	2.09		**Shallow Concentrated Flow, BC** Woodland Kv= 5.0 fps
1.6	123	0.0325	1.26		**Shallow Concentrated Flow, CD** Short Grass Pasture Kv= 7.0 fps
5.1	108	0.0050	0.35		**Shallow Concentrated Flow, DE** Woodland Kv= 5.0 fps
15.7	321	Total			

Subcatchment 2: E-2



Time span=0.00-60.00 hrs, dt=0.05 hrs, 1201 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1: E-1 Runoff Area=23,595 sf 70.74% Impervious Runoff Depth=4.69"
Tc=5.0 min CN=80 Runoff=2.97 cfs 0.212 af

Subcatchment 2: E-2 Runoff Area=62,035 sf 8.95% Impervious Runoff Depth=3.31"
Flow Length=321' Tc=15.7 min CN=67 Runoff=4.06 cfs 0.392 af

Total Runoff Area = 1.966 ac Runoff Volume = 0.604 af Average Runoff Depth = 3.69"
74.02% Pervious = 1.455 ac 25.98% Impervious = 0.511 ac

Summary for Subcatchment 1: E-1

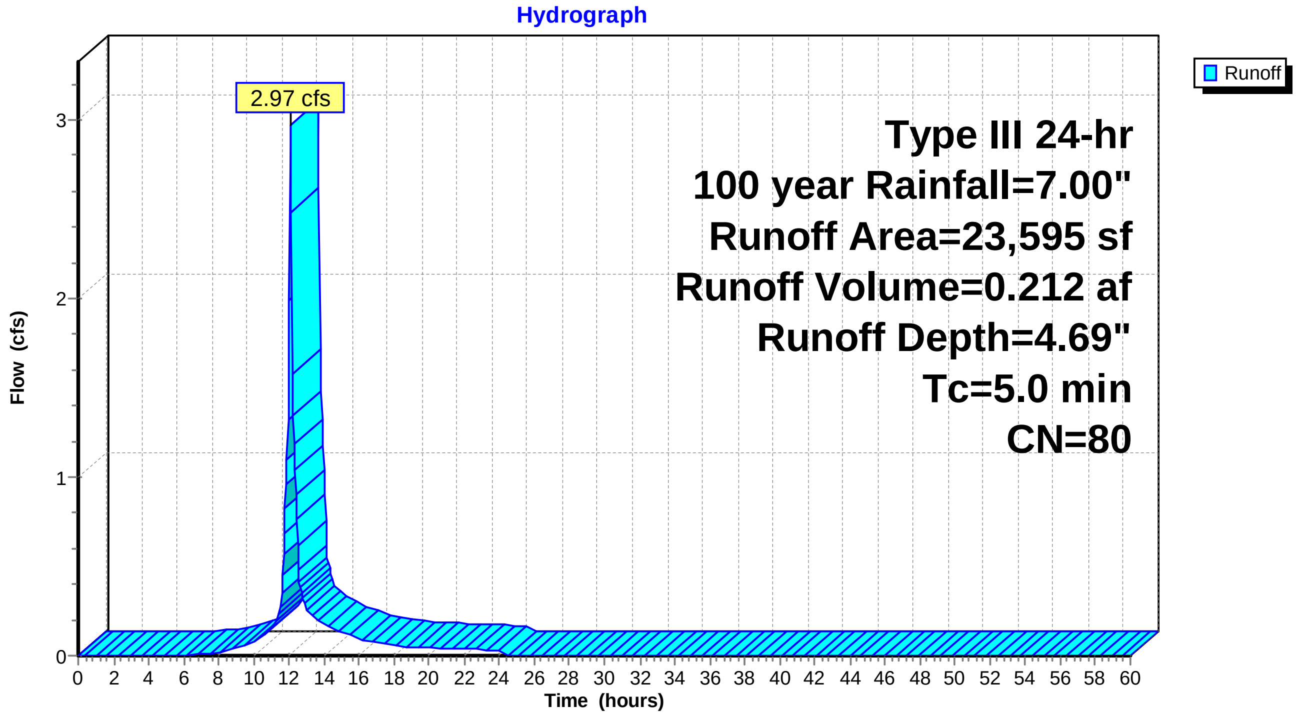
Runoff = 2.97 cfs @ 12.07 hrs, Volume= 0.212 af, Depth= 4.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=7.00"

	Area (sf)	CN	Description
*	16,692	98	Impervious
	1,257	30	Woods, Good, HSG A
*	5,646	39	>75% Grass Good/Landscape, HSG A
	23,595	80	Weighted Average
	6,903		29.26% Pervious Area
	16,692		70.74% Impervious Area

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

Subcatchment 1: E-1



Summary for Subcatchment 2: E-2

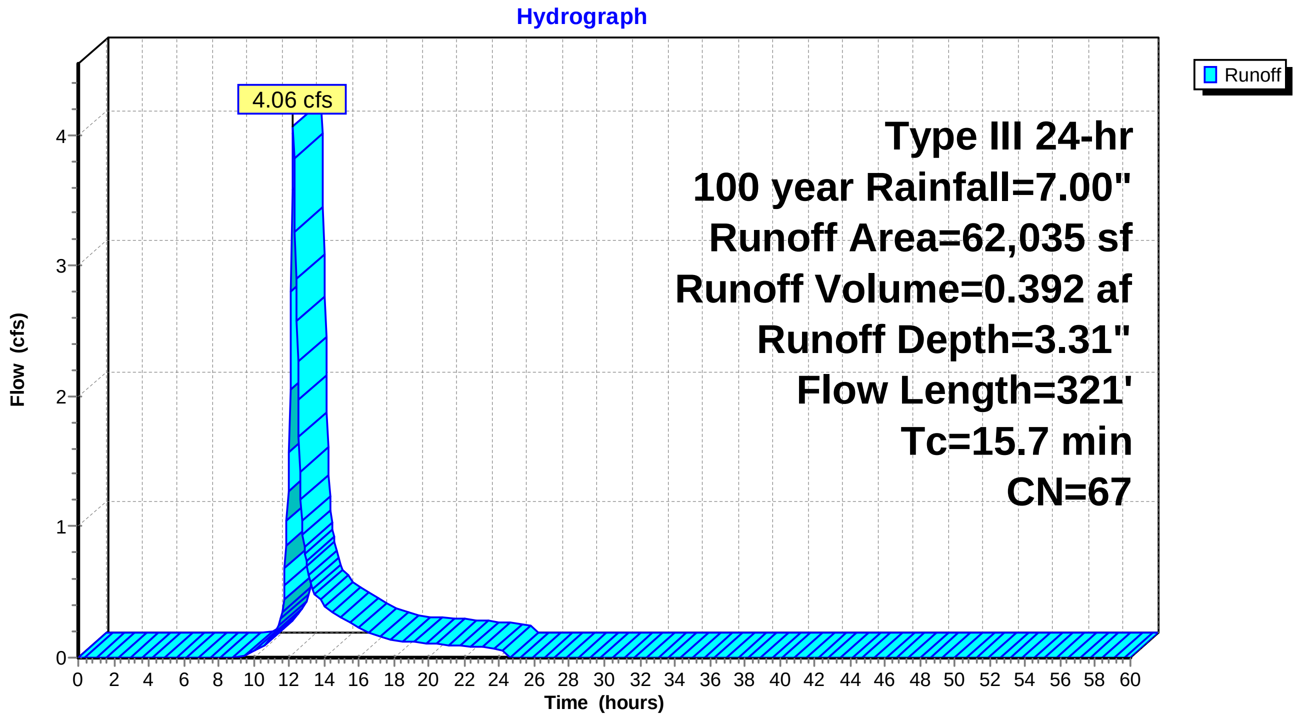
Runoff = 4.06 cfs @ 12.22 hrs, Volume= 0.392 af, Depth= 3.31"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-60.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=7.00"

	Area (sf)	CN	Description
	32,848	70	Woods, Good, HSG C
	2,312	30	Woods, Good, HSG A
	11,047	74	>75% Grass cover, Good, HSG C
	10,277	39	>75% Grass cover, Good, HSG A
*	5,551	98	Impervious
	62,035	67	Weighted Average
	56,484		91.05% Pervious Area
	5,551		8.95% Impervious Area

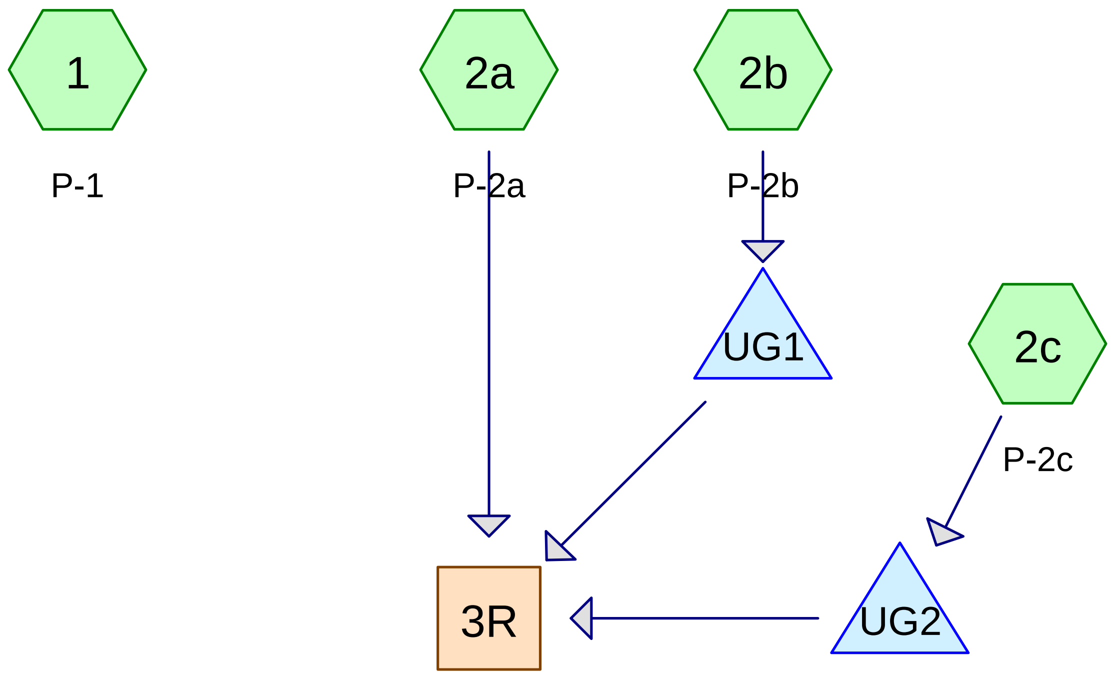
Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	50	0.1900	0.10		**Sheet Flow, AB** Woods: Dense underbrush n= 0.800 P2= 3.20"
0.3	40	0.1750	2.09		**Shallow Concentrated Flow, BC** Woodland Kv= 5.0 fps
1.6	123	0.0325	1.26		**Shallow Concentrated Flow, CD** Short Grass Pasture Kv= 7.0 fps
5.1	108	0.0050	0.35		**Shallow Concentrated Flow, DE** Woodland Kv= 5.0 fps
15.7	321	Total			

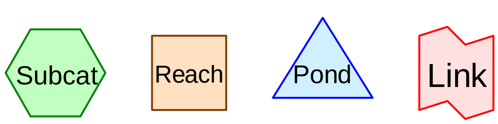
Subcatchment 2: E-2



Section 3.1.2

Post-Developed Stormwater Report Calculations





Routing Diagram for 27 Whiting Proposed Hydrology
Prepared by CHA Companies, Inc., Printed 9/10/2020
HydroCAD® 10.00-25 s/n 01012 © 2019 HydroCAD Software Solutions LLC

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1: P-1 Runoff Area=13,132 sf 81.11% Impervious Runoff Depth=2.09"
Tc=5.0 min CN=87 Runoff=0.74 cfs 0.053 af

Subcatchment 2a: P-2a Runoff Area=47,725 sf 0.00% Impervious Runoff Depth=0.89"
Flow Length=321' Tc=15.7 min CN=69 Runoff=0.76 cfs 0.082 af

Subcatchment 2b: P-2b Runoff Area=18,737 sf 85.52% Impervious Runoff Depth=2.26"
Tc=5.0 min CN=89 Runoff=1.14 cfs 0.081 af

Subcatchment 2c: P-2c Runoff Area=6,037 sf 69.95% Impervious Runoff Depth=1.56"
Tc=5.0 min CN=80 Runoff=0.25 cfs 0.018 af

Reach 3R: Inflow=0.79 cfs 0.178 af
Outflow=0.79 cfs 0.178 af

Pond UG1: Peak Elev=137.45' Storage=2,584 cf Inflow=1.14 cfs 0.081 af
Outflow=0.03 cfs 0.079 af

Pond UG2: Peak Elev=135.66' Storage=409 cf Inflow=0.25 cfs 0.018 af
Outflow=0.02 cfs 0.018 af

Total Runoff Area = 1.966 ac Runoff Volume = 0.233 af Average Runoff Depth = 1.42"
63.92% Pervious = 1.256 ac 36.08% Impervious = 0.709 ac

Summary for Subcatchment 1: P-1

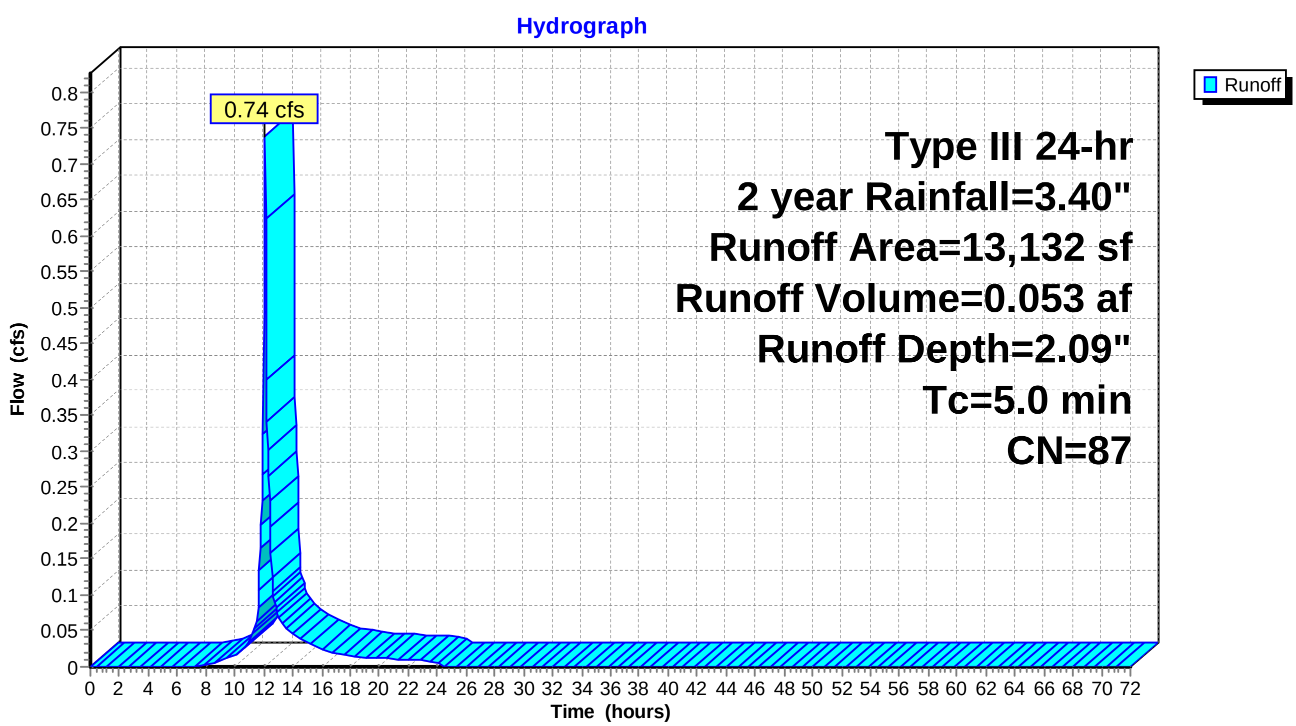
Runoff = 0.74 cfs @ 12.08 hrs, Volume= 0.053 af, Depth= 2.09"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.40"

	Area (sf)	CN	Description
*	10,651	98	Impervious
	2,481	39	>75% Grass cover, Good, HSG A
	13,132	87	Weighted Average
	2,481		18.89% Pervious Area
	10,651		81.11% Impervious Area

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

Subcatchment 1: P-1



Summary for Subcatchment 2a: P-2a

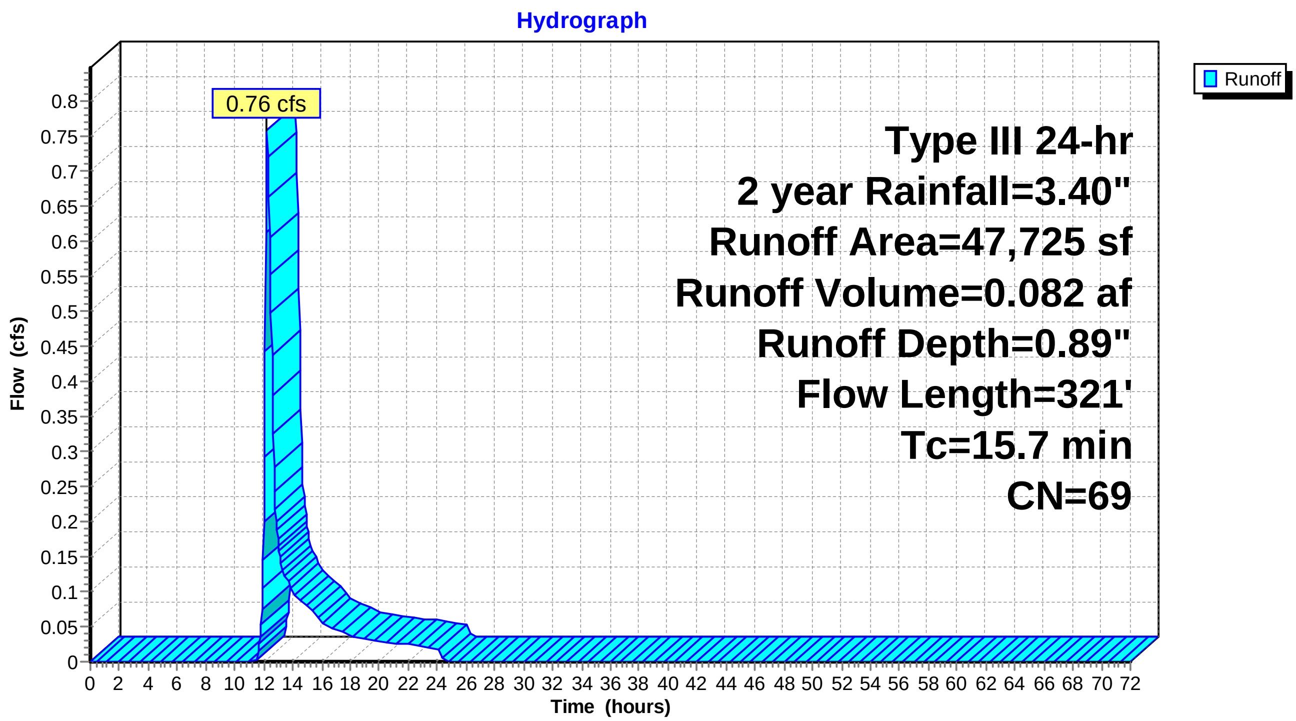
Runoff = 0.76 cfs @ 12.25 hrs, Volume= 0.082 af, Depth= 0.89"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.40"

Area (sf)	CN	Description
469	30	Woods, Good, HSG A
30,992	70	Woods, Good, HSG C
14,119	74	>75% Grass cover, Good, HSG C
2,145	39	>75% Grass cover, Good, HSG A
47,725	69	Weighted Average
47,725		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	50	0.1900	0.10		**Sheet Flow, AB** Woods: Dense underbrush n= 0.800 P2= 3.20"
0.3	40	0.1750	2.09		**Shallow Concentrated Flow, BC** Woodland Kv= 5.0 fps
1.6	123	0.0325	1.26		**Shallow Concentrated Flow, CD** Short Grass Pasture Kv= 7.0 fps
5.1	108	0.0050	0.35		**Shallow Concentrated Flow, DE** Woodland Kv= 5.0 fps
15.7	321	Total			

Subcatchment 2a: P-2a



Summary for Subcatchment 2b: P-2b

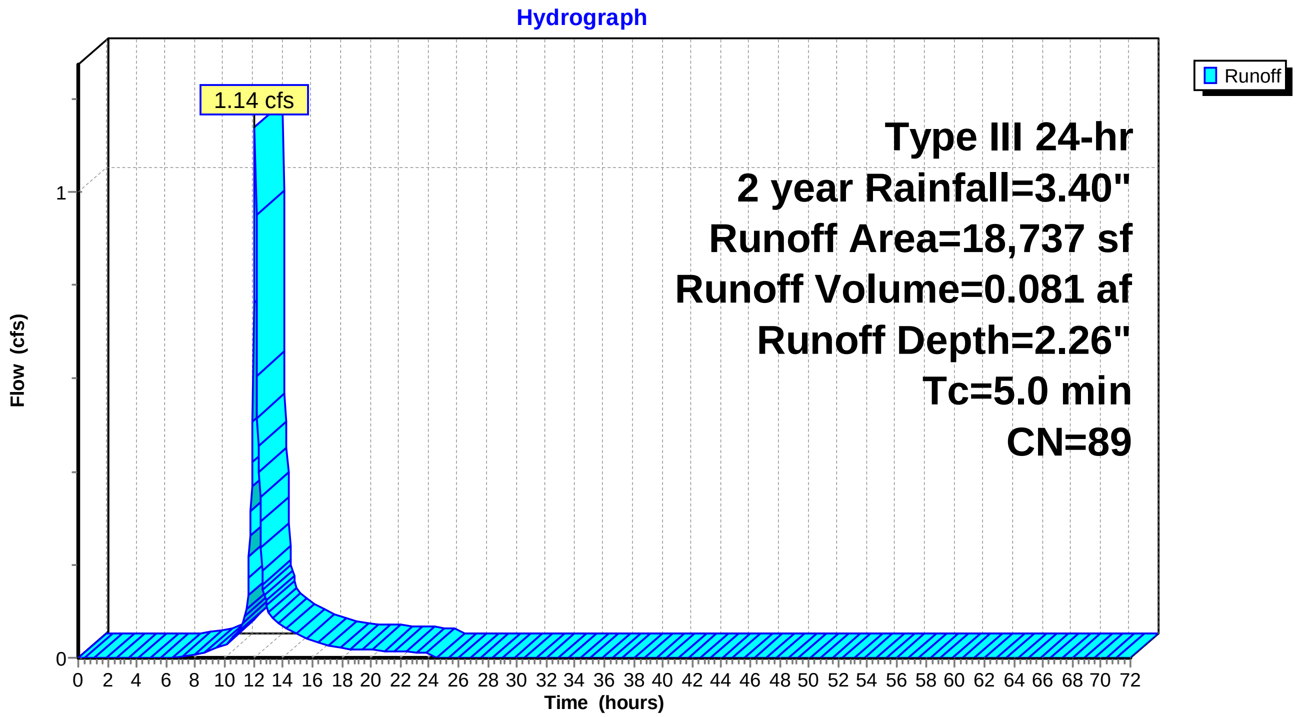
Runoff = 1.14 cfs @ 12.07 hrs, Volume= 0.081 af, Depth= 2.26"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.40"

	Area (sf)	CN	Description
	1,290	30	Woods, Good, HSG A
	1,423	39	>75% Grass cover, Good, HSG A
*	3,563	98	Roof
*	8,964	98	CB1
*	3,497	98	CB2
	18,737	89	Weighted Average
	2,713		14.48% Pervious Area
	16,024		85.52% Impervious Area

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

Subcatchment 2b: P-2b



Summary for Subcatchment 2c: P-2c

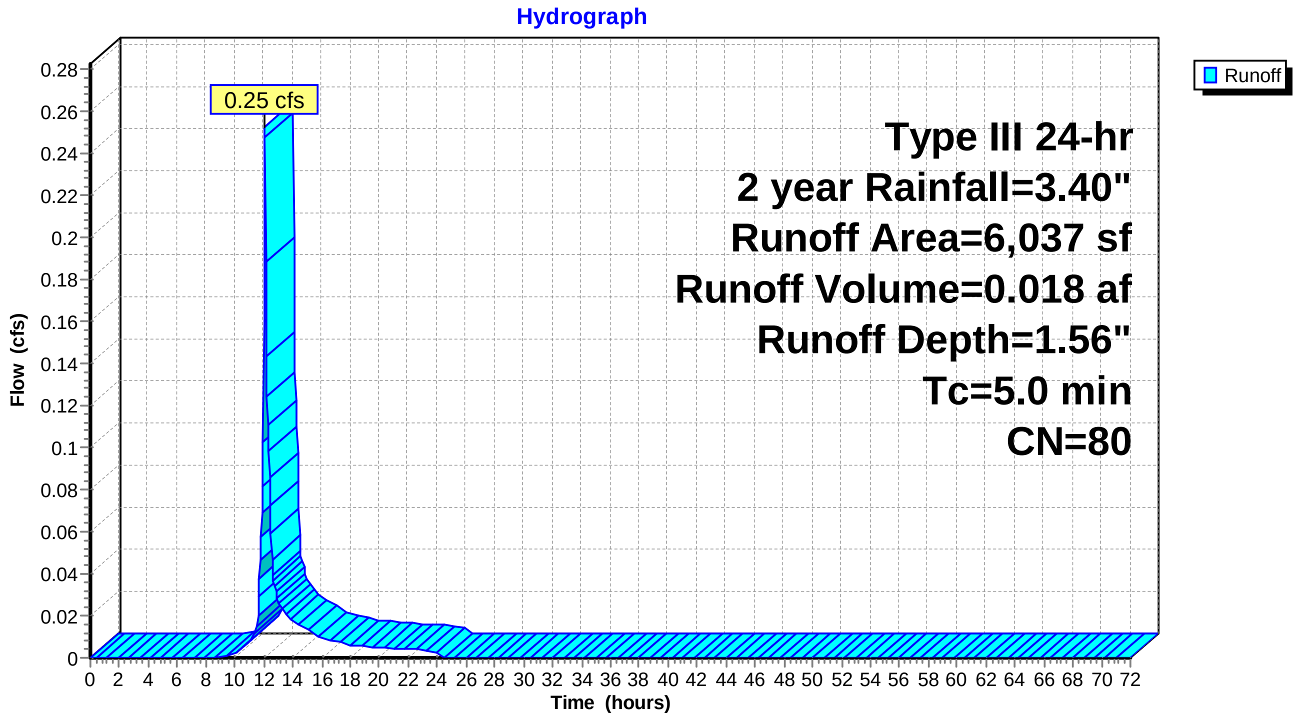
Runoff = 0.25 cfs @ 12.08 hrs, Volume= 0.018 af, Depth= 1.56"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 2 year Rainfall=3.40"

	Area (sf)	CN	Description
*	4,223	98	Impervious
	1,814	39	>75% Grass cover, Good, HSG A
	6,037	80	Weighted Average
	1,814		30.05% Pervious Area
	4,223		69.95% Impervious Area

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

Subcatchment 2c: P-2c

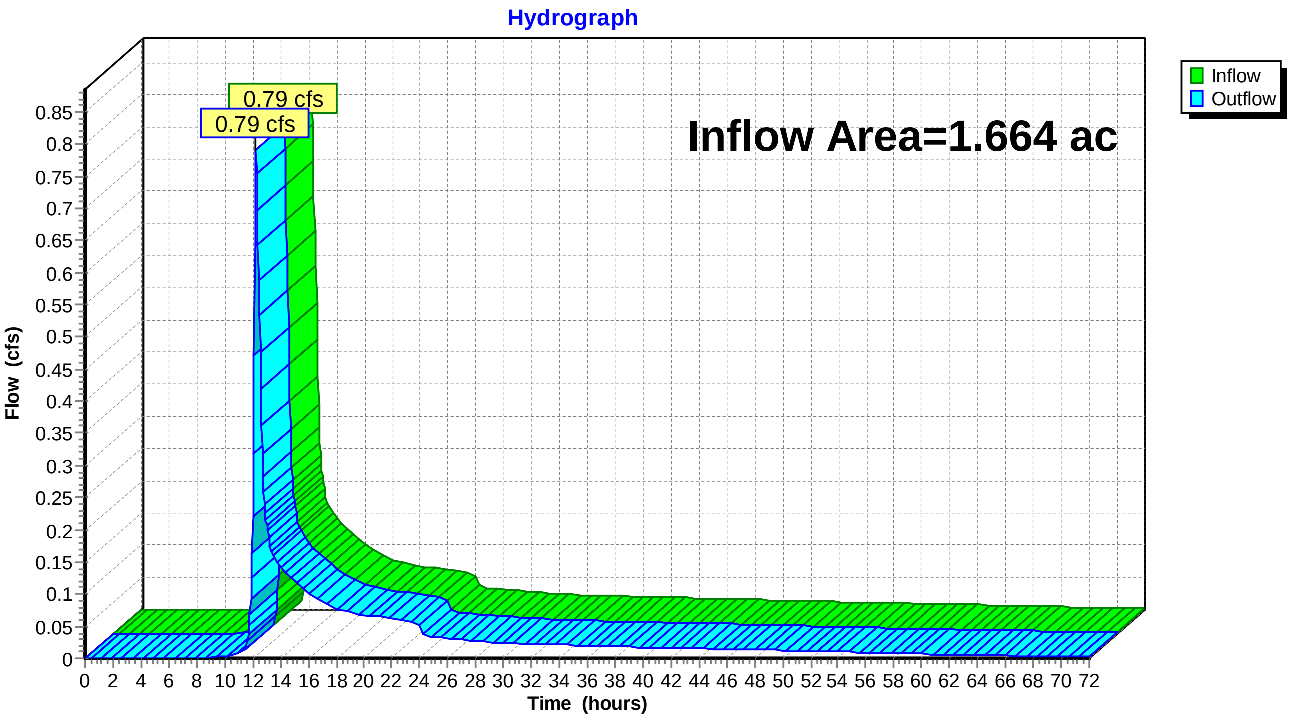


Summary for Reach 3R:

Inflow Area = 1.664 ac, 27.93% Impervious, Inflow Depth > 1.29" for 2 year event
Inflow = 0.79 cfs @ 12.25 hrs, Volume= 0.178 af
Outflow = 0.79 cfs @ 12.25 hrs, Volume= 0.178 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach 3R:



Summary for Pond UG1:

Inflow Area = 0.430 ac, 85.52% Impervious, Inflow Depth = 2.26" for 2 year event
Inflow = 1.14 cfs @ 12.07 hrs, Volume= 0.081 af
Outflow = 0.03 cfs @ 17.34 hrs, Volume= 0.079 af, Atten= 98%, Lag= 316.1 min
Primary = 0.03 cfs @ 17.34 hrs, Volume= 0.079 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 137.45' @ 17.34 hrs Surf.Area= 3,164 sf Storage= 2,584 cf

Plug-Flow detention time= 1,188.5 min calculated for 0.079 af (97% of inflow)
Center-of-Mass det. time= 1,171.9 min (1,979.6 - 807.8)

Volume	Invert	Avail.Storage	Storage Description
#1A	136.40'	1,972 cf	**34.75'W x 91.06'L x 3.00'H Field A** 9,493 cf Overall - 3,859 cf Embedded = 5,634 cf x 35.0% Voids
#2A	136.40'	3,859 cf	**ADS_StormTech SC-740 +Cap** x 84 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 84 Chambers in 7 Rows
		5,831 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	136.40'	**8.0" Round Culvert** L= 17.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 136.40' / 136.10' S= 0.0176 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf
#2	Device 1	136.40'	**1.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	138.50'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.03 cfs @ 17.34 hrs HW=137.45' (Free Discharge)
1=Culvert (Passes 0.03 cfs of 1.26 cfs potential flow)
2=Orifice/Grate (Orifice Controls 0.03 cfs @ 4.84 fps)
3=Sharp-Crested Rectangular Weir (Controls 0.00 cfs)

Pond UG1: - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-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

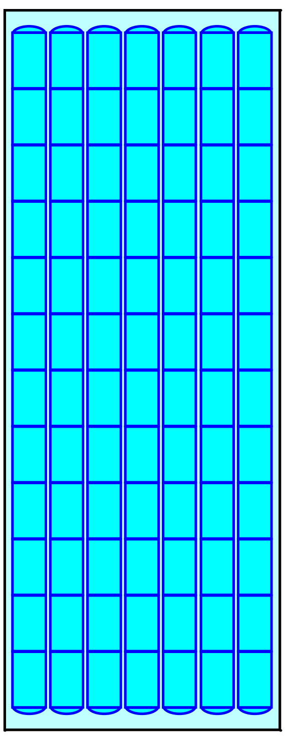
12 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 87.06' Row Length +24.0" End Stone x 2 = 91.06' Base Length
7 Rows x 51.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 34.75' Base Width
30.0" Chamber Height + 6.0" Cover = 3.00' Field Height

84 Chambers x 45.9 cf = 3,859.0 cf Chamber Storage

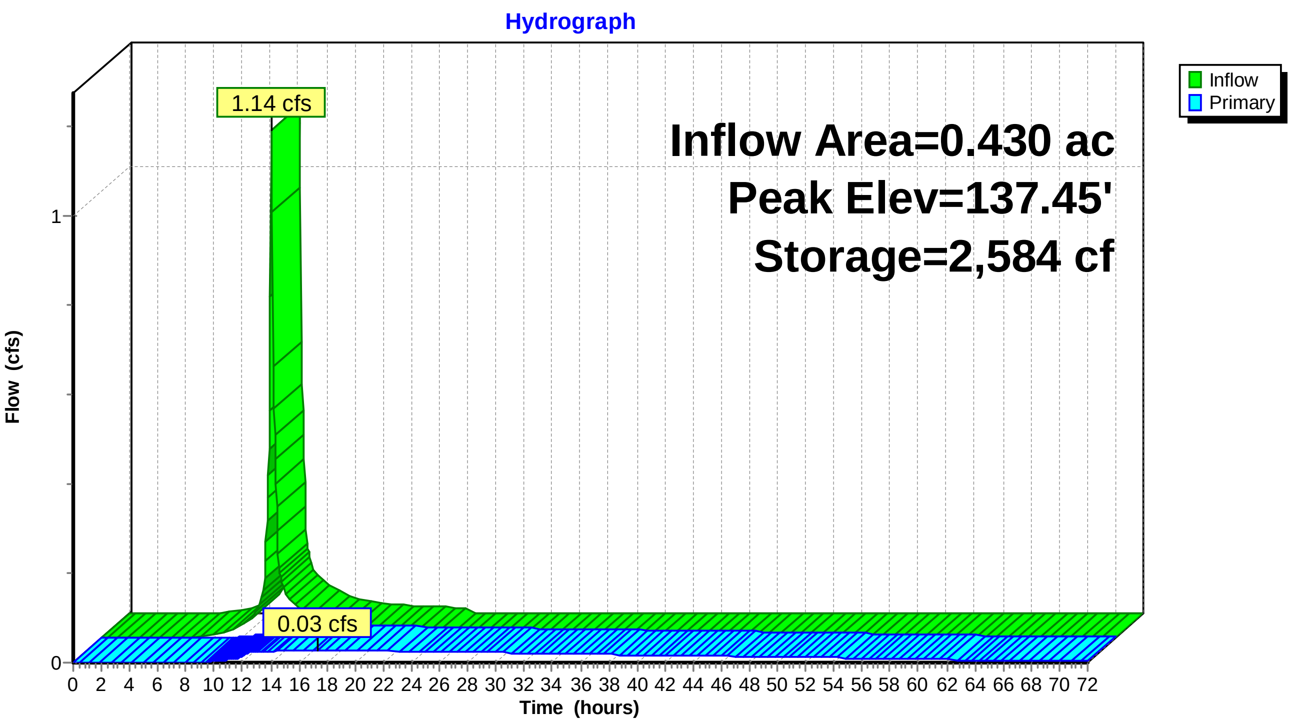
9,492.7 cf Field - 3,859.0 cf Chambers = 5,633.7 cf Stone x 35.0% Voids = 1,971.8 cf Stone Storage

Chamber Storage + Stone Storage = 5,830.8 cf = 0.134 af
Overall Storage Efficiency = 61.4%
Overall System Size = 91.06' x 34.75' x 3.00'

84 Chambers
351.6 cy Field
208.7 cy Stone



Pond UG1:


Hydrograph
1.14 cfs
0.03 cfs
Inflow Area=0.430 ac
Peak Elev=137.45'
Storage=2,584 cf
Inflow
Primary
Flow (cfs)
Time (hours)
0
1
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72

Summary for Pond UG2:

Inflow Area = 0.139 ac, 69.95% Impervious, Inflow Depth = 1.56" for 2 year event
Inflow = 0.25 cfs @ 12.08 hrs, Volume= 0.018 af
Outflow = 0.02 cfs @ 14.08 hrs, Volume= 0.018 af, Atten= 93%, Lag= 119.9 min
Primary = 0.02 cfs @ 14.08 hrs, Volume= 0.018 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 135.66' @ 14.08 hrs Surf.Area= 1,203 sf Storage= 409 cf

Plug-Flow detention time= 341.8 min calculated for 0.018 af (100% of inflow)
Center-of-Mass det. time= 341.6 min (1,180.4 - 838.8)

Volume	Invert	Avail.Storage	Storage Description
#1B	135.20'	1,234 cf	**22.50'W x 53.46'L x 4.00'H Field B** 4,811 cf Overall - 1,286 cf Embedded = 3,525 cf x 35.0% Voids
#2B	135.20'	1,286 cf	**ADS_StormTech SC-740 +Cap** x 28 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 28 Chambers in 4 Rows
		2,520 cf	Total Available Storage

Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	134.80'	**12.0" Round Culvert** L= 24.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 134.80' / 134.00' S= 0.0333 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf
#2	Device 1	135.20'	**1.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	137.50'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.02 cfs @ 14.08 hrs HW=135.66' (Free Discharge)
1=Culvert (Passes 0.02 cfs of 1.99 cfs potential flow)
2=Orifice/Grate (Orifice Controls 0.02 cfs @ 3.10 fps)
3=Sharp-Crested Rectangular Weir (Controls 0.00 cfs)

Pond UG2: - Chamber Wizard Field B

Chamber Model = ADS_StormTech SC-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

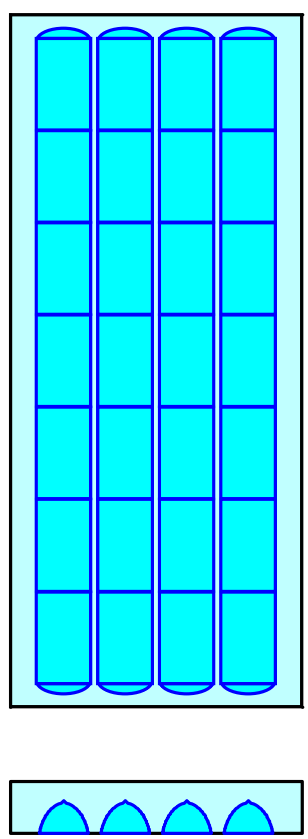
7 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 51.46' Row Length +12.0" End Stone x 2 = 53.46' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 24.0" Side Stone x 2 = 22.50' Base Width
30.0" Chamber Height + 18.0" Cover = 4.00' Field Height

28 Chambers x 45.9 cf = 1,286.3 cf Chamber Storage

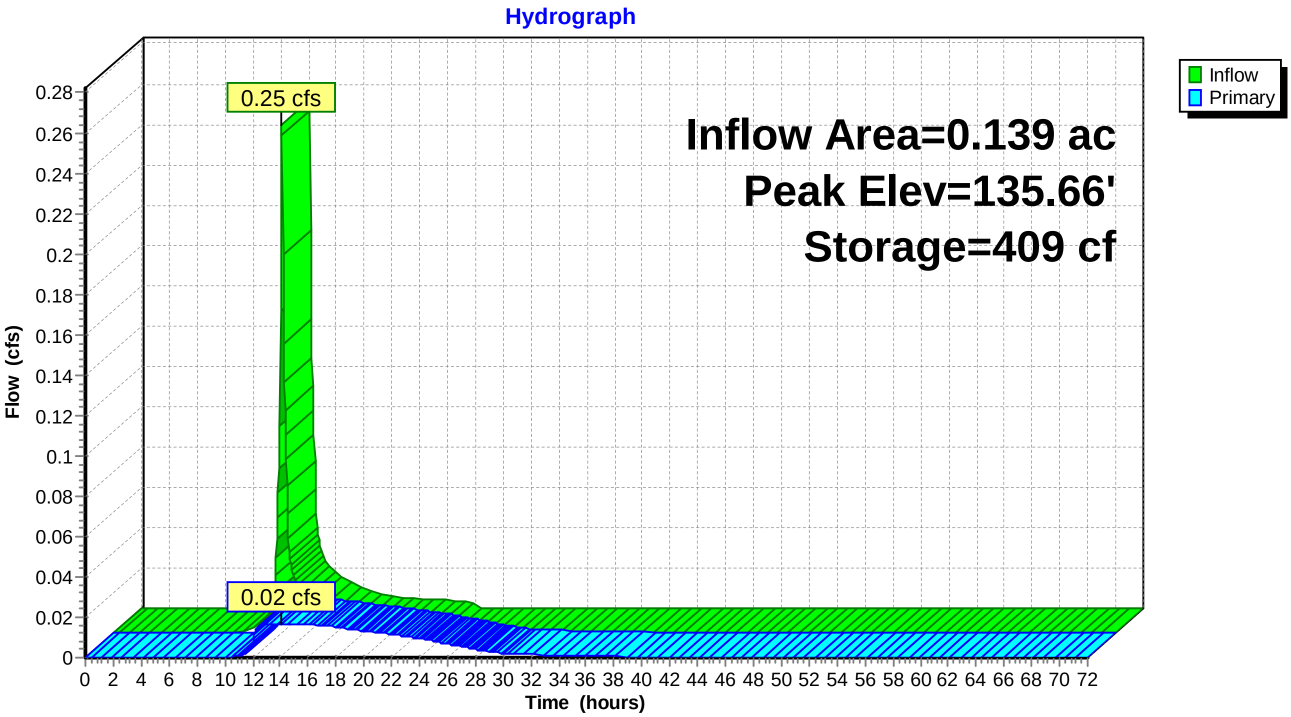
4,811.1 cf Field - 1,286.3 cf Chambers = 3,524.8 cf Stone x 35.0% Voids = 1,233.7 cf Stone Storage

Chamber Storage + Stone Storage = 2,520.0 cf = 0.058 af
Overall Storage Efficiency = 52.4%
Overall System Size = 53.46' x 22.50' x 4.00'

28 Chambers
178.2 cy Field
130.5 cy Stone



Pond UG2:


Hydrograph
Inflow
Primary
0.25 cfs
0.02 cfs
Inflow Area=0.139 ac
Peak Elev=135.66'
Storage=409 cf
Flow (cfs)
0.28
0.26
0.24
0.22
0.2
0.18
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72
Time (hours)

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1: P-1 Runoff Area=13,132 sf 81.11% Impervious Runoff Depth=3.29"
Tc=5.0 min CN=87 Runoff=1.15 cfs 0.083 af

Subcatchment 2a: P-2a Runoff Area=47,725 sf 0.00% Impervious Runoff Depth=1.74"
Flow Length=321' Tc=15.7 min CN=69 Runoff=1.59 cfs 0.159 af

Subcatchment 2b: P-2b Runoff Area=18,737 sf 85.52% Impervious Runoff Depth=3.49"
Tc=5.0 min CN=89 Runoff=1.72 cfs 0.125 af

Subcatchment 2c: P-2c Runoff Area=6,037 sf 69.95% Impervious Runoff Depth=2.63"
Tc=5.0 min CN=80 Runoff=0.43 cfs 0.030 af

Reach 3R: Inflow=1.64 cfs 0.306 af
Outflow=1.64 cfs 0.306 af

Pond UG1: Peak Elev=138.16' Storage=4,115 cf Inflow=1.72 cfs 0.125 af
Outflow=0.03 cfs 0.117 af

Pond UG2: Peak Elev=136.05' Storage=751 cf Inflow=0.43 cfs 0.030 af
Outflow=0.02 cfs 0.030 af

Total Runoff Area = 1.966 ac Runoff Volume = 0.397 af Average Runoff Depth = 2.42"
63.92% Pervious = 1.256 ac 36.08% Impervious = 0.709 ac

Summary for Subcatchment 1: P-1

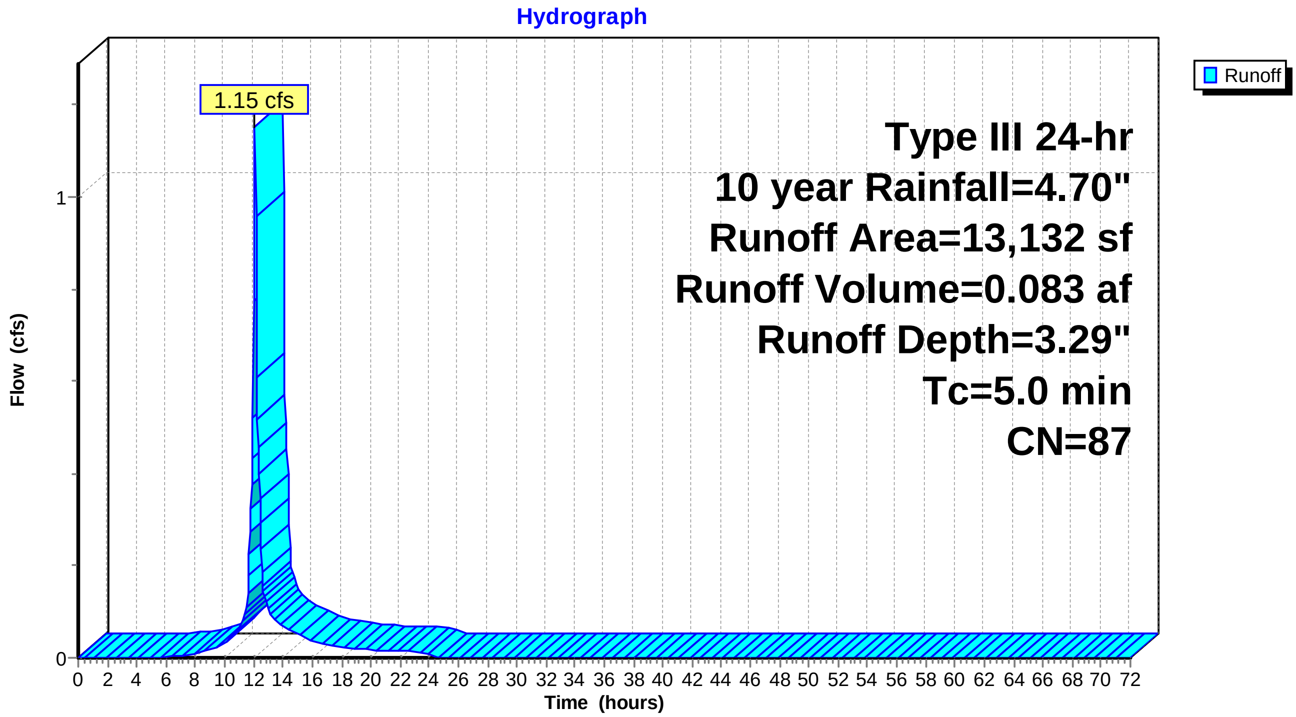
Runoff = 1.15 cfs @ 12.07 hrs, Volume= 0.083 af, Depth= 3.29"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.70"

	Area (sf)	CN	Description
*	10,651	98	Impervious
	2,481	39	>75% Grass cover, Good, HSG A
	13,132	87	Weighted Average
	2,481		18.89% Pervious Area
	10,651		81.11% Impervious Area

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

Subcatchment 1: P-1



Summary for Subcatchment 2a: P-2a

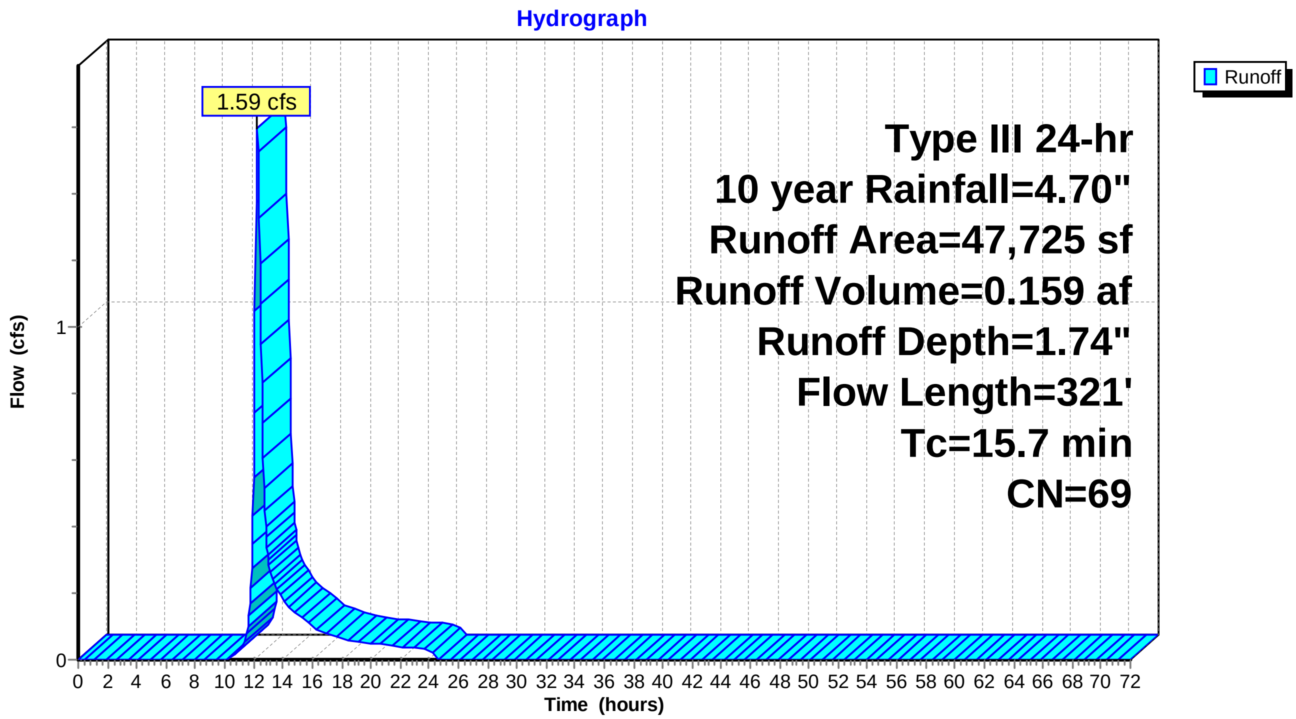
Runoff = 1.59 cfs @ 12.23 hrs, Volume= 0.159 af, Depth= 1.74"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.70"

Area (sf)	CN	Description
469	30	Woods, Good, HSG A
30,992	70	Woods, Good, HSG C
14,119	74	>75% Grass cover, Good, HSG C
2,145	39	>75% Grass cover, Good, HSG A
47,725	69	Weighted Average
47,725		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	50	0.1900	0.10		**Sheet Flow, AB** Woods: Dense underbrush n= 0.800 P2= 3.20"
0.3	40	0.1750	2.09		**Shallow Concentrated Flow, BC** Woodland Kv= 5.0 fps
1.6	123	0.0325	1.26		**Shallow Concentrated Flow, CD** Short Grass Pasture Kv= 7.0 fps
5.1	108	0.0050	0.35		**Shallow Concentrated Flow, DE** Woodland Kv= 5.0 fps
15.7	321	Total			

Subcatchment 2a: P-2a



Summary for Subcatchment 2b: P-2b

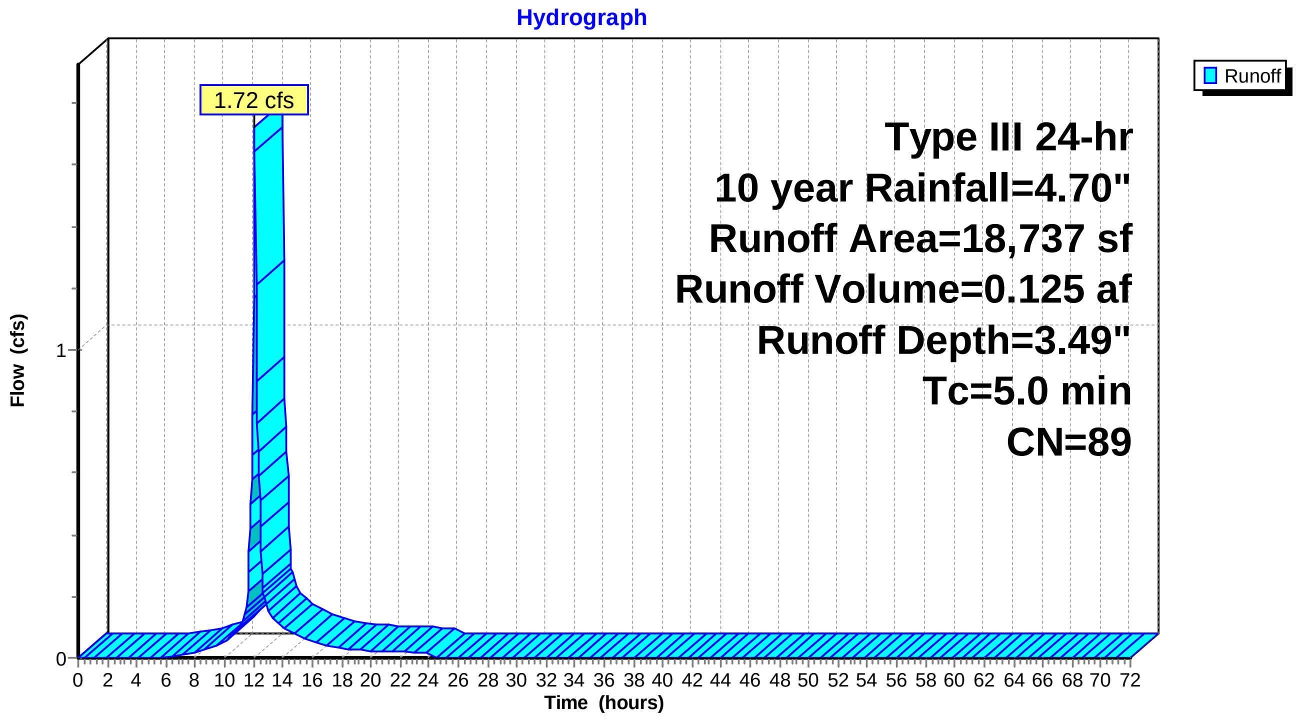
Runoff = 1.72 cfs @ 12.07 hrs, Volume= 0.125 af, Depth= 3.49"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.70"

	Area (sf)	CN	Description
	1,290	30	Woods, Good, HSG A
	1,423	39	>75% Grass cover, Good, HSG A
*	3,563	98	Roof
*	8,964	98	CB1
*	3,497	98	CB2
	18,737	89	Weighted Average
	2,713		14.48% Pervious Area
	16,024		85.52% Impervious Area

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

Subcatchment 2b: P-2b



Summary for Subcatchment 2c: P-2c

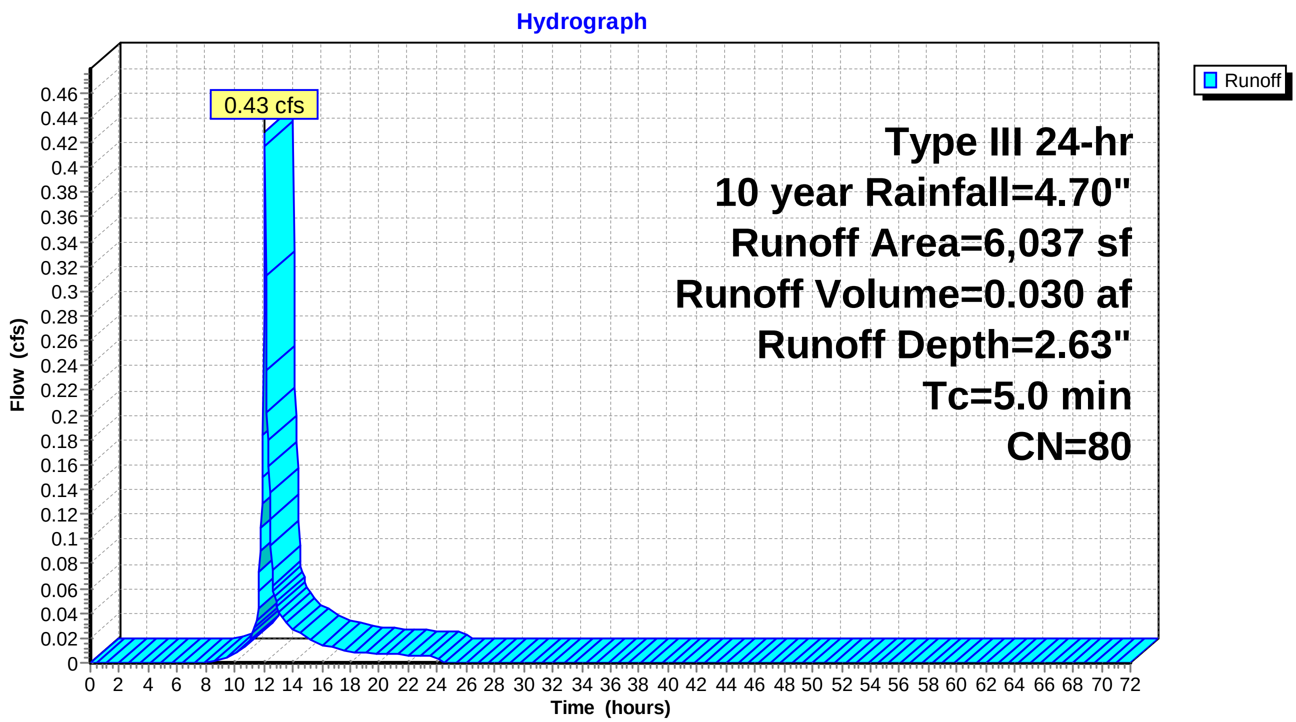
Runoff = 0.43 cfs @ 12.08 hrs, Volume= 0.030 af, Depth= 2.63"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 10 year Rainfall=4.70"

	Area (sf)	CN	Description
*	4,223	98	Impervious
	1,814	39	>75% Grass cover, Good, HSG A
	6,037	80	Weighted Average
	1,814		30.05% Pervious Area
	4,223		69.95% Impervious Area

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

Subcatchment 2c: P-2c

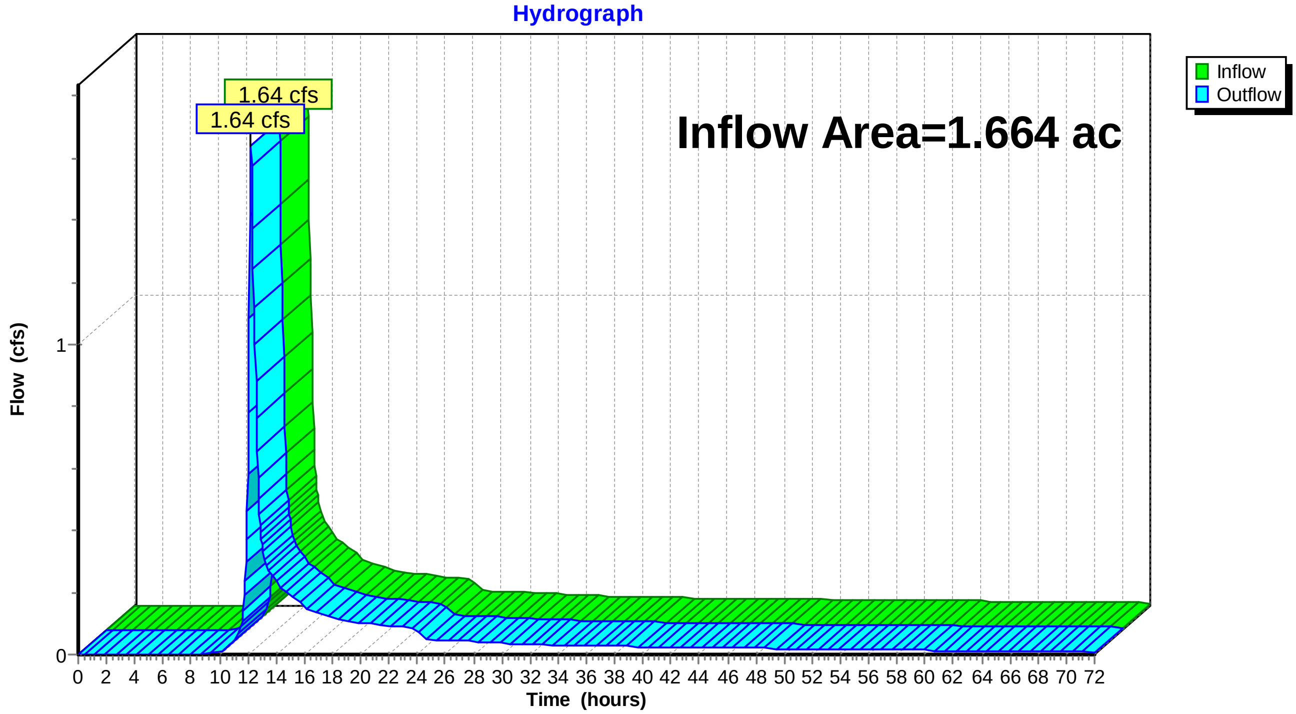


Summary for Reach 3R:

Inflow Area = 1.664 ac, 27.93% Impervious, Inflow Depth > 2.21" for 10 year event
Inflow = 1.64 cfs @ 12.23 hrs, Volume= 0.306 af
Outflow = 1.64 cfs @ 12.23 hrs, Volume= 0.306 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach 3R:



Summary for Pond UG1:

Inflow Area = 0.430 ac, 85.52% Impervious, Inflow Depth = 3.49" for 10 year event
Inflow = 1.72 cfs @ 12.07 hrs, Volume= 0.125 af
Outflow = 0.03 cfs @ 17.71 hrs, Volume= 0.117 af, Atten= 98%, Lag= 338.1 min
Primary = 0.03 cfs @ 17.71 hrs, Volume= 0.117 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 138.16' @ 17.71 hrs Surf.Area= 3,164 sf Storage= 4,115 cf

Plug-Flow detention time= 1,360.5 min calculated for 0.117 af (93% of inflow)
Center-of-Mass det. time= 1,324.9 min (2,120.5 - 795.7)

Volume	Invert	Avail.Storage	Storage Description
#1A	136.40'	1,972 cf	**34.75'W x 91.06'L x 3.00'H Field A** 9,493 cf Overall - 3,859 cf Embedded = 5,634 cf x 35.0% Voids
#2A	136.40'	3,859 cf	**ADS_StormTech SC-740 +Cap** x 84 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 84 Chambers in 7 Rows
		5,831 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	136.40'	**8.0" Round Culvert** L= 17.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 136.40' / 136.10' S= 0.0176 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf
#2	Device 1	136.40'	**1.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	138.50'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.03 cfs @ 17.71 hrs HW=138.16' (Free Discharge)
└─**1=Culvert** (Passes 0.03 cfs of 1.77 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.03 cfs @ 6.31 fps)
  └─**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond UG1: - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-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

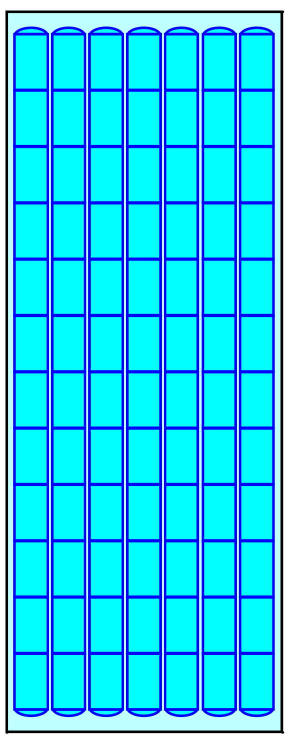
12 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 87.06' Row Length +24.0" End Stone x 2 = 91.06' Base Length
7 Rows x 51.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 34.75' Base Width
30.0" Chamber Height + 6.0" Cover = 3.00' Field Height

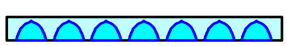
84 Chambers x 45.9 cf = 3,859.0 cf Chamber Storage

9,492.7 cf Field - 3,859.0 cf Chambers = 5,633.7 cf Stone x 35.0% Voids = 1,971.8 cf Stone Storage

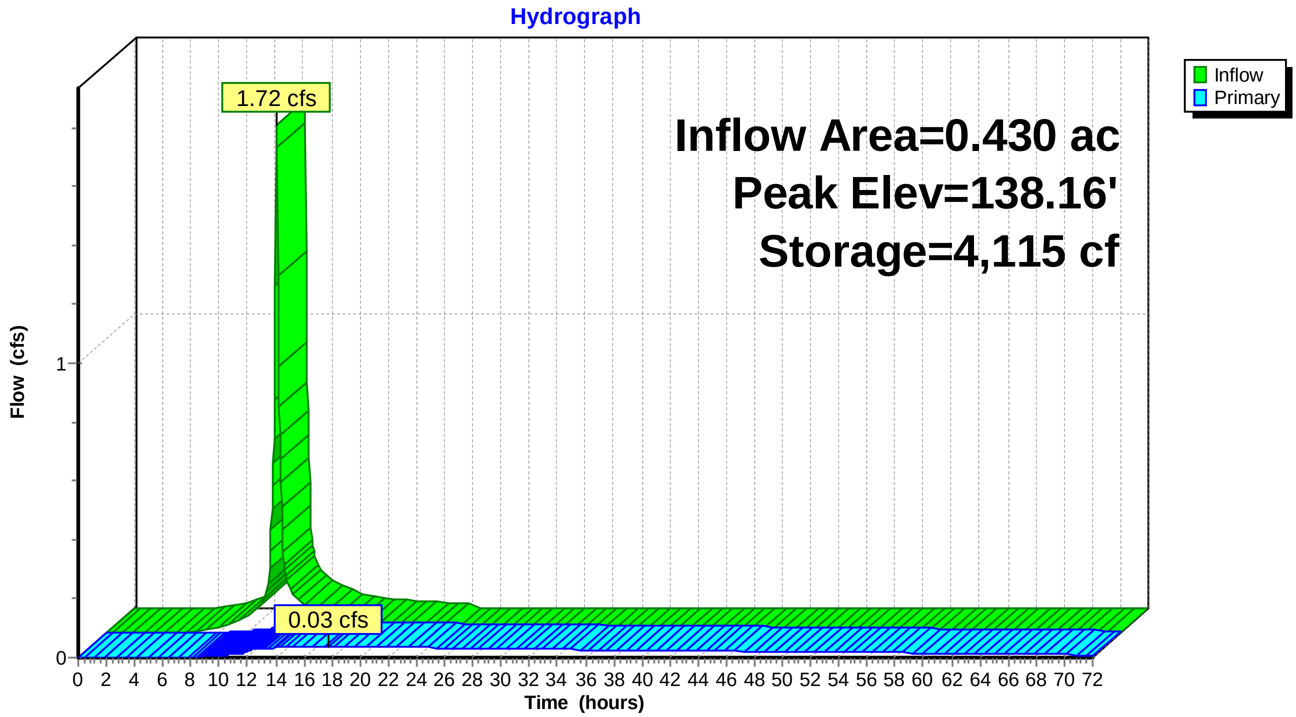
Chamber Storage + Stone Storage = 5,830.8 cf = 0.134 af
Overall Storage Efficiency = 61.4%
Overall System Size = 91.06' x 34.75' x 3.00'

84 Chambers
351.6 cy Field
208.7 cy Stone





Pond UG1:


Hydrograph
1.72 cfs
0.03 cfs
Inflow Area=0.430 ac
Peak Elev=138.16'
Storage=4,115 cf
Inflow
Primary
Flow (cfs)
0
1
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72
Time (hours)

Summary for Pond UG2:

Inflow Area = 0.139 ac, 69.95% Impervious, Inflow Depth = 2.63" for 10 year event
Inflow = 0.43 cfs @ 12.08 hrs, Volume= 0.030 af
Outflow = 0.02 cfs @ 14.52 hrs, Volume= 0.030 af, Atten= 94%, Lag= 146.8 min
Primary = 0.02 cfs @ 14.52 hrs, Volume= 0.030 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 136.05' @ 14.52 hrs Surf.Area= 1,203 sf Storage= 751 cf

Plug-Flow detention time= 426.6 min calculated for 0.030 af (100% of inflow)
Center-of-Mass det. time= 427.8 min (1,251.4 - 823.6)

Volume	Invert	Avail.Storage	Storage Description
#1B	135.20'	1,234 cf	**22.50'W x 53.46'L x 4.00'H Field B** 4,811 cf Overall - 1,286 cf Embedded = 3,525 cf x 35.0% Voids
#2B	135.20'	1,286 cf	**ADS_StormTech SC-740 +Cap** x 28 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 28 Chambers in 4 Rows
		2,520 cf	Total Available Storage

Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	134.80'	**12.0" Round Culvert** L= 24.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 134.80' / 134.00' S= 0.0333 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf
#2	Device 1	135.20'	**1.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	137.50'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.02 cfs @ 14.52 hrs HW=136.05' (Free Discharge)
└─**1=Culvert** (Passes 0.02 cfs of 2.90 cfs potential flow)
  ├─**2=Orifice/Grate** (Orifice Controls 0.02 cfs @ 4.34 fps)
  └─**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond UG2: - Chamber Wizard Field B

Chamber Model = ADS_StormTech SC-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

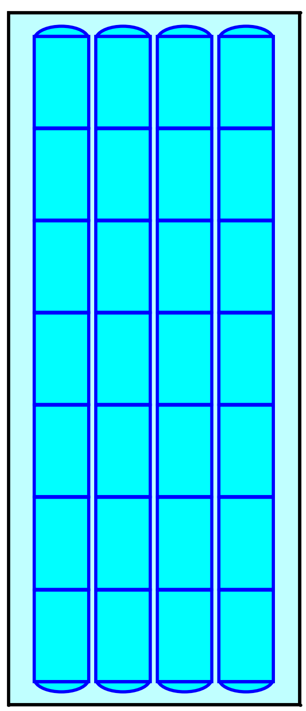
7 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 51.46' Row Length +12.0" End Stone x 2 = 53.46' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 24.0" Side Stone x 2 = 22.50' Base Width
30.0" Chamber Height + 18.0" Cover = 4.00' Field Height

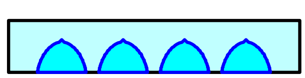
28 Chambers x 45.9 cf = 1,286.3 cf Chamber Storage

4,811.1 cf Field - 1,286.3 cf Chambers = 3,524.8 cf Stone x 35.0% Voids = 1,233.7 cf Stone Storage

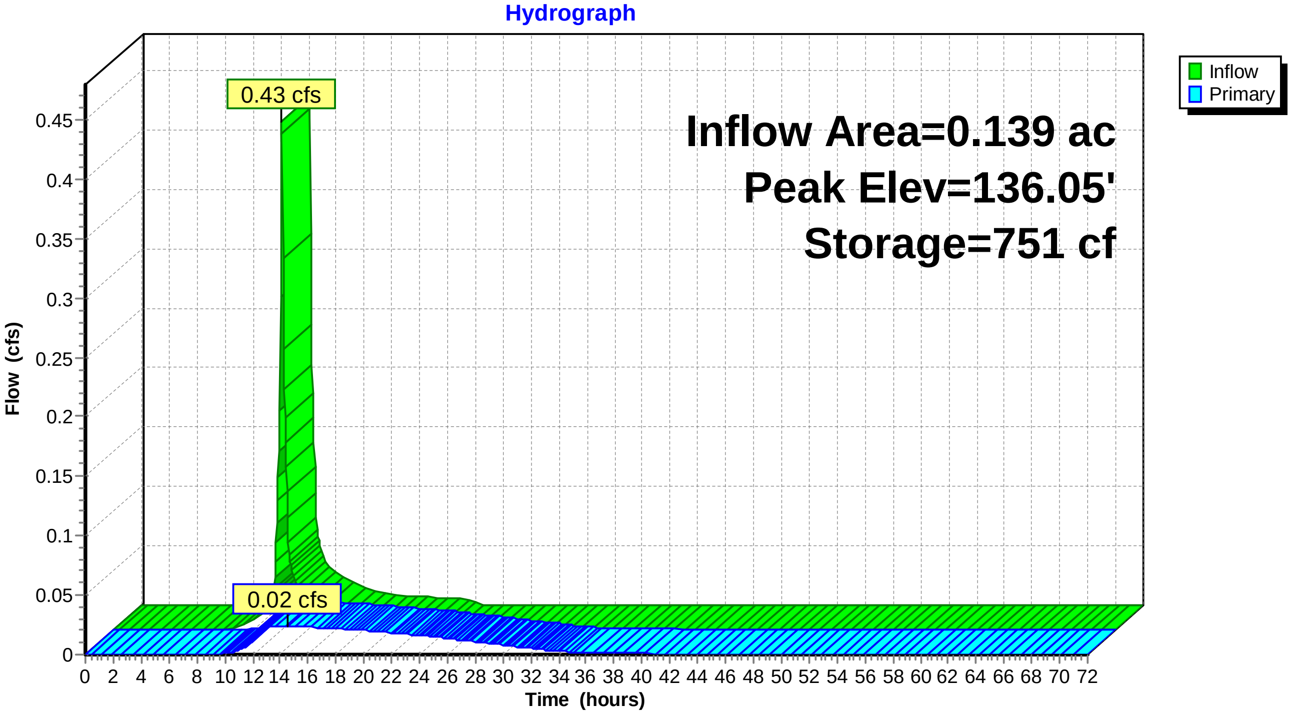
Chamber Storage + Stone Storage = 2,520.0 cf = 0.058 af
Overall Storage Efficiency = 52.4%
Overall System Size = 53.46' x 22.50' x 4.00'

28 Chambers
178.2 cy Field
130.5 cy Stone





Pond UG2:


Hydrograph
0.43 cfs
0.02 cfs
Inflow Area=0.139 ac
Peak Elev=136.05'
Storage=751 cf
Inflow
Primary
Flow (cfs)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72
Time (hours)

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1: P-1 Runoff Area=13,132 sf 81.11% Impervious Runoff Depth=4.14"
Tc=5.0 min CN=87 Runoff=1.43 cfs 0.104 af

Subcatchment 2a: P-2a Runoff Area=47,725 sf 0.00% Impervious Runoff Depth=2.40"
Flow Length=321' Tc=15.7 min CN=69 Runoff=2.25 cfs 0.219 af

Subcatchment 2b: P-2b Runoff Area=18,737 sf 85.52% Impervious Runoff Depth=4.35"
Tc=5.0 min CN=89 Runoff=2.13 cfs 0.156 af

Subcatchment 2c: P-2c Runoff Area=6,037 sf 69.95% Impervious Runoff Depth=3.42"
Tc=5.0 min CN=80 Runoff=0.55 cfs 0.040 af

Reach 3R: Inflow=2.30 cfs 0.402 af
Outflow=2.30 cfs 0.402 af

Pond UG1: Peak Elev=138.53' Storage=4,786 cf Inflow=2.13 cfs 0.156 af
Outflow=0.10 cfs 0.143 af

Pond UG2: Peak Elev=136.37' Storage=1,012 cf Inflow=0.55 cfs 0.040 af
Outflow=0.03 cfs 0.040 af

Total Runoff Area = 1.966 ac Runoff Volume = 0.519 af Average Runoff Depth = 3.17"
63.92% Pervious = 1.256 ac 36.08% Impervious = 0.709 ac

Summary for Subcatchment 1: P-1

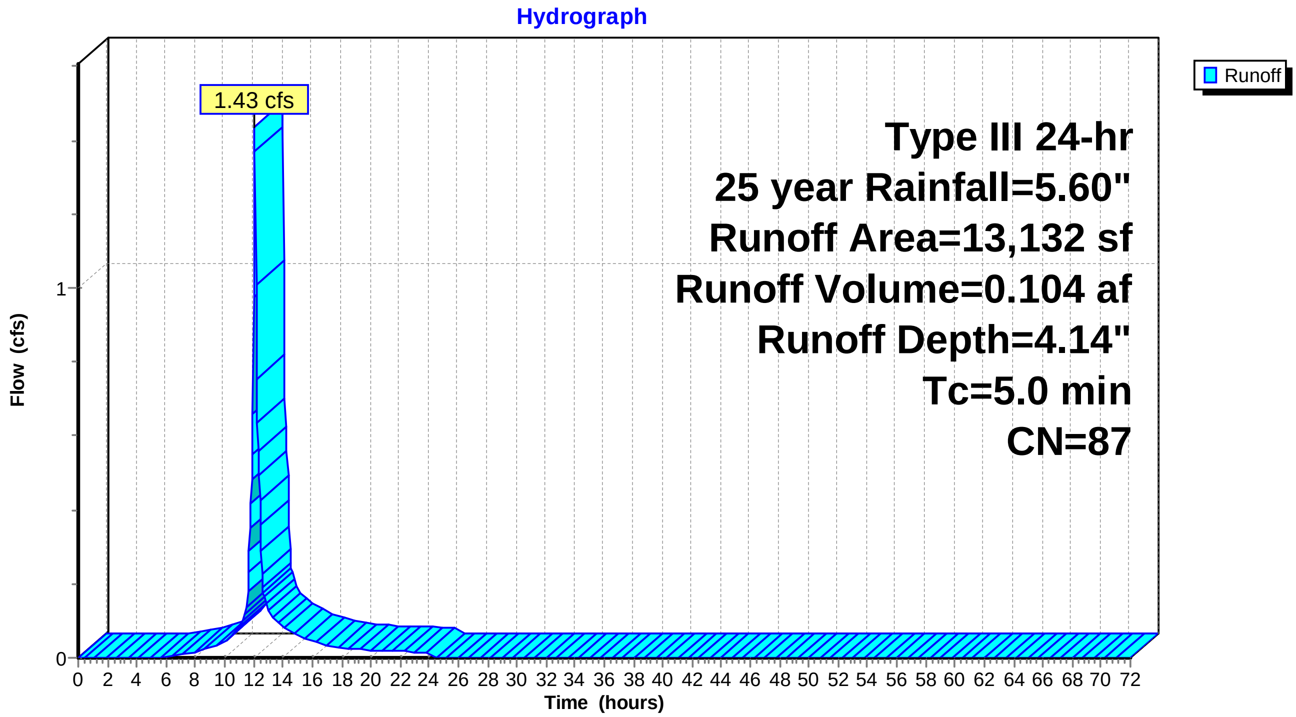
Runoff = 1.43 cfs @ 12.07 hrs, Volume= 0.104 af, Depth= 4.14"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 year Rainfall=5.60"

	Area (sf)	CN	Description
*	10,651	98	Impervious
	2,481	39	>75% Grass cover, Good, HSG A
	13,132	87	Weighted Average
	2,481		18.89% Pervious Area
	10,651		81.11% Impervious Area

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

Subcatchment 1: P-1



Summary for Subcatchment 2a: P-2a

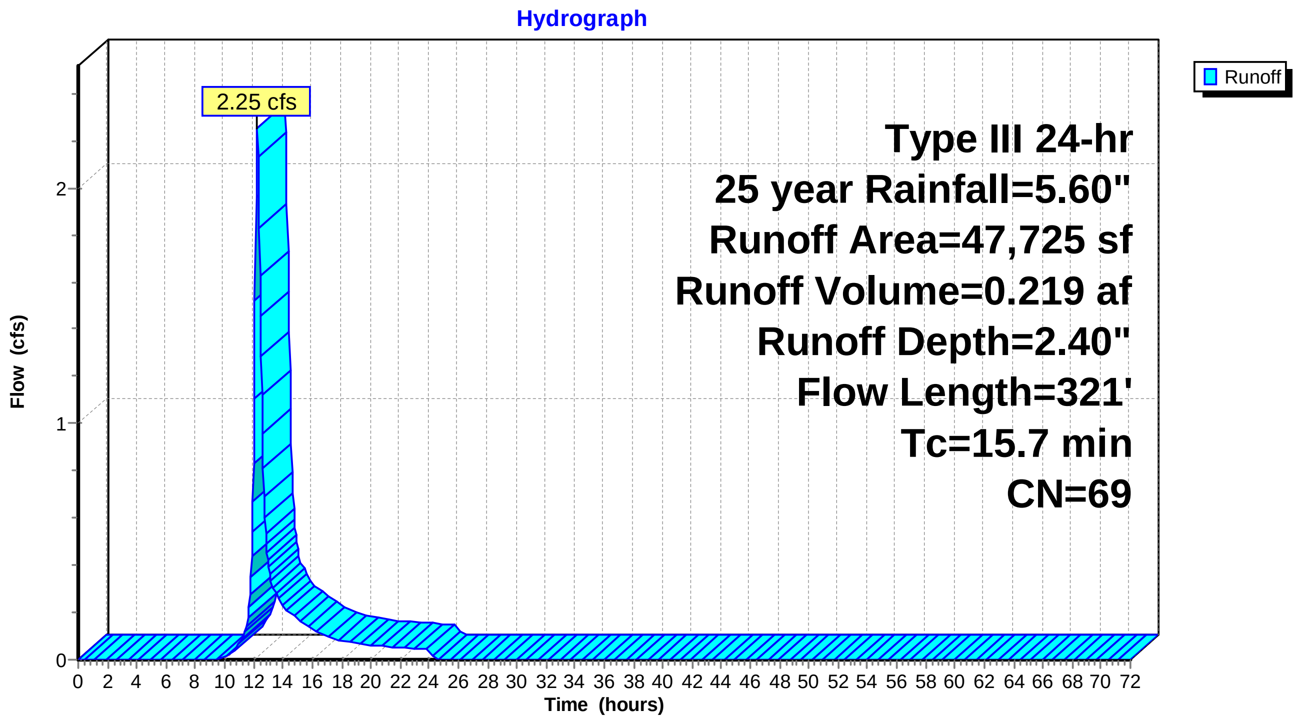
Runoff = 2.25 cfs @ 12.22 hrs, Volume= 0.219 af, Depth= 2.40"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 year Rainfall=5.60"

Area (sf)	CN	Description
469	30	Woods, Good, HSG A
30,992	70	Woods, Good, HSG C
14,119	74	>75% Grass cover, Good, HSG C
2,145	39	>75% Grass cover, Good, HSG A
47,725	69	Weighted Average
47,725		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	50	0.1900	0.10		**Sheet Flow, AB** Woods: Dense underbrush n= 0.800 P2= 3.20"
0.3	40	0.1750	2.09		**Shallow Concentrated Flow, BC** Woodland Kv= 5.0 fps
1.6	123	0.0325	1.26		**Shallow Concentrated Flow, CD** Short Grass Pasture Kv= 7.0 fps
5.1	108	0.0050	0.35		**Shallow Concentrated Flow, DE** Woodland Kv= 5.0 fps
15.7	321	Total			

Subcatchment 2a: P-2a



Summary for Subcatchment 2b: P-2b

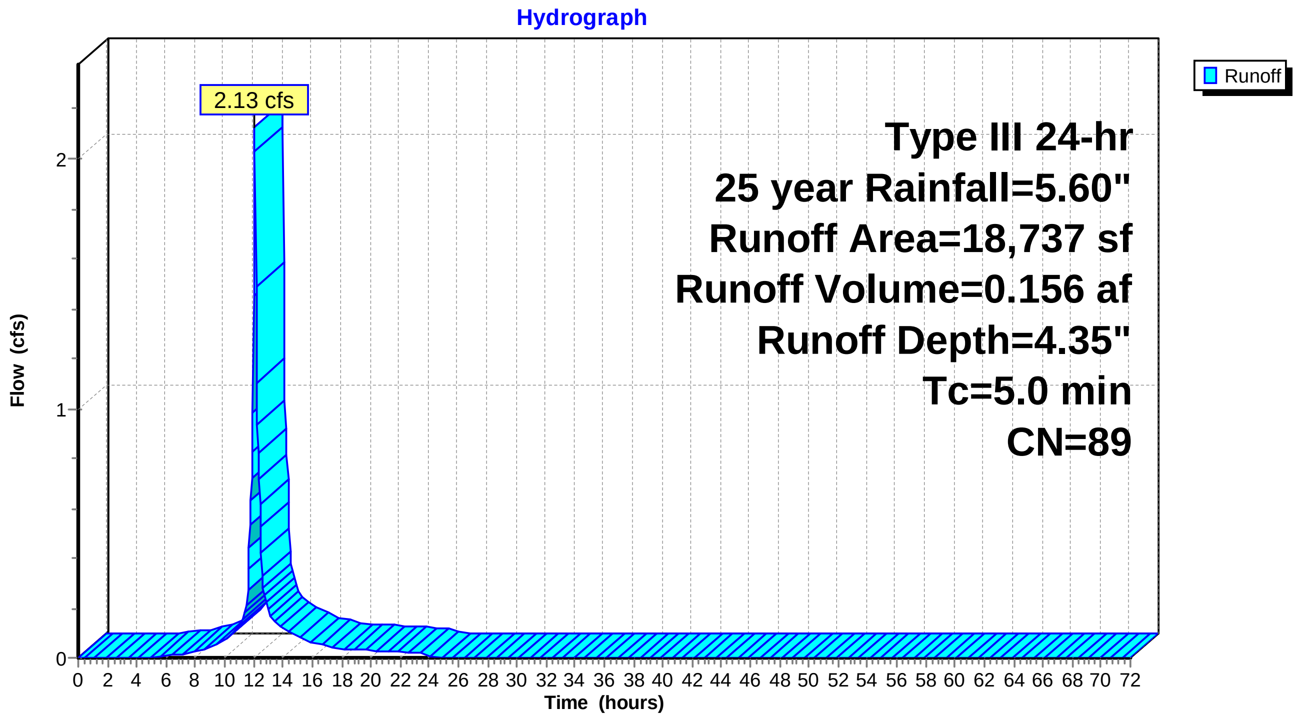
Runoff = 2.13 cfs @ 12.07 hrs, Volume= 0.156 af, Depth= 4.35"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 year Rainfall=5.60"

	Area (sf)	CN	Description
	1,290	30	Woods, Good, HSG A
	1,423	39	>75% Grass cover, Good, HSG A
*	3,563	98	Roof
*	8,964	98	CB1
*	3,497	98	CB2
	18,737	89	Weighted Average
	2,713		14.48% Pervious Area
	16,024		85.52% Impervious Area

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

Subcatchment 2b: P-2b



Summary for Subcatchment 2c: P-2c

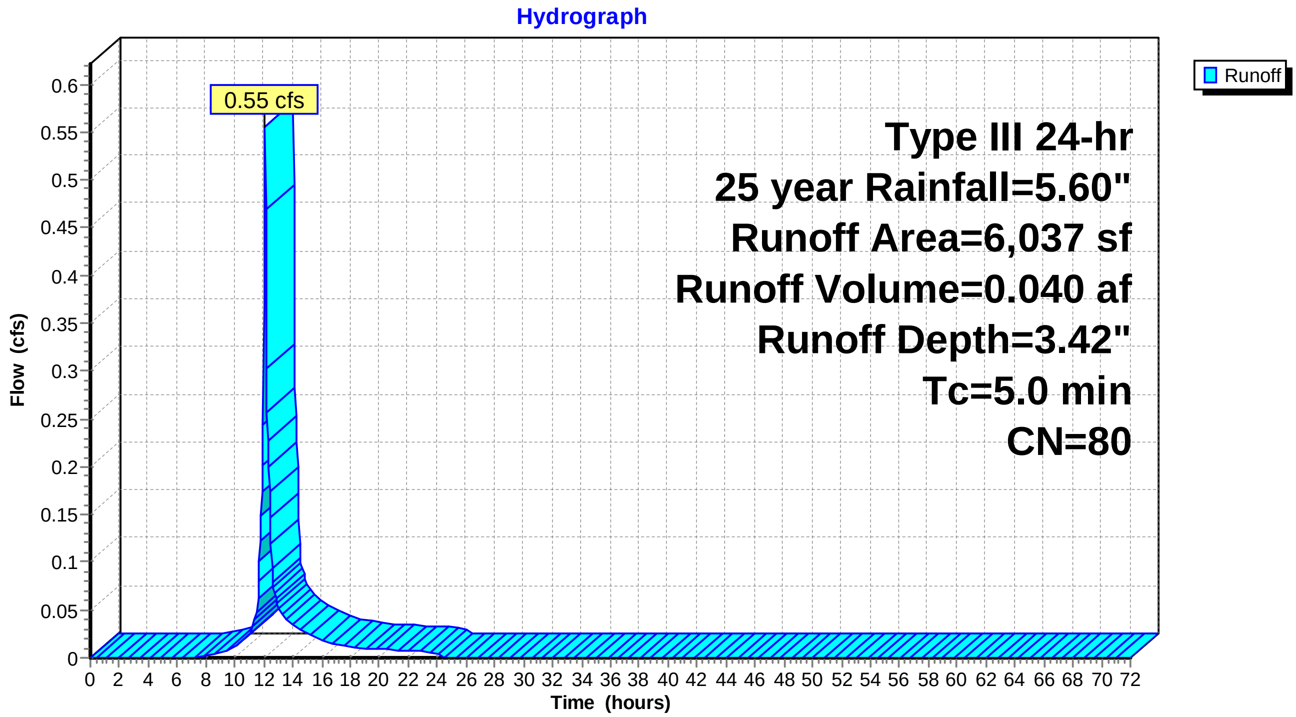
Runoff = 0.55 cfs @ 12.08 hrs, Volume= 0.040 af, Depth= 3.42"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 25 year Rainfall=5.60"

	Area (sf)	CN	Description
*	4,223	98	Impervious
	1,814	39	>75% Grass cover, Good, HSG A
	6,037	80	Weighted Average
	1,814		30.05% Pervious Area
	4,223		69.95% Impervious Area

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

Subcatchment 2c: P-2c

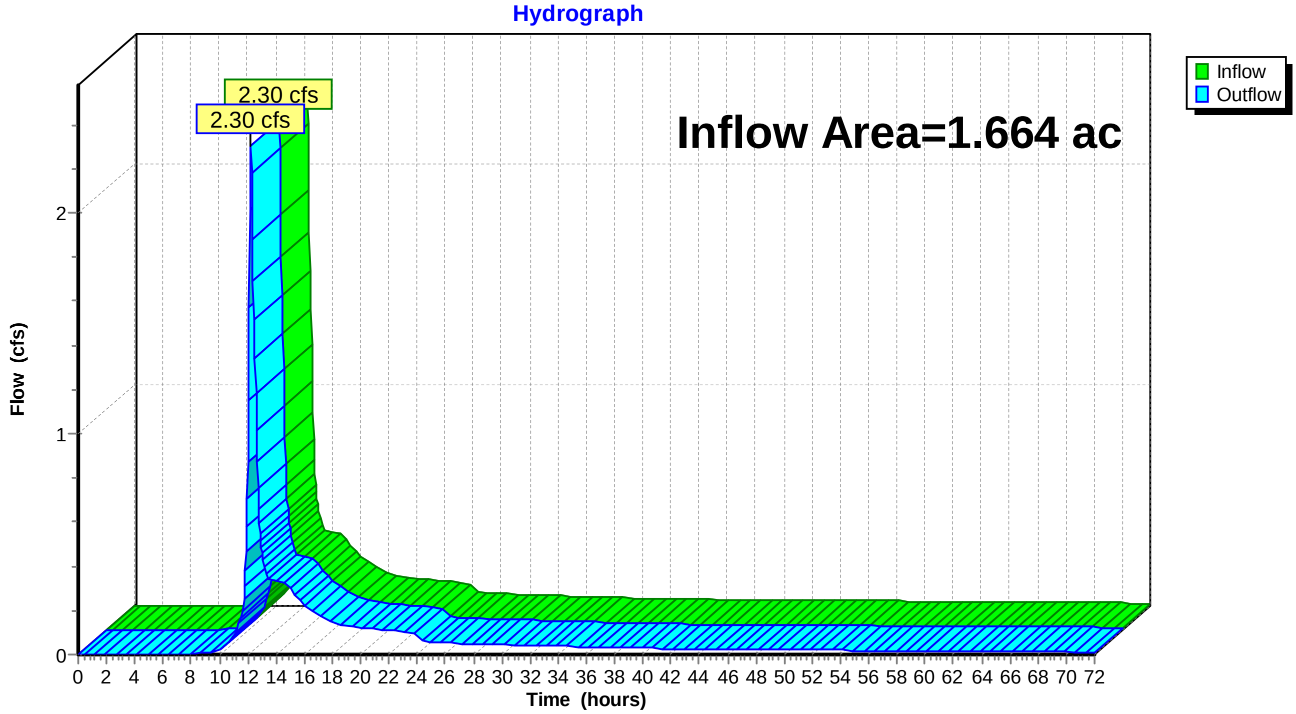


Summary for Reach 3R:

Inflow Area = 1.664 ac, 27.93% Impervious, Inflow Depth > 2.90" for 25 year event
Inflow = 2.30 cfs @ 12.22 hrs, Volume= 0.402 af
Outflow = 2.30 cfs @ 12.22 hrs, Volume= 0.402 af, Atten= 0%, Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach 3R:



Summary for Pond UG1:

Inflow Area = 0.430 ac, 85.52% Impervious, Inflow Depth = 4.35" for 25 year event
Inflow = 2.13 cfs @ 12.07 hrs, Volume= 0.156 af
Outflow = 0.10 cfs @ 14.43 hrs, Volume= 0.143 af, Atten= 95%, Lag= 141.7 min
Primary = 0.10 cfs @ 14.43 hrs, Volume= 0.143 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 138.53' @ 14.43 hrs Surf.Area= 3,164 sf Storage= 4,786 cf

Plug-Flow detention time= 1,293.5 min calculated for 0.143 af (92% of inflow)
Center-of-Mass det. time= 1,253.6 min (2,043.1 - 789.6)

Volume	Invert	Avail.Storage	Storage Description
#1A	136.40'	1,972 cf	**34.75'W x 91.06'L x 3.00'H Field A** 9,493 cf Overall - 3,859 cf Embedded = 5,634 cf x 35.0% Voids
#2A	136.40'	3,859 cf	**ADS_StormTech SC-740 +Cap** x 84 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 84 Chambers in 7 Rows
		5,831 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	136.40'	**8.0" Round Culvert** L= 17.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 136.40' / 136.10' S= 0.0176 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf
#2	Device 1	136.40'	**1.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	138.50'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.10 cfs @ 14.43 hrs HW=138.53' (Free Discharge)
1=Culvert (Passes 0.10 cfs of 1.99 cfs potential flow)
2=Orifice/Grate (Orifice Controls 0.04 cfs @ 6.96 fps)
3=Sharp-Crested Rectangular Weir (Weir Controls 0.06 cfs @ 0.56 fps)

Pond UG1: - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-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

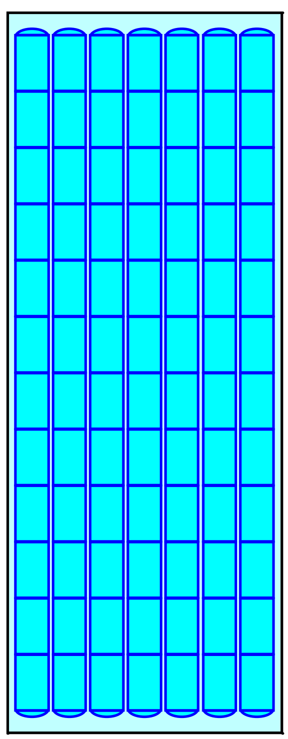
12 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 87.06' Row Length +24.0" End Stone x 2 = 91.06' Base Length
7 Rows x 51.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 34.75' Base Width
30.0" Chamber Height + 6.0" Cover = 3.00' Field Height

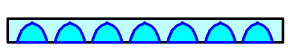
84 Chambers x 45.9 cf = 3,859.0 cf Chamber Storage

9,492.7 cf Field - 3,859.0 cf Chambers = 5,633.7 cf Stone x 35.0% Voids = 1,971.8 cf Stone Storage

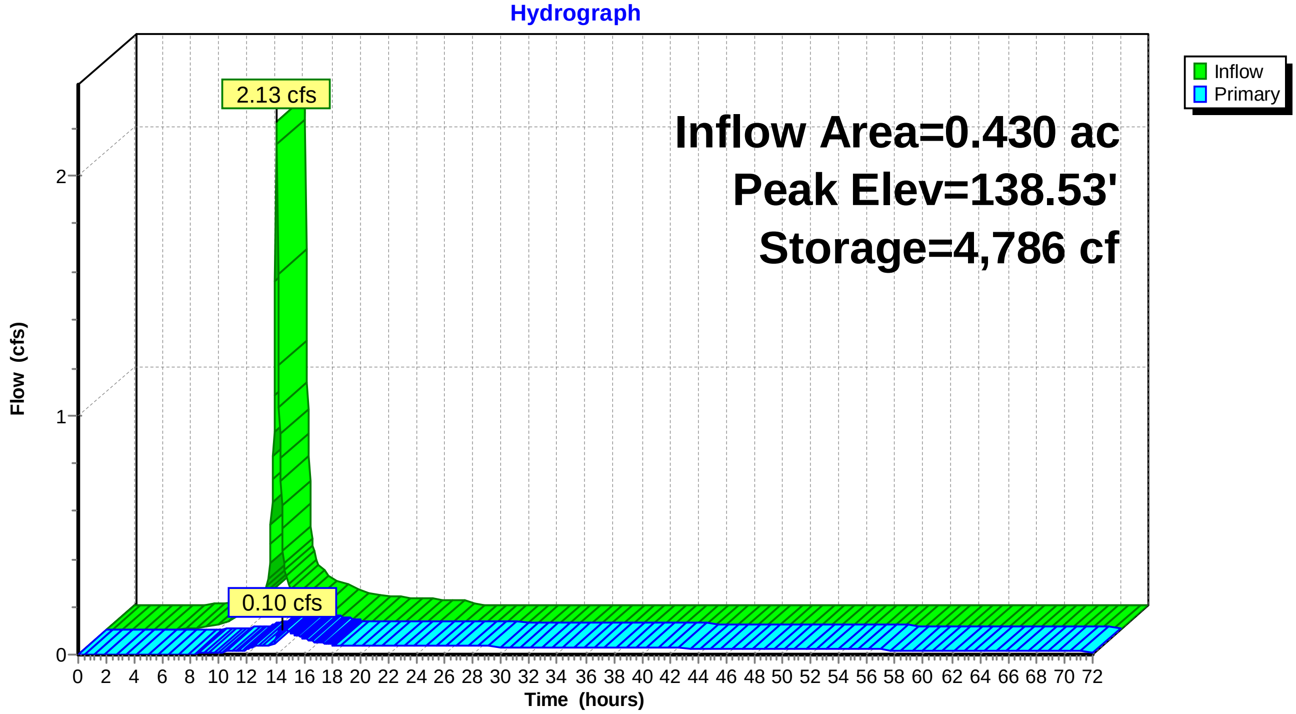
Chamber Storage + Stone Storage = 5,830.8 cf = 0.134 af
Overall Storage Efficiency = 61.4%
Overall System Size = 91.06' x 34.75' x 3.00'

84 Chambers
351.6 cy Field
208.7 cy Stone





Pond UG1:


Hydrograph
2.13 cfs
0.10 cfs
Inflow Area=0.430 ac
Peak Elev=138.53'
Storage=4,786 cf
Inflow
Primary
Flow (cfs)
Time (hours)
0
1
2
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72

Summary for Pond UG2:

Inflow Area = 0.139 ac, 69.95% Impervious, Inflow Depth = 3.42" for 25 year event
Inflow = 0.55 cfs @ 12.08 hrs, Volume= 0.040 af
Outflow = 0.03 cfs @ 14.74 hrs, Volume= 0.040 af, Atten= 95%, Lag= 160.0 min
Primary = 0.03 cfs @ 14.74 hrs, Volume= 0.040 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 136.37' @ 14.74 hrs Surf.Area= 1,203 sf Storage= 1,012 cf

Plug-Flow detention time= 481.0 min calculated for 0.040 af (100% of inflow)
Center-of-Mass det. time= 480.8 min (1,296.9 - 816.1)

Volume	Invert	Avail.Storage	Storage Description
#1B	135.20'	1,234 cf	**22.50'W x 53.46'L x 4.00'H Field B** 4,811 cf Overall - 1,286 cf Embedded = 3,525 cf x 35.0% Voids
#2B	135.20'	1,286 cf	**ADS_StormTech SC-740 +Cap** x 28 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 28 Chambers in 4 Rows
		2,520 cf	Total Available Storage

Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	134.80'	**12.0" Round Culvert** L= 24.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 134.80' / 134.00' S= 0.0333 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf
#2	Device 1	135.20'	**1.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	137.50'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.03 cfs @ 14.74 hrs HW=136.37' (Free Discharge)
↑—**1=Culvert** (Passes 0.03 cfs of 3.45 cfs potential flow)
  ↑—**2=Orifice/Grate** (Orifice Controls 0.03 cfs @ 5.11 fps)
  └—**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond UG2: - Chamber Wizard Field B

Chamber Model = ADS_StormTech SC-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

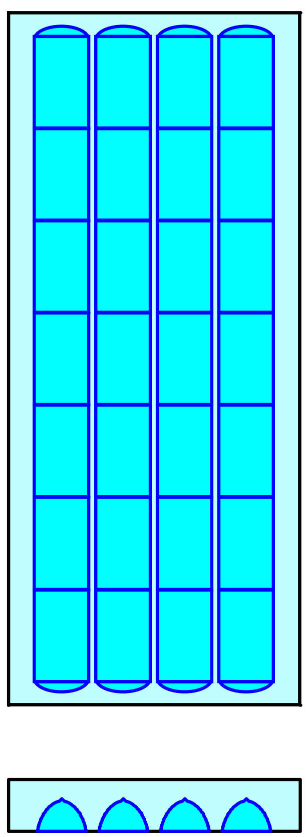
7 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 51.46' Row Length +12.0" End Stone x 2 = 53.46' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 24.0" Side Stone x 2 = 22.50' Base Width
30.0" Chamber Height + 18.0" Cover = 4.00' Field Height

28 Chambers x 45.9 cf = 1,286.3 cf Chamber Storage

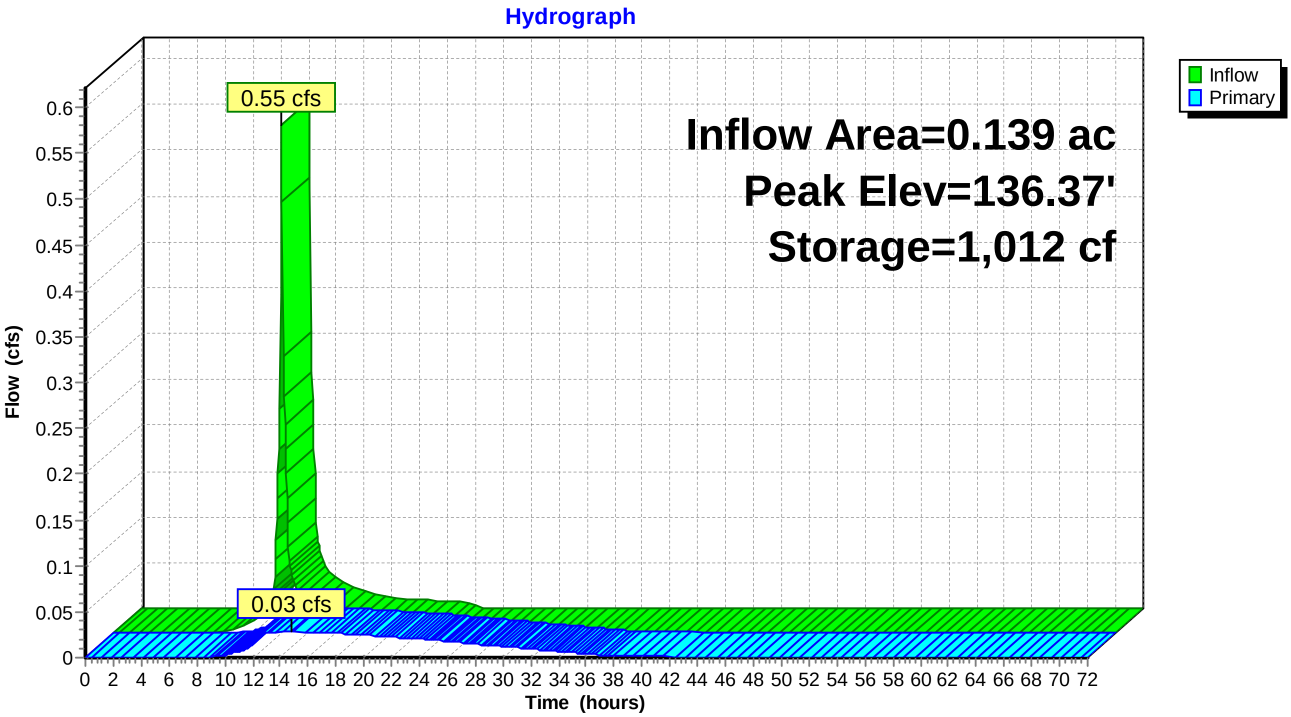
4,811.1 cf Field - 1,286.3 cf Chambers = 3,524.8 cf Stone x 35.0% Voids = 1,233.7 cf Stone Storage

Chamber Storage + Stone Storage = 2,520.0 cf = 0.058 af
Overall Storage Efficiency = 52.4%
Overall System Size = 53.46' x 22.50' x 4.00'

28 Chambers
178.2 cy Field
130.5 cy Stone



Pond UG2:


Hydrograph
0.55 cfs
0.03 cfs
Inflow Area=0.139 ac
Peak Elev=136.37'
Storage=1,012 cf
Inflow
Primary
Flow (cfs)
Time (hours)
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
0.4
0.45
0.5
0.55
0.6
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72

Time span=0.00-72.00 hrs, dt=0.05 hrs, 1441 points
Runoff by SCS TR-20 method, UH=SCS, Weighted-CN
Reach routing by Stor-Ind+Trans method - Pond routing by Stor-Ind method

Subcatchment 1: P-1 Runoff Area=13,132 sf 81.11% Impervious Runoff Depth=5.48"
Tc=5.0 min CN=87 Runoff=1.87 cfs 0.138 af

Subcatchment 2a: P-2a Runoff Area=47,725 sf 0.00% Impervious Runoff Depth=3.51"
Flow Length=321' Tc=15.7 min CN=69 Runoff=3.33 cfs 0.321 af

Subcatchment 2b: P-2b Runoff Area=18,737 sf 85.52% Impervious Runoff Depth=5.71"
Tc=5.0 min CN=89 Runoff=2.75 cfs 0.205 af

Subcatchment 2c: P-2c Runoff Area=6,037 sf 69.95% Impervious Runoff Depth=4.69"
Tc=5.0 min CN=80 Runoff=0.76 cfs 0.054 af

Reach 3R: Inflow=3.40 cfs 0.566 af
Outflow=3.40 cfs 0.566 af

Pond UG1: Peak Elev=138.64' Storage=4,959 cf Inflow=2.75 cfs 0.205 af
Outflow=0.74 cfs 0.191 af

Pond UG2: Peak Elev=136.93' Storage=1,442 cf Inflow=0.76 cfs 0.054 af
Outflow=0.03 cfs 0.054 af

Total Runoff Area = 1.966 ac Runoff Volume = 0.717 af Average Runoff Depth = 4.38"
63.92% Pervious = 1.256 ac 36.08% Impervious = 0.709 ac

Summary for Subcatchment 1: P-1

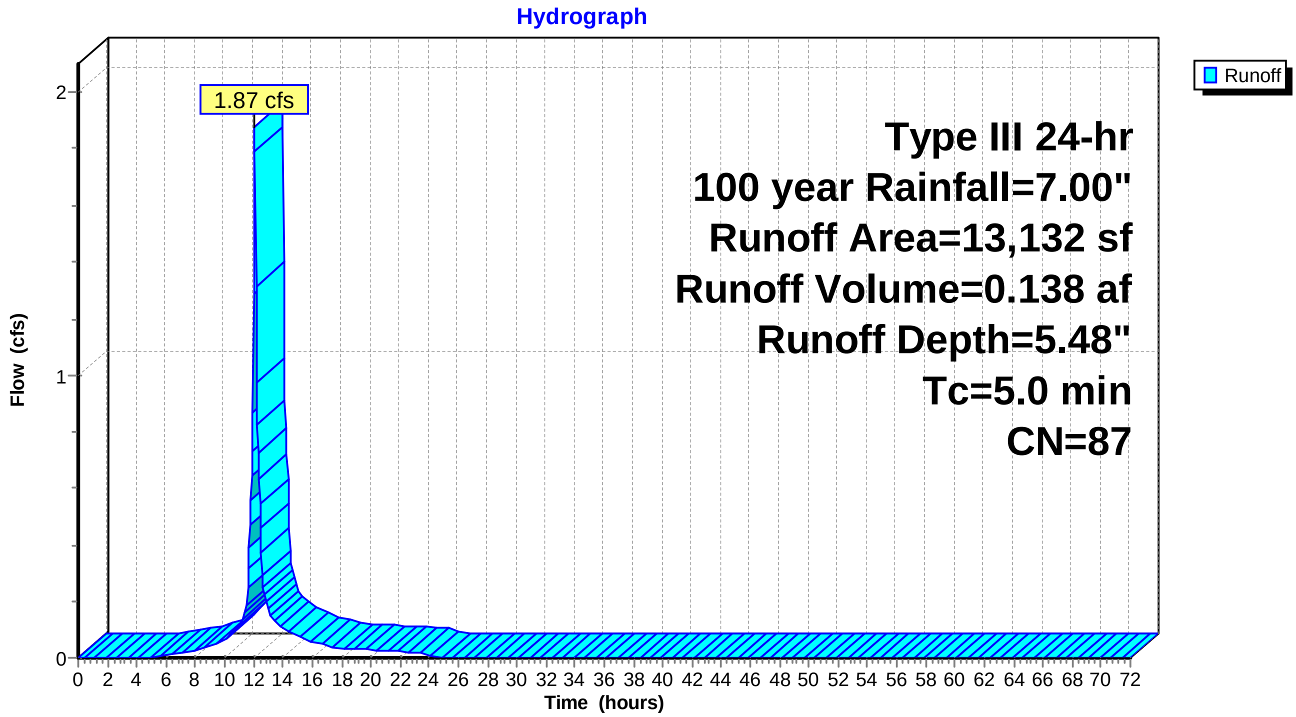
Runoff = 1.87 cfs @ 12.07 hrs, Volume= 0.138 af, Depth= 5.48"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=7.00"

	Area (sf)	CN	Description
*	10,651	98	Impervious
	2,481	39	>75% Grass cover, Good, HSG A
	13,132	87	Weighted Average
	2,481		18.89% Pervious Area
	10,651		81.11% Impervious Area

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

Subcatchment 1: P-1



Summary for Subcatchment 2a: P-2a

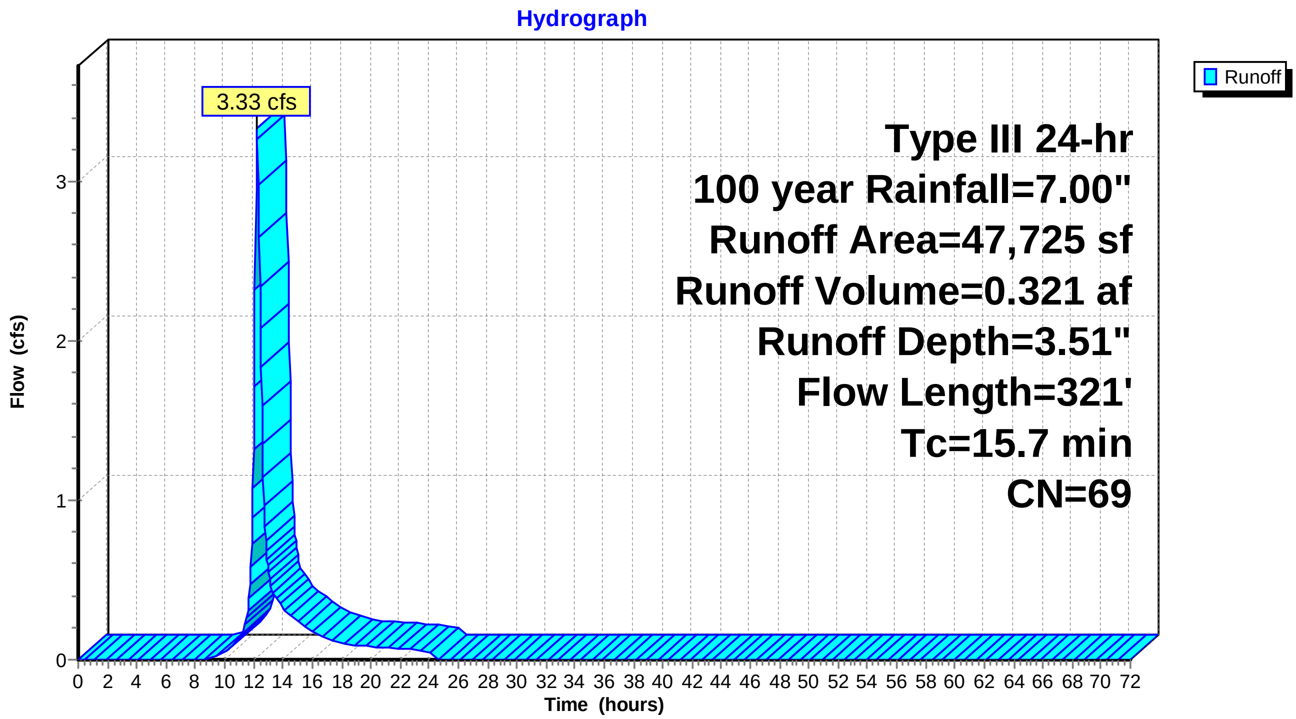
Runoff = 3.33 cfs @ 12.22 hrs, Volume= 0.321 af, Depth= 3.51"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=7.00"

Area (sf)	CN	Description
469	30	Woods, Good, HSG A
30,992	70	Woods, Good, HSG C
14,119	74	>75% Grass cover, Good, HSG C
2,145	39	>75% Grass cover, Good, HSG A
47,725	69	Weighted Average
47,725		100.00% Pervious Area

Tc (min)	Length (feet)	Slope (ft/ft)	Velocity (ft/sec)	Capacity (cfs)	Description
8.7	50	0.1900	0.10		**Sheet Flow, AB** Woods: Dense underbrush n= 0.800 P2= 3.20"
0.3	40	0.1750	2.09		**Shallow Concentrated Flow, BC** Woodland Kv= 5.0 fps
1.6	123	0.0325	1.26		**Shallow Concentrated Flow, CD** Short Grass Pasture Kv= 7.0 fps
5.1	108	0.0050	0.35		**Shallow Concentrated Flow, DE** Woodland Kv= 5.0 fps
15.7	321	Total			

Subcatchment 2a: P-2a



Summary for Subcatchment 2b: P-2b

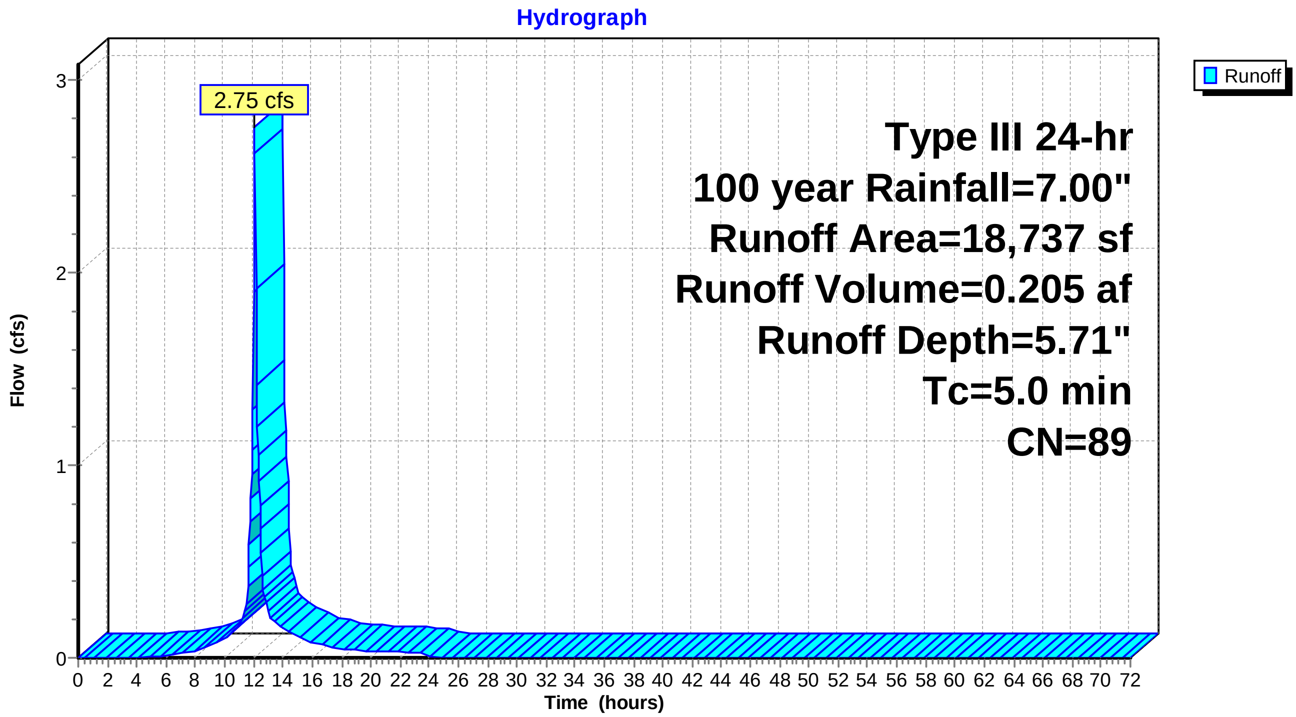
Runoff = 2.75 cfs @ 12.07 hrs, Volume= 0.205 af, Depth= 5.71"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=7.00"

	Area (sf)	CN	Description
	1,290	30	Woods, Good, HSG A
	1,423	39	>75% Grass cover, Good, HSG A
*	3,563	98	Roof
*	8,964	98	CB1
*	3,497	98	CB2
	18,737	89	Weighted Average
	2,713		14.48% Pervious Area
	16,024		85.52% Impervious Area

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

Subcatchment 2b: P-2b



Summary for Subcatchment 2c: P-2c

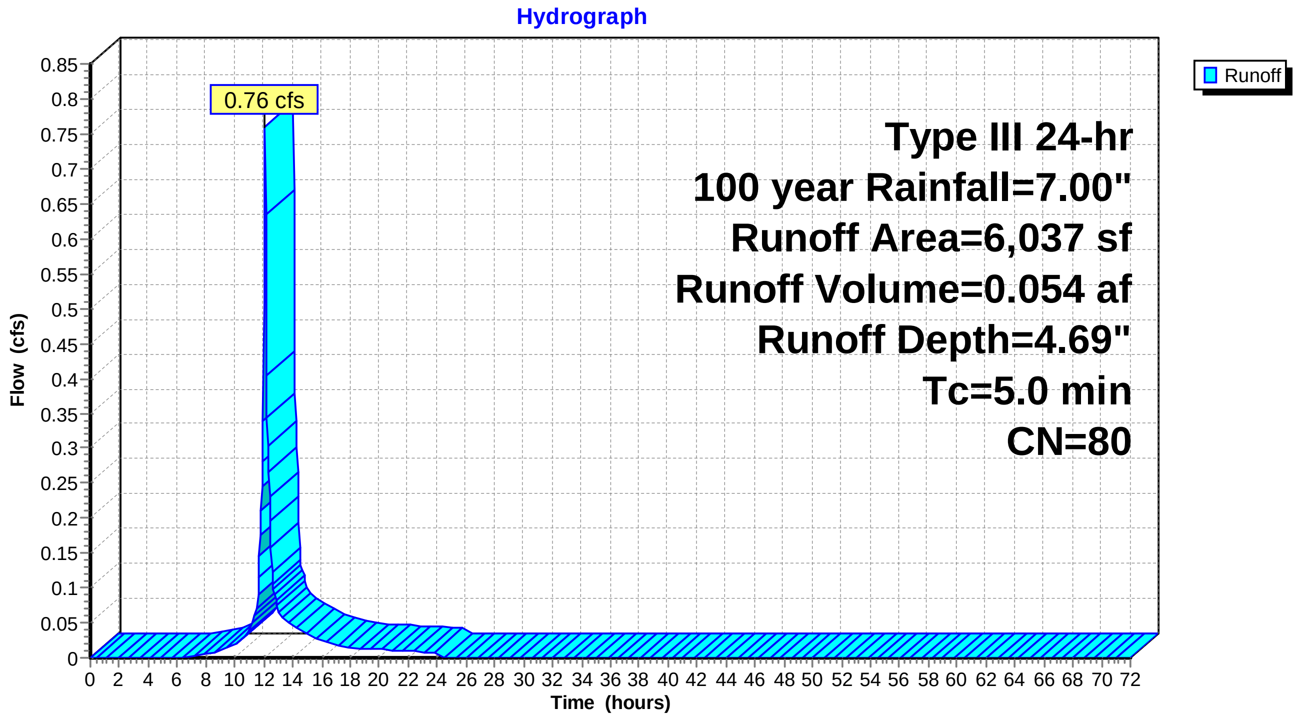
Runoff = 0.76 cfs @ 12.07 hrs, Volume= 0.054 af, Depth= 4.69"

Runoff by SCS TR-20 method, UH=SCS, Weighted-CN, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Type III 24-hr 100 year Rainfall=7.00"

	Area (sf)	CN	Description
*	4,223	98	Impervious
	1,814	39	>75% Grass cover, Good, HSG A
	6,037	80	Weighted Average
	1,814		30.05% Pervious Area
	4,223		69.95% Impervious Area

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

Subcatchment 2c: P-2c

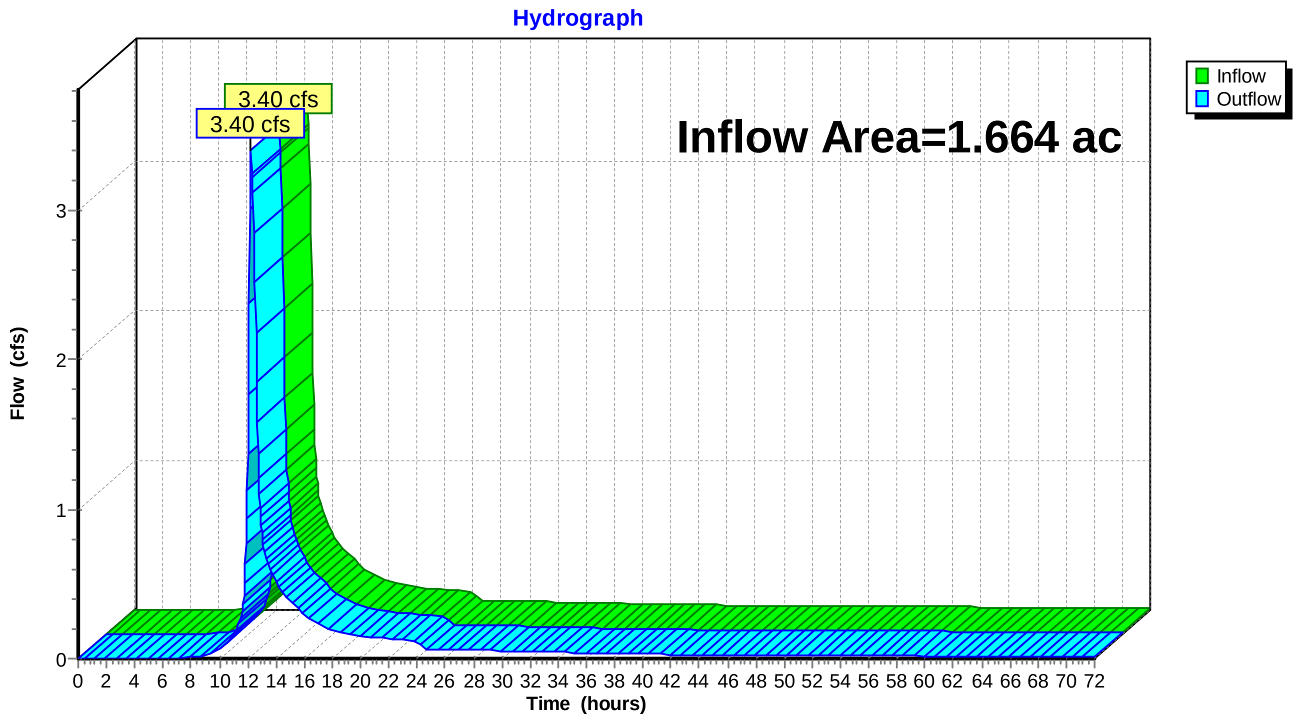


Summary for Reach 3R:

Inflow Area =	1.664 ac,	27.93% Impervious,	Inflow Depth > 4.08"	for 100 year event	
Inflow =	3.40 cfs @	12.22 hrs, Volume=	0.566 af		
Outflow =	3.40 cfs @	12.22 hrs, Volume=	0.566 af,	Atten= 0%,	Lag= 0.0 min

Routing by Stor-Ind+Trans method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs

Reach 3R:



Summary for Pond UG1:

Inflow Area = 0.430 ac, 85.52% Impervious, Inflow Depth = 5.71" for 100 year event
Inflow = 2.75 cfs @ 12.07 hrs, Volume= 0.205 af
Outflow = 0.74 cfs @ 12.43 hrs, Volume= 0.191 af, Atten= 73%, Lag= 21.2 min
Primary = 0.74 cfs @ 12.43 hrs, Volume= 0.191 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 138.64' @ 12.43 hrs Surf.Area= 3,164 sf Storage= 4,959 cf

Plug-Flow detention time= 1,003.0 min calculated for 0.191 af (93% of inflow)
Center-of-Mass det. time= 969.4 min (1,751.7 - 782.3)

Volume	Invert	Avail.Storage	Storage Description
#1A	136.40'	1,972 cf	**34.75'W x 91.06'L x 3.00'H Field A** 9,493 cf Overall - 3,859 cf Embedded = 5,634 cf x 35.0% Voids
#2A	136.40'	3,859 cf	**ADS_StormTech SC-740 +Cap** x 84 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 84 Chambers in 7 Rows
		5,831 cf	Total Available Storage

Storage Group A created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	136.40'	**8.0" Round Culvert** L= 17.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 136.40' / 136.10' S= 0.0176 '/' Cc= 0.900 n= 0.010, Flow Area= 0.35 sf
#2	Device 1	136.40'	**1.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	138.50'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.73 cfs @ 12.43 hrs HW=138.64' (Free Discharge)
↑—**1=Culvert** (Passes 0.73 cfs of 2.05 cfs potential flow)
  ↑—**2=Orifice/Grate** (Orifice Controls 0.04 cfs @ 7.14 fps)
  └—**3=Sharp-Crested Rectangular Weir** (Weir Controls 0.69 cfs @ 1.23 fps)

Pond UG1: - Chamber Wizard Field A

Chamber Model = ADS_StormTech SC-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

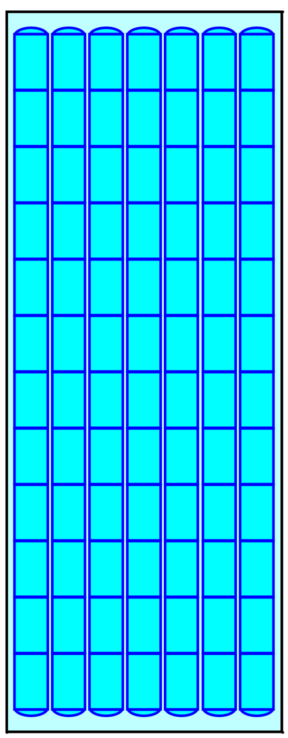
12 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 87.06' Row Length +24.0" End Stone x 2 = 91.06' Base Length
7 Rows x 51.0" Wide + 6.0" Spacing x 6 + 12.0" Side Stone x 2 = 34.75' Base Width
30.0" Chamber Height + 6.0" Cover = 3.00' Field Height

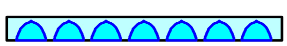
84 Chambers x 45.9 cf = 3,859.0 cf Chamber Storage

9,492.7 cf Field - 3,859.0 cf Chambers = 5,633.7 cf Stone x 35.0% Voids = 1,971.8 cf Stone Storage

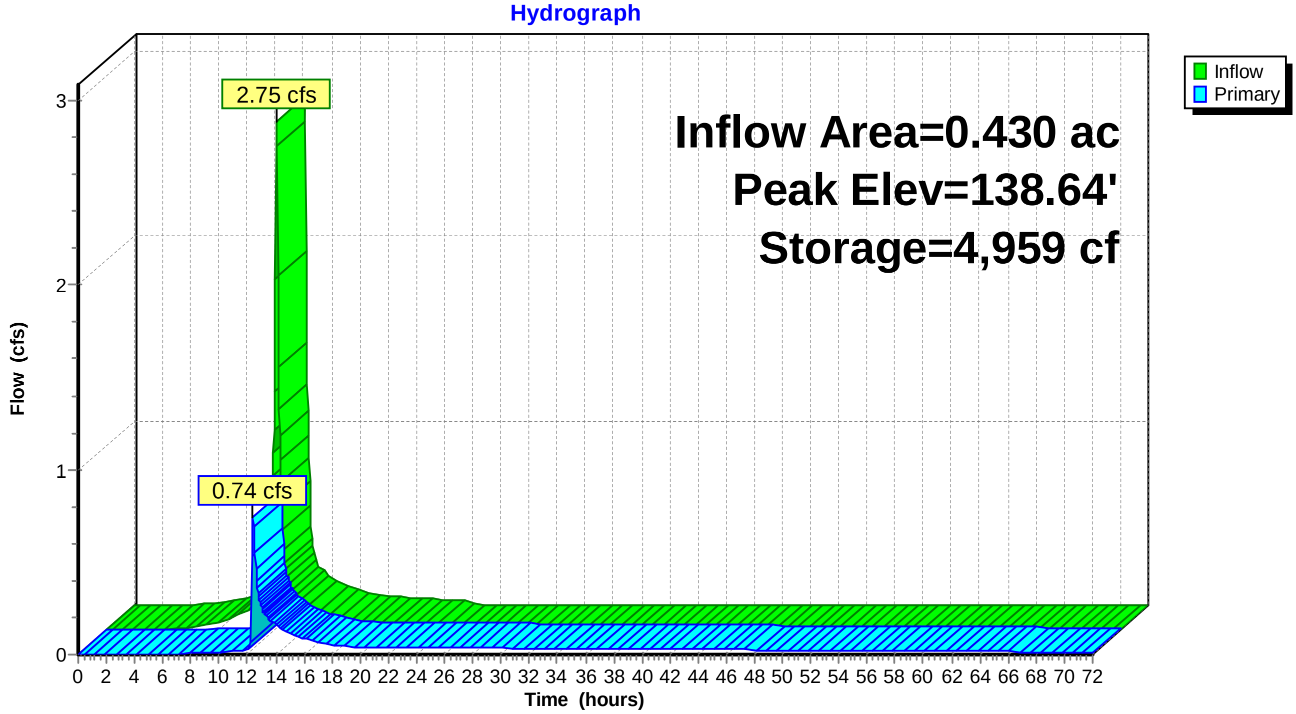
Chamber Storage + Stone Storage = 5,830.8 cf = 0.134 af
Overall Storage Efficiency = 61.4%
Overall System Size = 91.06' x 34.75' x 3.00'

84 Chambers
351.6 cy Field
208.7 cy Stone





Pond UG1:


Hydrograph
2.75 cfs
0.74 cfs
Inflow Area=0.430 ac
Peak Elev=138.64'
Storage=4,959 cf
Inflow
Primary
Flow (cfs)
Time (hours)
0
1
2
3
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72

Summary for Pond UG2:

Inflow Area = 0.139 ac, 69.95% Impervious, Inflow Depth = 4.69" for 100 year event
Inflow = 0.76 cfs @ 12.07 hrs, Volume= 0.054 af
Outflow = 0.03 cfs @ 14.97 hrs, Volume= 0.054 af, Atten= 96%, Lag= 173.9 min
Primary = 0.03 cfs @ 14.97 hrs, Volume= 0.054 af

Routing by Stor-Ind method, Time Span= 0.00-72.00 hrs, dt= 0.05 hrs
Peak Elev= 136.93' @ 14.97 hrs Surf.Area= 1,203 sf Storage= 1,442 cf

Plug-Flow detention time= 552.9 min calculated for 0.054 af (100% of inflow)
Center-of-Mass det. time= 552.8 min (1,359.8 - 807.1)

Volume	Invert	Avail.Storage	Storage Description
#1B	135.20'	1,234 cf	**22.50'W x 53.46'L x 4.00'H Field B** 4,811 cf Overall - 1,286 cf Embedded = 3,525 cf x 35.0% Voids
#2B	135.20'	1,286 cf	**ADS_StormTech SC-740 +Cap** x 28 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 28 Chambers in 4 Rows
		2,520 cf	Total Available Storage

Storage Group B created with Chamber Wizard

Device	Routing	Invert	Outlet Devices
#1	Primary	134.80'	**12.0" Round Culvert** L= 24.0' CPP, mitered to conform to fill, Ke= 0.700 Inlet / Outlet Invert= 134.80' / 134.00' S= 0.0333 '/' Cc= 0.900 n= 0.010, Flow Area= 0.79 sf
#2	Device 1	135.20'	**1.0" Vert. Orifice/Grate** C= 0.600
#3	Device 1	137.50'	**4.0' long Sharp-Crested Rectangular Weir** 2 End Contraction(s)

Primary OutFlow Max=0.03 cfs @ 14.97 hrs HW=136.93' (Free Discharge)
↑—**1=Culvert** (Passes 0.03 cfs of 4.26 cfs potential flow)
  ↑—**2=Orifice/Grate** (Orifice Controls 0.03 cfs @ 6.26 fps)
  └—**3=Sharp-Crested Rectangular Weir** (Controls 0.00 cfs)

Pond UG2: - Chamber Wizard Field B

Chamber Model = ADS_StormTech SC-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

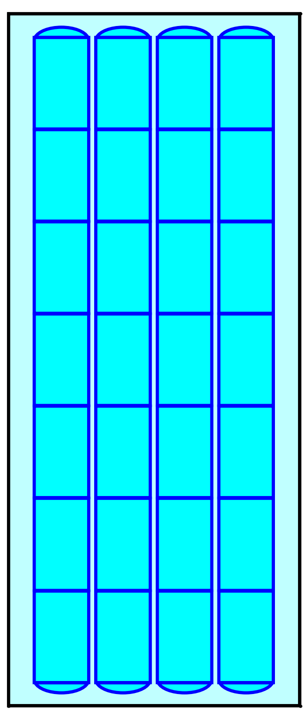
7 Chambers/Row x 7.12' Long +0.81' Cap Length x 2 = 51.46' Row Length +12.0" End Stone x 2 = 53.46' Base Length
4 Rows x 51.0" Wide + 6.0" Spacing x 3 + 24.0" Side Stone x 2 = 22.50' Base Width
30.0" Chamber Height + 18.0" Cover = 4.00' Field Height

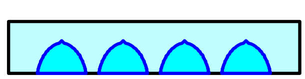
28 Chambers x 45.9 cf = 1,286.3 cf Chamber Storage

4,811.1 cf Field - 1,286.3 cf Chambers = 3,524.8 cf Stone x 35.0% Voids = 1,233.7 cf Stone Storage

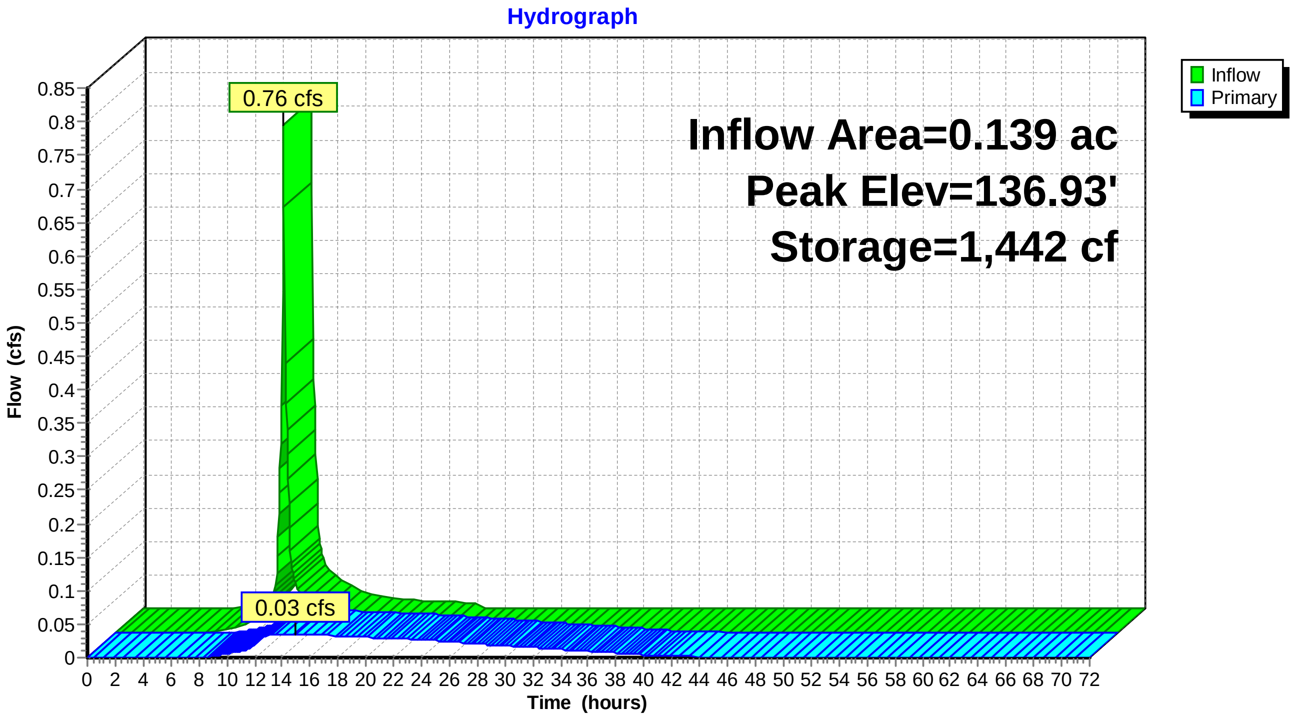
Chamber Storage + Stone Storage = 2,520.0 cf = 0.058 af
Overall Storage Efficiency = 52.4%
Overall System Size = 53.46' x 22.50' x 4.00'

28 Chambers
178.2 cy Field
130.5 cy Stone





Pond UG2:


Hydrograph
0.76 cfs
0.03 cfs
Inflow Area=0.139 ac
Peak Elev=136.93'
Storage=1,442 cf
Inflow
Primary
Flow (cfs)
0.85
0.8
0.75
0.7
0.65
0.6
0.55
0.5
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0 2 4 6 8 10 12 14 16 18 20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66 68 70 72
Time (hours)

Section 3.2

Proposed Pipe Hydraulic Calculations

OCEAN HONDA - STORM SEWER DESIGN

Design Assumptions

Project No. 360903
Project 19 & 27 Whiting Street
Location Whiting St
Hingham MA

100 Year Storm
5 Minute Duration
7 in/hr Intensity for Boston, MA IDF Curve

Pipe Coefficient "n" 0.013 HDPE/RCP

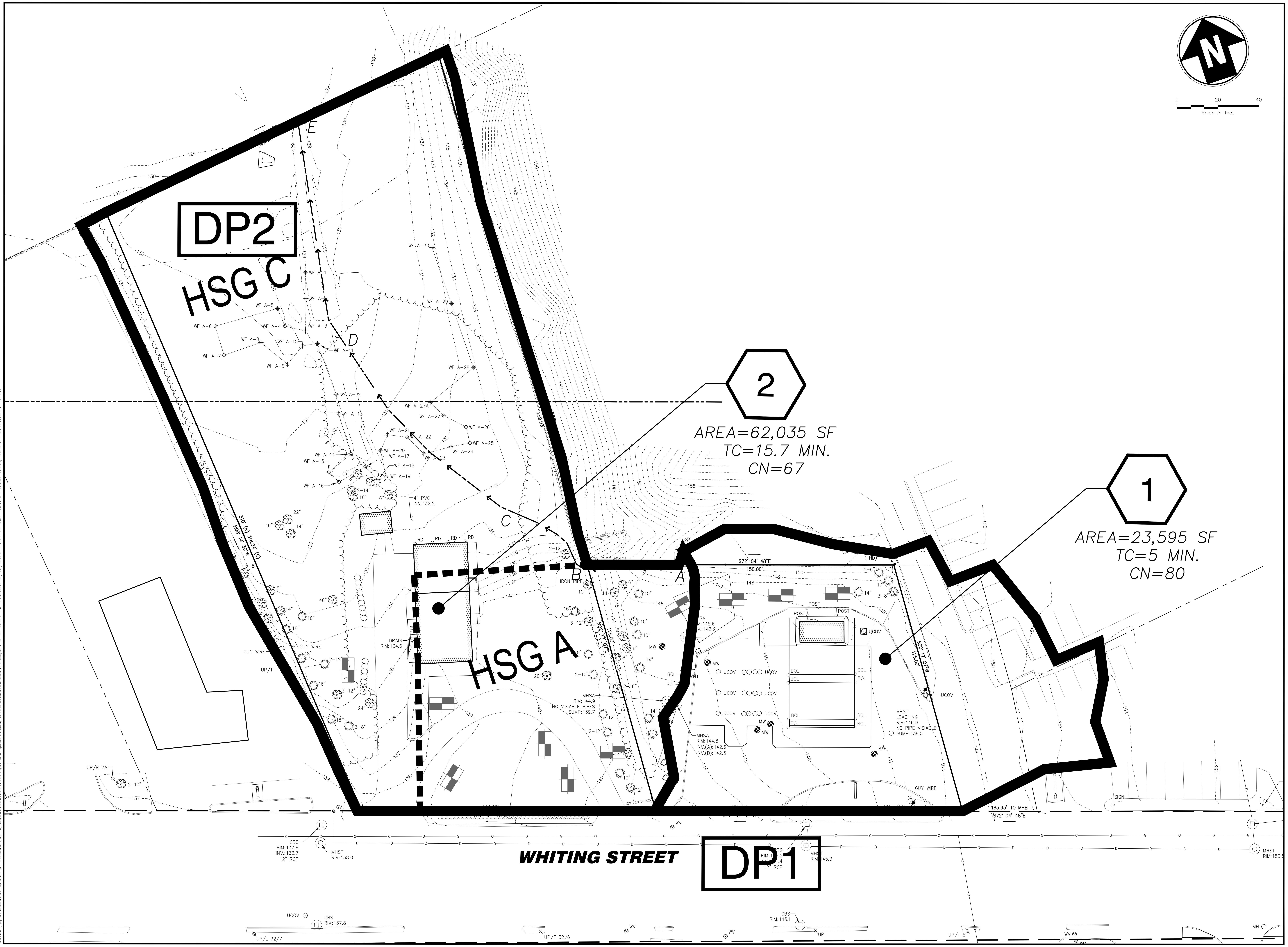
SHEET 1 OF 1
COMPUTED BY DR DATE 9/10/2020

CHECKED BY DR DATE

DRAINAGE STRUCTURE FROM STRUCT.	TO STRUCT.	TRIBUTRARY AREA INCREM. (AC)	TRIBUTRARY AREA TOTAL	RUNOFF COEFFICIENT "C"	RUNOFF RATIONAL METHOD Q=Ca x C x i x A "Ca"	"Ca" X "C" X "A"	TIME OF FLOW TC(MIN)	TIME OF FLOW TF(MIN)	RAINFALL INTENSITY (IN/HR)	DISCHARGE (Q) INCREM (CFS)	DISCHARGE (Q) TOTAL (CFS)	PIPE LENGTH (FT)	DIA (IN)	SLOPE (FT/FT)	CAPACITY Q (CFS)	MEAN VELOCITY VF (FT/S)	AVAILABLE CAPACITY	FROM INVERT	TO INVERT	FROM STRUCTURE RIM
CB1	DMH1	0.27		0.76	1.1	0.22	5		7	1.57		72	12	0.022	5.32	6.78	3.75	138.70	137.10	143.20
DMH1	OW1		0.27		1.1		5		7		1.57	3	12	0.033	6.52	8.30	4.95	137.00	136.90	140.50
CB2	OW1	0.09		0.90	1.1	0.09	5		7	0.61		6	12	0.017	4.61	5.87	4.00	137.00	136.90	140.00
OW1	DMH2		0.09		1.1		5		7		2.18	6	12	0.017	4.61	5.87	2.43	136.60	136.50	140.50
Roof	DMH3	0.08		0.90	1.1	0.08	5		7	0.57		12	8	0.017	1.60	4.57	1.03	138.20	138.00	141.90
OCS1	DMH4		2.75		1.1		5		7		2.76	17	12	0.018	4.74	6.04	1.98	136.40	136.10	140.70
DMH4	DMH5		2.75		1.1		5		7		2.76	55	12	0.009	3.40	4.33	0.64	136.00	135.50	140.00
DMH5	OCS2		2.75		1.1		5		7		2.76	18	12	0.017	4.61	5.87	1.85	135.40	135.10	142.00
CB3	OW2	0.14		0.72	1.1	0.11	5		7	0.77		16	12	0.006	2.82	3.59	2.05	135.80	135.70	138.30
OW2	DMH6		0.00		1.1						0.77	4	12	0.025	5.64	7.19	4.87	135.40	135.30	139.00
OCS2	FES1				1.1						3.52	24	12	0.033	6.51	8.30	2.99	134.80	134.00	140.00

Section 3.3

Drainage Area Plans



CHA
141 Longwater Drive - Suite 104
Norwell, MA 02061
781.982.5400 • www.chacompanies.com

OWNER/APPLICANT:

MERHEJ & SONS REALTY, LLC
87 DERBY STREET
HINGHAM, MA 02043

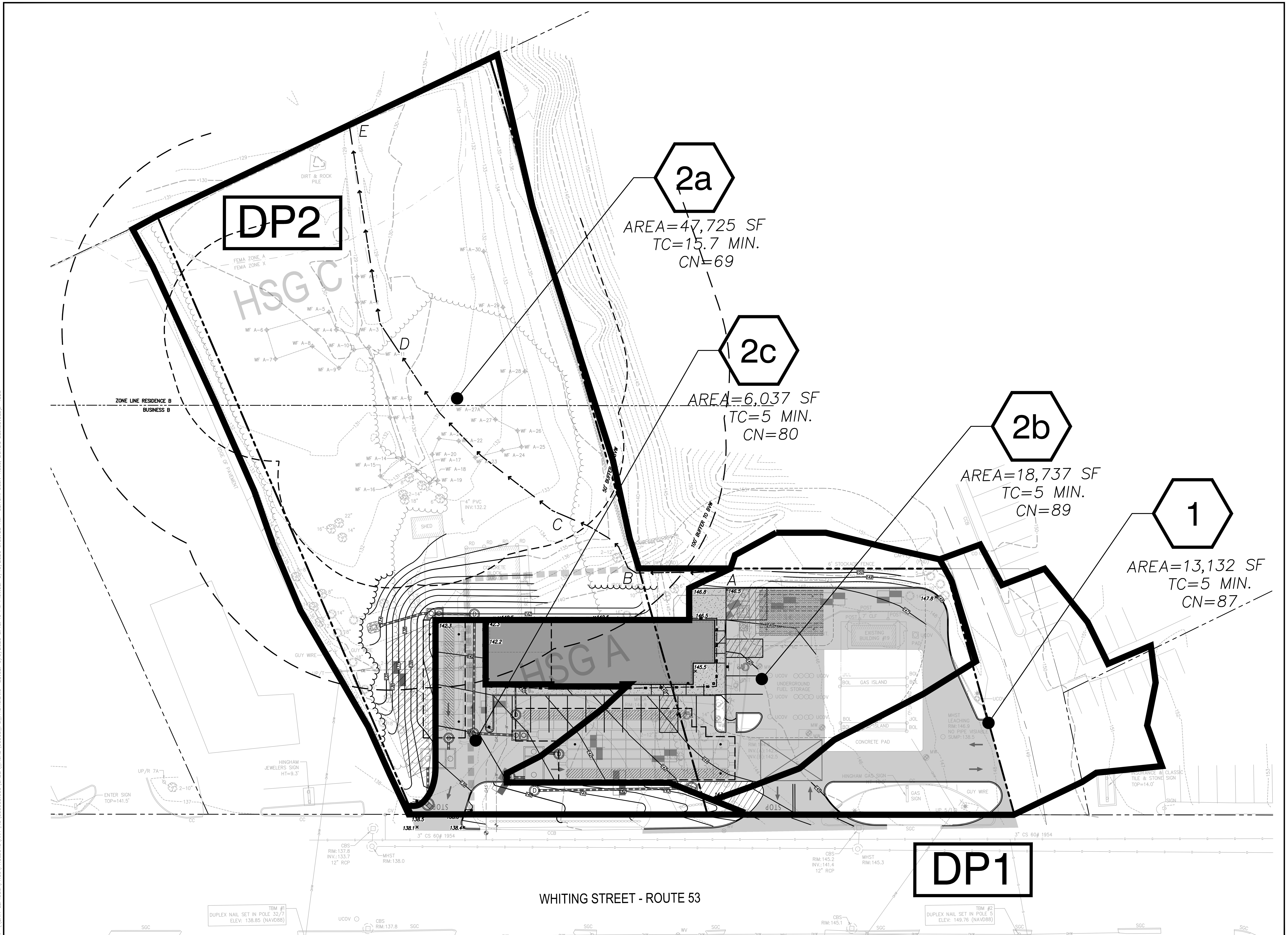
HINGHAM GAS
#19 & 27 WHITING STREET
HINGHAM, MA 02043

No.	Submittal / Revision	App'd.	By	Date
2	PERMIT SET	KK	JM	9/11/2020
1	PERMIT SET	KK	JM	5/1/2020

EXISTING CONDITIONS HYDROLOGY

Designed By:	Drawn By:	Checked By:
DR/BN	DR/BN	KK
Issue Date:	Project No:	Scale:
05/01/2020	060903	

Drawing No.:
DR-1



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HINGHAM, MA 02043

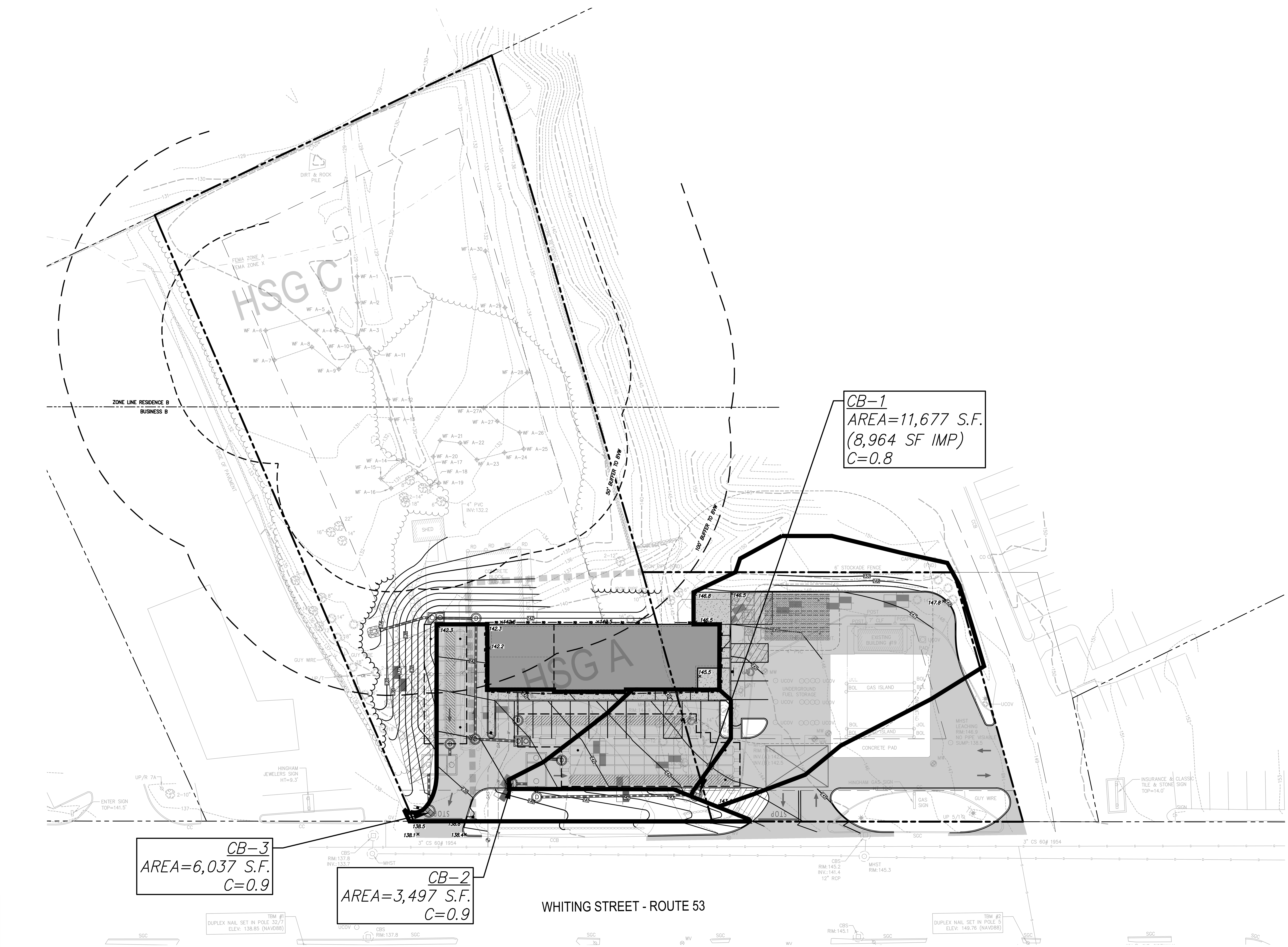
HINGHAM GAS
#19 & 27 WHITING
STREET
HINGHAM, MA 02043

No.	Submittal / Revision	App'd.	By	Date
	PERMIT SET	KK	JM	9/11/2020
	PERMIT SET	KK	JM	5/1/2020

PROPOSED
CONDITIONS
HYDROLOGY

Designed By:	Drawn By:	Checked By:
DR/BN	DR/BN	KK
Issue Date:	Project No:	Scale:
05/01/2020	060903	1" = 20'

Drawing No.:
DR-2



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STREET
HINGHAM, MA 02043

No.	Submittal / Revision	App'd.	By	Date
2	PERMIT SET	KK	JM	9/11/2020
1	PERMIT SET	KK	JM	5/1/2020

CATCH BASIN
AREA PLAN

Designed By:	Drawn By:	Checked By:
DR/BN	DR/BN	KK
Issue Date:	Project No:	Scale:
05/01/2020	060903	1" = 20'

Drawing No.:

DR-3

Section 4.0

Stormwater Management Calculations

Section 4.1

Water Quality

WATER QUALITY

The water quality volume has been calculated based on 1” of rainfall over the net new impervious area. The calculation is shown below. Note that the impervious areas are on-site and do not include off-site areas.

Existing Impervious	**= 15,645 sq. ft.**	**= 0.359 ac.**
Proposed Impervious	**= 24,296 sq. ft**	**= 0.558 ac**
Net New Impervious On-Site	**= 8,651 sq. ft.**	**= 0.199 ac.**

WQV (Water Quality Volume) based on 1-inch rainfall event

Required WQV = (1”/12”) ft. x (8,651) sq. ft. = 720.9 cu. ft.

The treatment units are sized based on flow capacity not volume per MassDEP’s requirements for flow through devices. The calculations that follow convert the runoff volume to a 1.0” Equivalent Water Quality Flow rate. See the document that follows with the flows and the proposed treatment units.

Sizing using the equivalent water quality flow from 1.0" rainfall depth

Basin	Structure	Tributary Area (acres)	Tributary Area (sq miles)	% Impervious	CN Value (Estimated)	WQV (Watershed Inches)	Tc (min)	qu (csm/in)	WQF = qu A Q (cfs)	Unit
UG-1	Roof	0.08	0.0001	100%	98	1.0	5	795	0.10	SC-310
	CB1/CB2	0.29	0.0005	100%	98	1.0	5	795	0.36	SC-310
UG-2	CB3	0.09	0.0001	100%	98	1.0	5	795	0.11	SC-310

Isolator Row #	Unit Type	Treated flow per unit* (cfs)	Flow Required to be Treated (cfs)	Number of Units Provided	Treated Flow per Isolator Row (cfs)
ROOF	SC-310	0.15	0.10	11	1.65
CB1/CB2	SC-310	0.15	0.36	11	1.65
CB3	SC-310	0.15	0.11	7	1.05

Section 4.2

Total Suspended Solids (TSS) Removal Calculations

INSTRUCTIONS: *Non-automated: Mar. 4, 2008*

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

Location: Pretreatment to Recharge - CB - Oil/Water - Isolator

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Catch basin	**0.25**	**1.00**	**0.25**	**0.75**
Oil/Water Separator	**0.00**	**0.75**	**0.00**	**0.75**
StormTech Isolator Row	**0.65**	**0.75**	**0.49**	**0.26**

Total TSS Removal = 74%

Project: **Hingham Gas**
Prepared By: **DR**
Date: **9/10/2020**

*Equals remaining load from previous BMP (E) which enters the BMP

INSTRUCTIONS:

Non-automated: Mar. 4, 2008

1. Sheet is nonautomated. Print sheet and complete using hand calculations. Column A and B: See MassDEP Structural BMP Table
2. The calculations must be completed using the Column Headings specified in Chart and Not the Excel Column Headings
3. To complete Chart Column D, multiple Column B value within Row x Column C value within Row
4. To complete Chart Column E value, subtract Column D value within Row from Column C within Row
5. Total TSS Removal = Sum All Values in Column D

Location: CB - Oil/Water Sep - Isolator Row - Recharge

TSS Removal Calculation Worksheet

A BMP[1]	B TSS Removal Rate[1]	C Starting TSS Load*	D Amount Removed (B*C)	E Remaining Load (C-D)
Catch Basin	**0.25**	**1.00**	**0.25**	**0.75**
Oil/Water Separator	**0.00**	**0.75**	**0.00**	**0.75**
StormTech Isolator Row and Recharge	**0.80**	**0.75**	**0.60**	**0.15**

Total TSS Removal = **85%**

Project: **Hingham Gas**

Prepared By: **DR**

Date: **9/10/2011**

*Equals remaining load from previous BMP (E) which enters the BMP

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

UNHSC Pollutant Removal Efficiencies

Treatment Unit Description	Reference	TSS Total Suspended Solids (% Removal)	TPH-D Total Petroleum Hydrocarbons in the Diesel Range (% Removal)	NO3-N (DIN) Dissolved Inorganic Nitrogen (% Removal)	TZn Total Zinc (% Removal)	TP Total Phosphorus (% Removal)	Average Annual Peak Flow Reduction (% Removal)	Average Annual Lag Time (Minutes)
Conventional Treatment Devices								
Retention Pond	UNH	68	82	33	68	NT	86	455
Stone (rip-rap) Swale	UNH	50	33	NT	64	–	6	7
Vegetated Swale	UNH	58	82	NT	88	NT	52	38
Berm Swale	UNH	50	81	NT	50	8	24	58
Deep Sump Catch Basin	UNH	9	14	NT	NT	NT	NT	NT
Manufactured Treatment Devices (MTDs)								
ADS Infiltration Unit	UNH	99	99	NT	99	81	87	228
StormTech	UNH	80	93	NT	56	49	76	274
Aquafilter	UNH	62	26	NT	52	59	NT	NT
Hydrodynamic Separators	UNH	27	1	NT	24	42	NT	NT
Low Impact Development (LID)								
Surface Sand Filter	UNH	51	98	NT	77	33	69	187
Bioretention								
Bio I - 48" depth	UNH	97	99	44	99	–	75	266
Bio II - 30" depth	UNH	87	99	NT	68	34	79	309
Gravel Wetland	UNH	99	99	98	99	56	87	251
Porous Asphalt	UNH	99	99	NT	75	60	82	1,275
Pervious Concrete	UNH	97	99	NT	99	NT	93	1,144
Tree Filter	UNH	93	99	3	78	NT	NT	62

Reference Published Pollutant Removal Efficiencies

Treatment Unit Description	Reference	TSS Total Suspended Solids (% Removal)	TPH-D Total Petroleum Hydrocarbons in the Diesel Range (% Removal)	NO3-N (DIN) Dissolved Inorganic Nitrogen (% Removal)	TZn Total Zinc (% Removal)	TP Total Phosphorus (% Removal)
Sub Surface Detention/Infiltration	EPA Fact Sheet: Infiltration Trenches	–	–	–	–	60
Sand Filter	EPA Fact Sheet: Sand Filters	70	–	NT	45	33
	Claytor & Schueler, 1996	85	–	–	71	50
	Bell, W., et al, 1995	61-70	–	–	>82	–
	Winer, R., 2000	87	–	NT	80	59
Retention Pond	EPA Fact Sheet: Wet Detention Ponds	50-90	–	–	40-50	30-90
	EPA Fact Sheet: Wet Detention Ponds	80-90	–	–	–	–
Bioretention	Winer, R., 2000	79	–	36	65	49
	EPA Fact Sheet: Bioretention	90	–	–	–	70-83
Bio - 12" depth	Winogradoff, 2001	–	–	-97	87	NT
Bio - 24" depth	Winogradoff, 2001	–	–	-194	98	73
Bio - 36" depth	Winogradoff, 2001	–	–	23	99	81
	EPA website	84	–	–	–	–
Hydrodynamic Separators	various	52-84	–	–	–	30
Gravel Wetland	Claytor & Schueler, 1996	80-93	–	75	55-90	80-89
	Winer, R., 2000	83	–	81	55	64
Vegetated Swale	EPA Fact Sheet: Vegetated Swales	81	–	38	71	9
	Claytor & Schueler, 1996	30-90	–	0-80	71	10-65
Porous Pavement	NAPA, undated	89-95	–	–	62-99	65-71
	EPA Fact Sheet: Porous Pavement	82-95	–	–	–	65
	Winer, R., 2000	95	–	–	99	65

StormTech Isolator Row

The StormTech Isolator Row is an effective filtration/infiltration system best suited to locations where space is at a premium and the system's relatively expensive installation cost can be offset by increasing available space for development.

About the StormTech Isolator Row

The StormTech Isolator Row is a manufactured system designed to provide subsurface water quality treatment and easy access for maintenance. It is typically used to remove pollution from runoff before it flows into unlined infiltration chambers designed for detention and water quantity control. The Isolator Row consists of a series of StormTech chambers installed over a layer of woven geotextile, which sits on a crushed stone infiltration bed surrounded with filter fabric. The bed is directly connected to an upstream manhole for maintenance access and large storm bypass. At UNHSC, the Isolator Row has met a TSS median annual removal standard of 80 percent, and exhibited an enhanced capacity to remove phosphorus. The Isolator Row is well suited for urban environments where space is at a premium.

Implementation

The StormTech Isolator Row is part of a class of manufactured, subsurface filtration/infiltration systems that are being used more and more throughout the United States. In general, these systems are best suited to locations where above ground space is at a premium. They are often used in urban areas, where they are located beneath parking lots and other infrastructure. As with any infiltration system, care must be taken when locating these systems near pollution hotspots, or where seasonal high groundwater levels may lead to groundwater contamination. In such cases, if installed, the systems should be lined to prevent infiltration into groundwater, and outfitted with subdrains that discharge to the surface. Designs for the StormTech Isolator Row are available from the manufacturer.

System Performance

Cost & Maintenance

While subsurface HDPE systems such as the Isolator Row tend to be more expensive than conventional stormwater treatments like retention ponds, the costs are ameliorated by the increase in available space for development. The cost to install a StormTech Isolator Row system large enough to treat runoff from one acre of impervious surface was $34,000 in 2006.

In more than two years of operation, the system is at less than 50 percent of its recommended maintenance trigger point. Maintenance should be conducted when the sediment in the chambers reaches approximately three inches in depth according to recommendations from the manufacturer. Sediment accumulation can be monitored through inspection ports. When maintenance is needed, the entire row can be

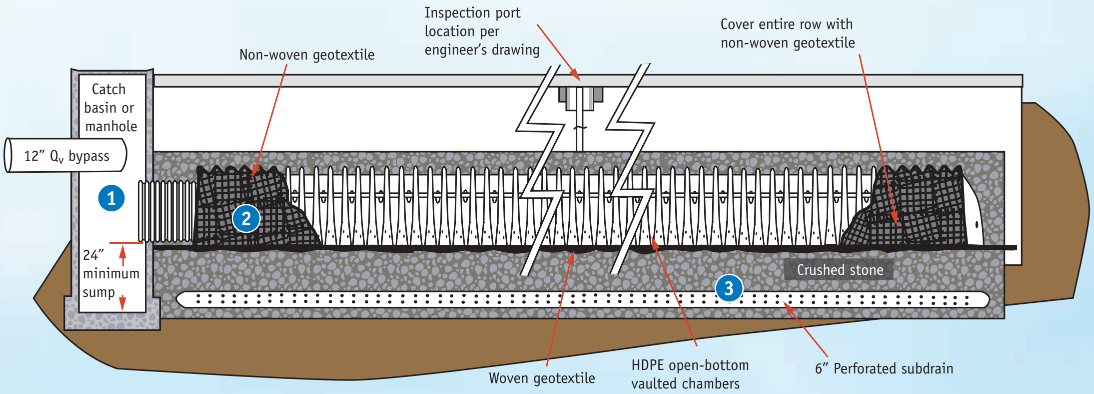
Fast Facts

CATEGORY / BMP TYPE Filtration, Infiltration, Manufactured Treatment Device **UNIT OPERATIONS & PROCESSES** Hydrologic (Flow Alteration)	Water Quality: Physical (Sedimentation, Filtration) & Chemical (Sorption) **DESIGN SOURCE** StormTech, LLC **BASIC DIMENSIONS** Chamber: 51″ wide X 30″ high X 85.4″ long	**SPECIFICATIONS** Catchment Area: 1 acre Water Quality Flow: 1 cfs Water Quality Volume: 3,300 cf **INSTALLATION COST** $34,000 per acre treated	**MAINTENANCE** Maintenance Sensitivity: Low Inspections: High Sediment Removal: Moderate

How the System Works

WATER QUALITY TREATMENT PROCESS ▼

1. **Runoff flows into the Isolator Row chambers from a catchbasin or pipe.**
2. **Runoff slowly passes from the chambers through a woven geotextile fabric and into the crushed stone reservoir below the system. The runoff passes through the fabric, leaving behind sediments and associated contaminants through the physical unit operations of filtration and sedimentation. As an organic filter cake develops over the fabric, phosphorus is also removed via the chemical process of sorption.**
3. **Filtered runoff collects in a perforated subdrain and returns to a storm drain system, infiltrates into the subgrade, or is discharged to the surface.**



washed clean through an access manhole and by a hydro-jet with sediment removed by vactoring (vacuuming). Entry into the system is considered a confined space entry and requires trained personnel and equipment.

During two years of evaluation at UNHSC, the Isolator Row has accumulated, at most, one and one half inches of sediment in its chambers. As a result, researchers have not performed maintenance on the system. The Isolator Row presents an interesting opportunity to study the relationship between maintenance and performance. Researchers have observed enhanced phosphorus removal as the system develops an organic filter cake between the chambers and the woven geotextile fabric that lies beneath them. This enhancement is tempered by the likelihood that, as the filter cake continues to grow, hydraulic efficiency will decline and more runoff will bypass the system untreated until maintenance is performed. Analyses are underway to develop maintenance recommendations that balance and optimize the water quality and water quantity management abilities of this system.

Cold Climate

This system's water quality treatment and volume control capacity remained strong in all seasons, reinforcing the conclusion that filtration and infiltration systems perform well, even in cold climates.

Water Quality Treatment

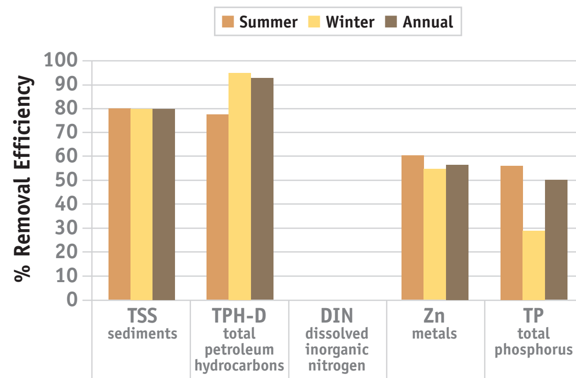
The StormTech Isolator Row system does a good job of reducing the concentration of common pollutants associated with stormwater performance assessment with the exception of nitrogen. It generally meets EPA's recommended level of removal for total suspended solids, and meets regional ambient water quality criteria for heavy metals and petroleum hydrocarbons. The system has a capacity to achieve modest levels of total phosphorus removal, which may be enhanced over time. (See Cost & Maintenance Section.) The lack of nitrogen treatment is typical for non-vegetated aerobic systems. Nutrient load reduction would be further increased through volume reduction by infiltration. Like all other systems monitored at UNHSC, it does not provide chloride removal.

The chart at top right reflects the system's performance in removing total suspended solids, total petroleum hydrocarbons, dissolved inorganic nitrogen, total phosphorus, and zinc. Values represent results recorded over a two-year monitoring period, with the data further divided into summer and winter components.

Water Quantity Control

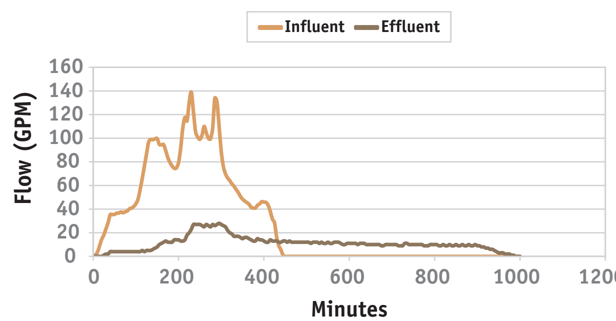
Like other infiltration and filtration systems, the StormTech Isolator Row system exhibits the capacity to reduce peak flows and could be used to reduce runoff volume in appropriate soils, such as those belonging to groups "A" or "B." The figure at bottom right provides information on peak flow reduction and lag times for the system.

POLLUTANT REMOVAL: 2006–2008



Median Annual Influent Event Mean Concentrations (EMC) in mg/L				
48	860 ug/L	.2	.04	.08

HYDRAULIC PERFORMANCE



	Winter	Summer	Annual Average
Average Peak Flow Reduction	71%	81%	76%
Average Lag Time (minutes)	358	190	274

SYSTEM DESIGN ▼

The StormTech Isolator Row is designed to provide subsurface water quality treatment for small storms. The manufacturer adapts the system's design in accordance with local watershed conditions and target treatment objectives.

Chamber units are made of high-density polyethylene (HDPE) pipe and are designed to bear loads consistent with those experienced by parking lots. The UNHSC chamber dimensions are 51 x 30 x 85.4 inches and can be linked together to form linear rows up to 200 feet long. The chambers are laid over woven geotextile, which rests on an infiltration base composed of one foot of three quarter inch crushed stone. The entire excavation is then wrapped in nonwoven geotextile to protect the system from the migration of fine particles from the surrounding soil.

A three- to five-foot separation from seasonal high groundwater table (as designated by regulations) is necessary to minimize the potential for groundwater contamination. Stormwater flows of up to one cubic foot per second (cfs) enter the system through an upstream manhole or other flow diverter. This is representative of flow-based sizing of a BMP common for devices that have limited detention or storage. Such devices are often better described by a maximum treatable flow rate as opposed to a treatment volume.

A bypass is incorporated in the StormTech system where flows exceeding the design rate are bypassed around the device and flow directly into adjacent chambers that can be sized to treat the CP_v and Q_p. Because of the bypass design, maintenance requirements are extremely important. A poorly maintained device would bypass prematurely into the unlined chamber systems and eventually clog subsurface soils resulting in system failure.

Section 4.3

Required Recharge Volume

RECHARGE

The *Required Recharge Volume* is calculated using the equation in the 2008 Massachusetts Stormwater Handbook. The *Required Recharge Volume* equals a depth of runoff corresponding to the soil type multiplied by the new impervious areas covering that soil type at the post-development site. The *Required Recharge Volume* is based on the *Static* method.

The project is a mix of new and redevelopment and subject to the Recharge Standard to the extent practicable.

Soils on the site consist soils from hydrologic soil groups (HSG) "A" through "D" based on the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS), Soil Survey of Plymouth County. Soils within the property are classified as: Urban Land towards Whiting Street, Hinckley gravely sandy loam and Newfields fine sandy loam within the interior of the parcel, and Scarboro muck within the wetland areas.

Test pits and site visits indicate permeable soils located on the south and east side of the 27 Whiting St. parcel with less permeable soils to the west and north towards the wetland resource area. HSG "A" was utilized for the area as indicated on the Hydrology Plans and HSG "C" was utilized for all other areas on the site. Refer to the watershed plans in Section 3.3 of this report for more information.

The project has been designed to integrate recharge BMP's consisting of a StormTech subsurface chamber systems with stone beds receive stormwater runoff collected through the use of a catch basin and roof drains. The following equation can be used to determine the Required Recharge Volume.

Rv = F x increase in impervious area (Equation 1) Volume 3, Ch 1, page 15

Rv = *Required Recharge Volume*, expressed in cubic feet, cubic yards, or acre-feet
F = Target Depth Factor associated with each Hydrologic Soil Group (HSG)
Impervious Area = new pavement and new rooftop area

***F* for A soils = 0.60 inches** (Table 2.3.2) Volume 3, Ch 1, page 16
F for B soils = 0.35 inches
F for C soils = 0.25 inches
F for D soils = 0.10 inches

Using the formula above, the following table shows the site's proposed impervious surface area (does not include off-site impervious) and the calculated *Required Recharge Volume*.

Existing Impervious	= 15,645 sq. ft.	= 0.359 ac.
Proposed Impervious	= 24,296 sq. ft	= 0.558 ac
Net New Impervious On-Site	= 8,651 sq. ft.	= 0.199 ac.

Required Recharge Volume

Rv_1 = (*F_A x increase in impervious area*) $_{HSGB}$

Rv_1 = 0.6 in x (0.199 ac) x 1 ft/12 in

Rv_1 = 0.00993 ac-ft or 432.6 cu. ft.

Impervious Areas Tributary to Systems

UG-1 = 16,024 sq. ft. = 0.367 ac.

UG-2 = 4,223 sq. ft. = 0.097 ac.

The amount of impervious area proposed to be collected and directed towards the recharge systems is greater than the total new impervious proposed on the site. Thus, the project does not require an additional capture area adjustment.

Storage volume in UG-1 and UG-2 for Recharge in the stone below chamber elevations and two feet above the estimated seasonal high groundwater elevations determined from the test pits.

Storage in UG-1 Field A =

Chamber bottom elevation is 136.4, Bottom of Stone = 135.9 (6" depth), Estimated Season high is 133.8 (TP2), Area of Stone 2' above 133.8 = 1,487 sq. ft.

0.5 ft. x 1,487 sq. ft. x 0.35 = 260.2 cu. ft.

Storage in UG-1 Field B =

Chamber bottom elevation is 135.2, Bottom of Stone = 134.7 (6" depth), Estimated Season high is estimate at 132.6 (131.4 TP5 and 133.6 TP6), Area of Stone 2' above 132.6 = 1,181 sq. ft.

0.5 ft. x 1,181 sq. ft. x 0.35 = 206.7 cu. ft.

Total = 260.2 cu. ft. + 206.7 cu. ft. = 466.9 cu. ft. or 0.0107 ac-ft

Conclusion:

Hence, the storage available in stone below UG-1 and UG-2 is greater than the Required Recharge Volume:

466.9 cu. ft. > 432.6 cu. ft.

The recharge volume provided by the proposed subsurface chamber systems exceeds the Required Recharge Volume for the net impervious proposed on the site. The project's stormwater management system satisfies Standard 3 of the MassDEP Stormwater Regulations.

Section 4.4

Drawdown Time Calculations

DRAWDOWN TIME

Below are the drawdown time calculations for the recharge systems proposed on the site. The calculation uses an estimated hydraulic conductivity value "*K*." Soils on the site consist soils from hydrologic soil groups (HSG) "A" through "D" based on the U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS), Soil Survey of Plymouth County. Soils within the property are classified as: Urban Land towards Whiting Street, Hinckley gravely sandy loam and Newfields fine sandy loam within the interior of the parcel, and Scarboro muck within the wetland areas. Test pits and site visits indicate permeable soils located on the south and east side of the 27 Whiting St. parcel with less permeable soils to the west and north towards the wetland resource area.

A reasonable value of a conservative hydraulic conductivity "K" of <u>2.41 inches per hour which corresponds to HSG "A" loamy sand and 0.27 inches per hour which corresponds to HSG "C" silt loam</u> was selected for the basis of design.

The formula below is the recommended method of calculating drawdown times from the Massachusetts Stormwater Management Handbook

DRAWDOWN TIME CALCULATION

$$Time_{drawdown} = \frac{Rv}{(K)(Bottom\ Area)}$$

Where:
Rv = Storage Volume
K = Saturated Hydraulic Conductivity, Rawls Rate
Bottom Area = Bottom Area of Recharge Structure

See the following Drawdown Calculation table for infiltration rates, bottom area, and drawdown times.

Drawdown Calculation

Recharge BMP	Infiltration Rate (in/hr) k	Storage Volume (c.f.) Rv	Bottom Area (s.f.)	Draw Down Time (hrs.)
UG-1	2.41	260.2	1,487	0.9
UG-2	0.27	206.7	1,181	7.8

<u>Conclusion:</u>

The calculations show that the drawdown times for the infiltration BMPs is less than 72 hours, as required.

Section 4.5

Rip-Rap Calculations

RIP RAP SPLASH PAD

Rip rap splash pads are designed to dissipate energy, prevent scour at the stormwater outlet, and minimize the potential for downstream erosion. A riprap splash pad was sized for each of the outlets of the drainage system. Below is presented the evaluation of the riprap splash pads to prevent scour as required by the Standard 1 of Stormwater Management Checklist. The calculations below are in accordance with the methodology of the "2002 Connecticut Guidelines for Soil Erosion and Sediment Control" produced by The Connecticut Council on Soil and Water Conservation.

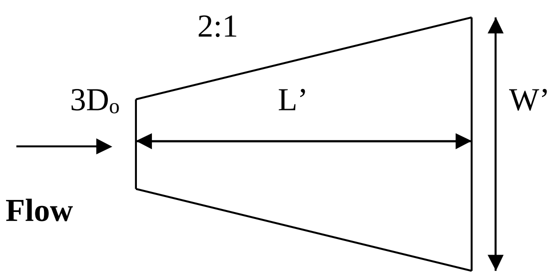
Apron Length

$L_a = 1.7Q/(D_o^{3/2}) + 8 D_o$ L_a = Length of Apron.

D_o= Maximum inside culvert width.

Apron Width

$W = 3D_o + L_a$



Stone Diameter

$d_{50} = 0.02/TW * (Q/ D_o)^{4/3}$ d_{50} = median diameter size of rip-rap stone (inches)

TW = tail water, assumed to be 0.3

Outlet	Pipe Diameter (feet)	Q Flow (cfs)* 100-yr	La (Length of Apron - feet)	W (Width of Apron – feet)	d_{50} (inches)
FES1	1.0	3.52	14.1'	17.1'	4.32"**

*This is the actual 100-year flow as calculated through basin design software (HydroCAD) if flow was unimpeded by the underground system

**A minimum rip-rap size of 4" should be utilized

Preformed Scour Hole Calculation Results

	Q*	Do	TW*	Depression (F)	C	3Sp	B	2Sp	d50***	
	(cfs)	(ft.)	(ft.)	(ft.)	(ft.)	(ft.)	(ft.)	(ft.)	(ft.)	(in.)
FES1	3.52	1.0	0.30	0.50	6.0	3.0	5.0	2.0	0.22	2.69

*This is the actual 100-year flow as calculated through basin design software (HydroCAD) if flow was unimpeded by the underground system
**A conservative tail-water of 0.30 was utilized.
***A minimum rip-rap size of 6" should be utilized for FES1

Conclusion:

As shown in the first table above, the proposed flows from the 100-year storm event result in a rip-rap apron which are adequately sized to dissipate the runoff discharge energy without causing scour but are extremely long and would cause more disruption and/or be difficult to construct.

To reduce the amount of rip-rap as well as provide enhanced scour protection, we are proposing a different mechanism of slowing the water as we feel additional slowing of the water over the calculated rip-rap pads would be beneficial. The detail provided is a combination of a Plunge Pool/ Energy Dissipater. The detail uses a plunge pool to dissipate the energy and level spreader to disperse the water to prevent erosion. The calculations for the flared end and outlet presented above are for a preformed scour hole. The calculations were performed in accordance with the ConnDOT Drainage Manual. As the system is multi-faceted (plunge pool, rip-rap, and level spreader), we feel it is more than adequately designed to prevent scour at the outlets.

In order to ensure that the rip rap / level spreader systems are working, the outlets should be inspected after the first large storm 10+ year event to inspect for erosion. If no erosion is evident, then the stone size is adequate. We recommend that the aprons be inspected and cleaned annually as part of the outlet maintenance to ensure future adequacy.

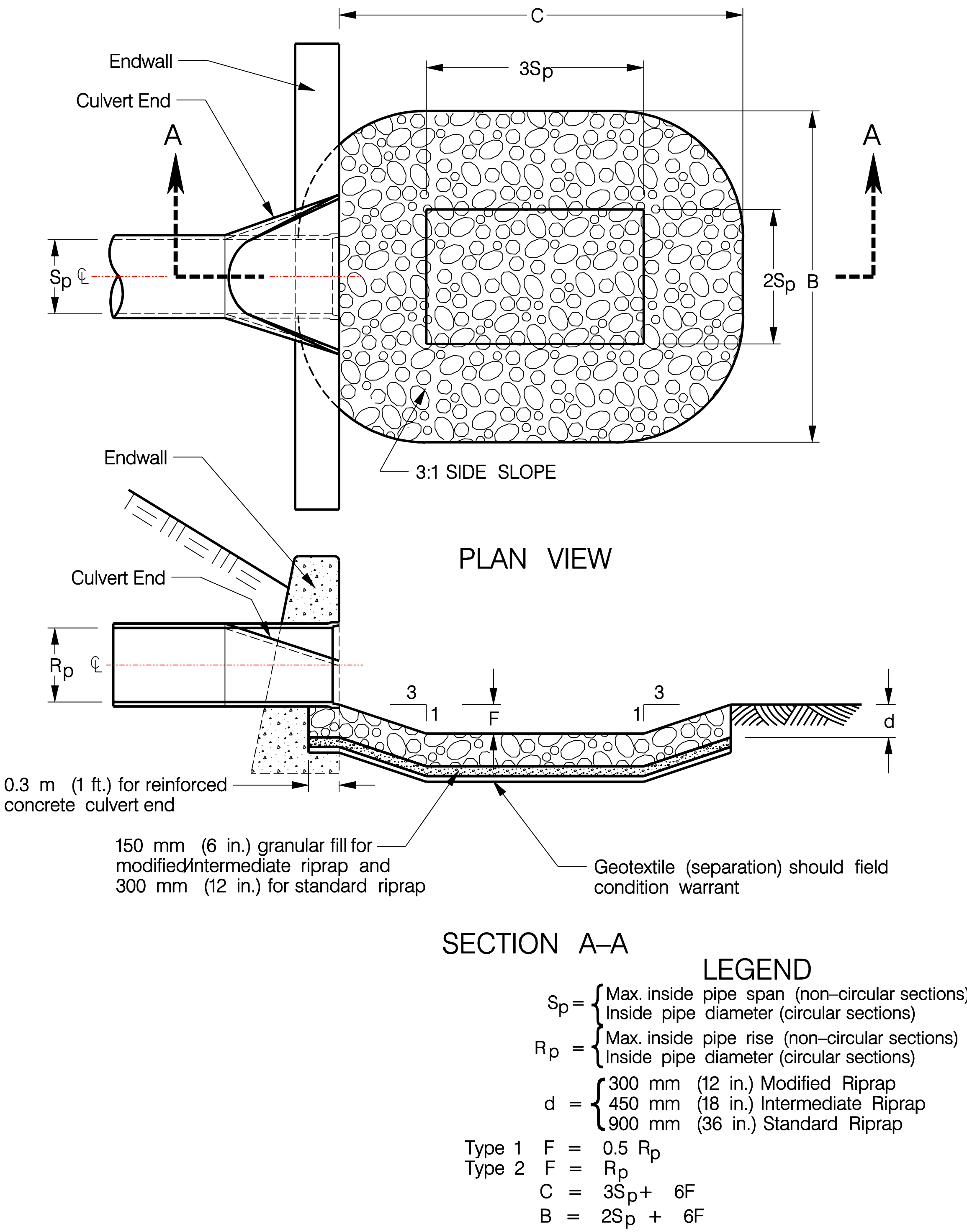


Figure 11-15 Preformed Scour Hole Type 1 and Type 2

Section 4.6

Illicit Discharge Statement

ILLICIT DISCHARGE COMPLIANCE STATEMENT

Standard 10: Massachusetts Stormwater Standards Handbook

Illicit discharges are defined as discharges into waters of the State or municipal separate stormwater system (MS4) that are not entirely comprised of stormwater. Exclusions for non-stormwater discharges into drainage systems include activities or facilities for firefighting, water line flushing, landscape irrigation, uncontaminated groundwater discharge, potable water sources, foundation drains, air conditioning condensation, footing drains, individual resident car washing, water used to clean residential buildings without detergents, water used for street washing, and flows from riparian habitats/wetlands. These exclusions are subject to change and are under the discretion of the local governing authority.

To the best of our knowledge and professional belief no illicit discharges to the stormwater system, surface waters, or wetland resource areas will remain on the site after construction. We will agree to implement a pollution prevention plan to prevent illicit discharges into the stormwater management system. The design of the site based on the plans prepared by CHA, 141 Longwater Drive, Suite104, Norwell, Massachusetts show a separation and no direct connection between the stormwater management systems and the wastewater and/or groundwater on the site. To the maximum extent practicable, the design prevents entry of illicit discharges into the stormwater management system.

Engineer's Name: Kelly Killeen, P.E.
(please print)

Engineer's Signature: ____________________________

Company: CHA Consulting, Inc.

Section 5.0

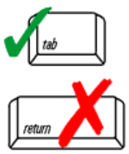
Stormwater Checklist

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

COMMONWEALTH OF MASSACHUSETTS
KELLY KILLEEN
CIVIL
No. 38991
REGISTERED PROFESSIONAL ENGINEER

9.10.20

Kelly Killeen, P.E.
CHA Consulting, Inc.
141 Longwater Drive, Suite 104
Norwell, MA 02061
(781) 982-5400

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): ______________________________

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 (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 (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 (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.

Appendix A

Soils

United States Department of Agriculture

NRCS

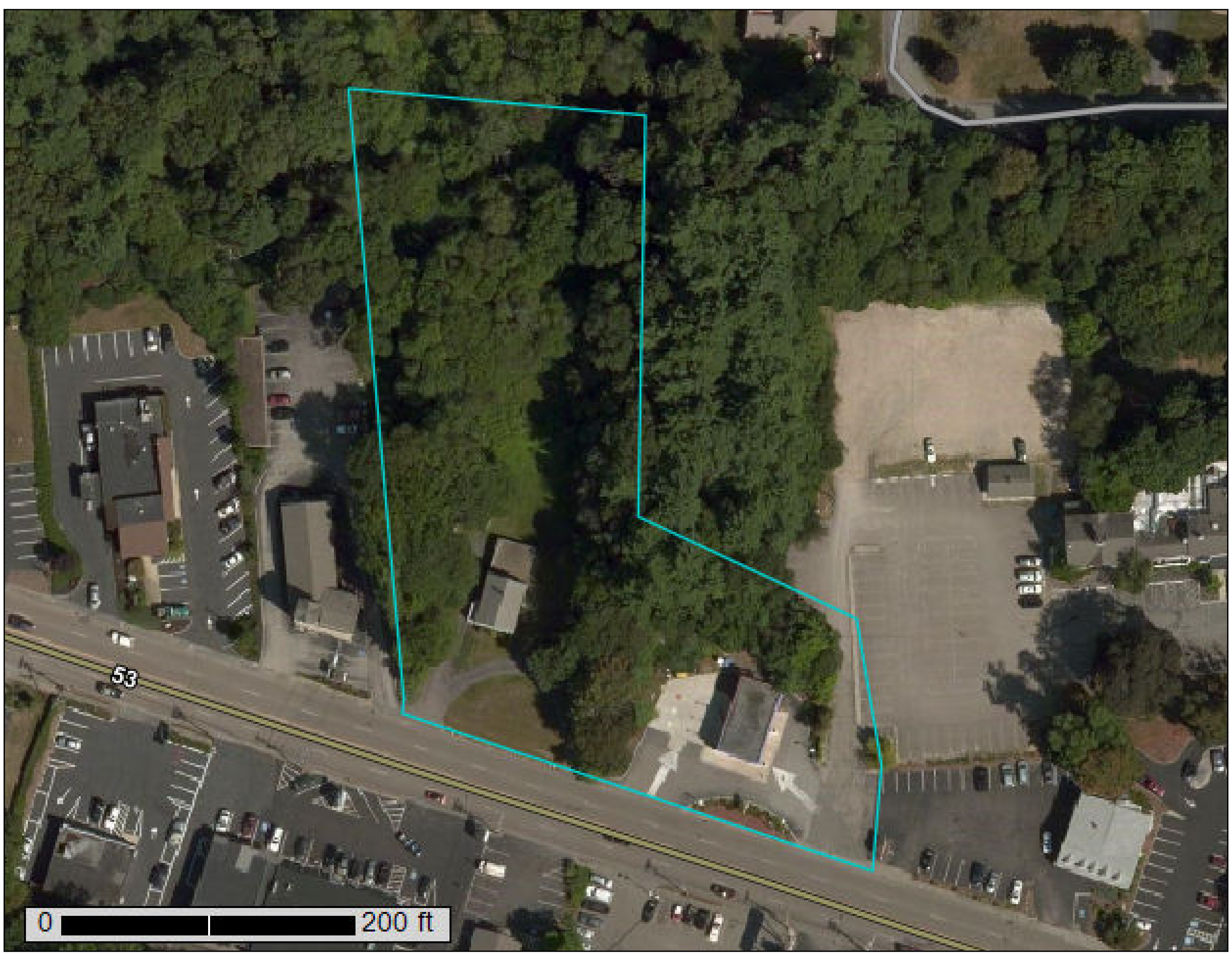
Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Plymouth County, Massachusetts

27 Whiting Street



February 26, 2020

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require alternative means for communication of program information (Braille, large print, audiotape, etc.) should contact USDA's TARGET Center at (202) 720-2600 (voice and TDD). To file a complaint of discrimination, write to USDA, Director, Office of Civil Rights, 1400 Independence Avenue, S.W., Washington, D.C. 20250-9410 or call (800) 795-3272 (voice) or (202) 720-6382 (TDD). USDA is an equal opportunity provider and employer.

Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

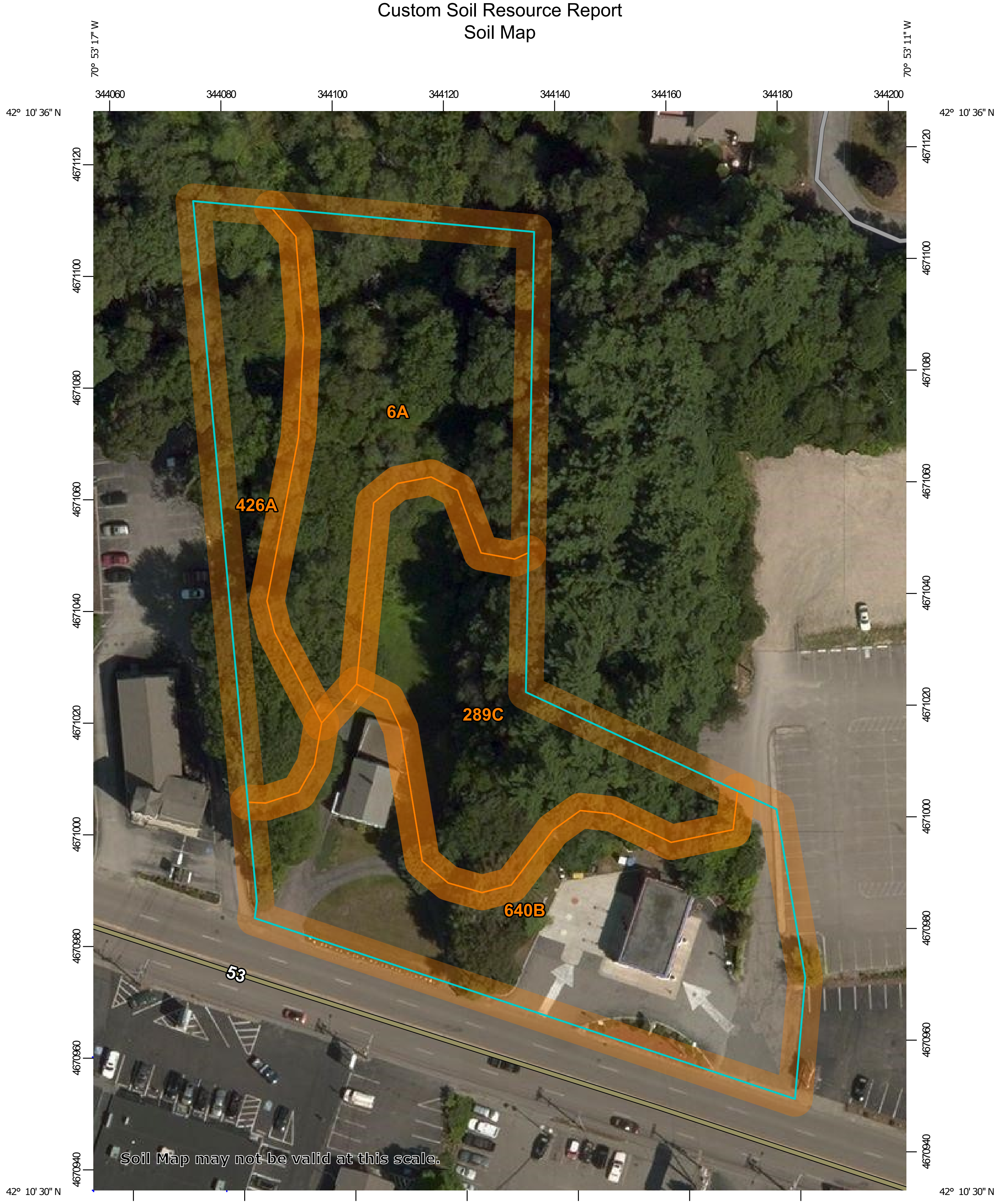
Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map



Map Scale: 1:942 if printed on A portrait (8.5" x 11") sheet.

Meters: 0, 10, 20, 40, 60

Feet: 0, 45, 90, 180, 270

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

MAP LEGEND

Area of Interest (AOI)

Area of Interest (AOI)

Soils

Soil Map Unit Polygons

Soil Map Unit Lines

Soil Map Unit Points

Special Point Features

Blowout

Borrow Pit

Clay Spot

Closed Depression

Gravel Pit

Gravelly Spot

Landfill

Lava Flow

Marsh or swamp

Mine or Quarry

Miscellaneous Water

Perennial Water

Rock Outcrop

Saline Spot

Sandy Spot

Severely Eroded Spot

Sinkhole

Slide or Slip

Sodic Spot

Spoil Area

Stony Spot

Very Stony Spot

Wet Spot

Other

Special Line Features

Water Features

Streams and Canals

Transportation

Rails

Interstate Highways

US Routes

Major Roads

Local Roads

Background

Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

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

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

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Plymouth County, Massachusetts
Survey Area Data: Version 12, Sep 12, 2019

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

Date(s) aerial images were photographed: Aug 26, 2014—Sep 4, 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.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
6A	Scarboro muck, coastal lowland, 0 to 3 percent slopes	0.7	27.7%
289C	Hinckley gravelly sandy loam, 8 to 15 percent slopes, bouldery	0.6	23.0%
426A	Newfields fine sandy loam, 0 to 3 percent slopes	0.3	14.4%
640B	Urban land, till substratum, 0 to 8 percent slopes	0.9	35.0%
Totals for Area of Interest		**2.4**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Plymouth County, Massachusetts

6A—Scarboro muck, coastal lowland, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: 2svkw
Elevation: 0 to 650 feet
Mean annual precipitation: 36 to 71 inches
Mean annual air temperature: 39 to 55 degrees F
Frost-free period: 140 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Scarboro, coastal lowland, and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Scarboro, Coastal Lowland

Setting

Landform: Outwash deltas, depressions, drainageways, outwash terraces
Landform position (two-dimensional): Toeslope
Landform position (three-dimensional): Base slope, tread, dip
Down-slope shape: Concave
Across-slope shape: Concave, linear
Parent material: Sandy glaciofluvial deposits derived from schist and/or gneiss and/or granite

Typical profile

Oa - 0 to 8 inches: muck
A - 8 to 14 inches: mucky fine sandy loam
Cg1 - 14 to 22 inches: sand
Cg2 - 22 to 65 inches: gravelly sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Very poorly drained
Runoff class: Negligible
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (1.42 to 14.17 in/hr)
Depth to water table: About 0 to 2 inches
Frequency of flooding: None
Frequency of ponding: Frequent
Salinity, maximum in profile: Nonsaline (0.0 to 1.9 mmhos/cm)
Available water storage in profile: Moderate (about 6.1 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 5w
Hydrologic Soil Group: A/D
Hydric soil rating: Yes

Minor Components

Swansea

Percent of map unit: 10 percent
Landform: Bogs, swamps
Landform position (three-dimensional): Dip
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Mashpee

Percent of map unit: 5 percent
Landform: Depressions, drainageways, terraces
Landform position (two-dimensional): Footslope, toeslope
Landform position (three-dimensional): Tread
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

289C—Hinckley gravelly sandy loam, 8 to 15 percent slopes, bouldery

Map Unit Setting

National map unit symbol: bd1l
Elevation: 0 to 400 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: Not prime farmland

Map Unit Composition

Hinckley, bouldery, and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Hinckley, Bouldery

Setting

Landform: Terraces, outwash deltas, kames, eskers
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Sandy and gravelly glaciofluvial deposits

Typical profile

Oe - 0 to 2 inches: moderately decomposed plant material
A - 2 to 3 inches: gravelly sandy loam
Bw - 3 to 19 inches: very gravelly loamy coarse sand
C1 - 19 to 33 inches: very gravelly coarse sand
C2 - 33 to 60 inches: very gravelly coarse sand

Properties and qualities

Slope: 8 to 15 percent
Percent of area covered with surface fragments: 0.1 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Excessively drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to very high (1.42 to 28.34 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Very low (about 1.9 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Merrimac

Percent of map unit: 10 percent
Landform: Terraces, outwash plains, kames
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Riser
Down-slope shape: Linear
Across-slope shape: Convex
Hydric soil rating: No

Gloucester, bouldery

Percent of map unit: 7 percent
Landform: Ground moraines, hills
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Barnstable, bouldery

Percent of map unit: 3 percent
Landform: Moraines
Landform position (two-dimensional): Summit, shoulder
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

426A—Newfields fine sandy loam, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: bcxx
Elevation: 10 to 400 feet
Mean annual precipitation: 41 to 54 inches
Mean annual air temperature: 43 to 54 degrees F
Frost-free period: 145 to 240 days
Farmland classification: All areas are prime farmland

Map Unit Composition

Newfields and similar soils: 80 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Newfields

Setting

Landform: Till plains, moraines, hills
Landform position (two-dimensional): Footslope, summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Coarse-loamy eolian deposits over sandy and gravelly supraglacial meltout till

Typical profile

Oe - 0 to 2 inches: moderately decomposed plant material
A - 2 to 3 inches: fine sandy loam
Bs - 3 to 4 inches: fine sandy loam
Bw1 - 4 to 16 inches: fine sandy loam
Bw2 - 16 to 28 inches: gravelly fine sandy loam
2C - 28 to 63 inches: gravelly loamy coarse sand

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: 15 to 36 inches to strongly contrasting textural stratification
Natural drainage class: Moderately well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 5.95 in/hr)
Depth to water table: About 18 to 30 inches
Frequency of flooding: None
Frequency of ponding: None
Available water storage in profile: Low (about 3.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 2w

Hydrologic Soil Group: B
Hydric soil rating: No

Minor Components

Barnstable

Percent of map unit: 8 percent
Landform: Moraines
Landform position (two-dimensional): Summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Convex
Across-slope shape: Convex
Hydric soil rating: No

Norwell

Percent of map unit: 7 percent
Landform: Depressions, drainageways
Landform position (two-dimensional): Toeslope, footslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Scituate

Percent of map unit: 5 percent
Landform: Ridges, drumlins
Landform position (two-dimensional): Footslope, summit
Landform position (three-dimensional): Interfluve
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: No

640B—Urban land, till substratum, 0 to 8 percent slopes

Map Unit Composition

Urban land, till substratum: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

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Commonwealth of Massachusetts
City/Town of Hingham

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

A. Facility Information

Merhej And Sons Realty LLC
Owner Name

87 Derby Street — Street Address
204-0-9 — Map/Lot #

Hingham — City
MA — State
02043 — Zip Code

B. Site Information

1. (Check one) ☒ New Construction ☐ Upgrade ☐ Repair

2. Soil Survey Available? ☒ Yes ☐ No If yes: USGS and UCDavis — 640B (Soil Map Unit)

   Urban land, till substratum — Soil Name
   Excessively Drained — Soil Limitations

   Urban land, till substratum — Soil Parent material
   Landform: ____

3. Surficial Geological Report Available? ☒ Yes ☐ No If yes: 2018/ USGS — Year Published/Source; Map Unit: ____

   Coarse-Glacial Stratified Deposits
   Description of Geologic Map Unit:

4. Flood Rate Insurance Map Within a regulatory floodway? ☐ Yes ☒ No

5. Within a velocity zone? ☐ Yes ☒ No

6. Within a Mapped Wetland Area? ☐ Yes ☒ No If yes, MassGIS Wetland Data Layer: ____ Wetland Type

7. Current Water Resource Conditions (USGS): 02/21/2020 (Month/Day/ Year) Range: ☐ Above Normal ☒ Normal ☐ Below Normal

8. Other references reviewed: MassGIS Oliver

Commonwealth of Massachusetts
City/Town of Hingham

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review *(minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-1 (Hole #) | 03/06/2020 (Date) | 9:15 am (Time) | 30/47 Sunny (Weather) | 42.175 N (Latitude) | -70.887 W (Longitude:)

1. Land Use: Single-Family (e.g., woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | ____ (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 2% (Slope (%))

   Description of Location: Near Garage Building

2. Soil Parent Material: Glacial Stratified Deposits | Kame Terrace (Landform) | SH (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >20 feet | Wetlands >100 feet

   Property Line 40 feet | Drinking Water Well ____feet | Other ______ feet

4. Unsuitable Materials Present: ☒ Yes ☐ No If Yes: ☐ Disturbed Soil ☒ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 102-inch Depth Weeping from Pit ______ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-20	Fill										
20-120	C	Loamy Sand	10YR5/4	96	7.5yr5/8 2.5y4/3	20%	25%	10%	Massive	Very Friable	

Additional Notes:
Weeping at 102 inches.

Commonwealth of Massachusetts
City/Town of Hingham

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review *(minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-2 (Hole #) | 03/06/2020 (Date) | 10:00 am (Time) | 30/47 Sunny (Weather) | 42.175 N (Latitude) | -70.887 W (Longitude:)

1. Land Use: Single-Family (e.g., woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | ______ Surface Stones (e.g., cobbles, stones, boulders, etc.) | 2% Slope (%)

   Description of Location: Near Garage Building

2. Soil Parent Material: Glacial Stratified Deposits | Delta (Landform) | SH Position on Landscape (SU, SH, BS, FS, TS)

3. Distances from: Open Water Body >100 feet | Drainage Way >20 feet | Wetlands >100 feet
   Property Line >10 feet | Drinking Water Well ______ feet | Other ______ feet

4. Unsuitable Materials Present: ☒ Yes ☐ No If Yes: ☐ Disturbed Soil ☒ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 91-inch Depth Weeping from Pit ______ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-16	Fill										
16-114	C	Sand	10YR5/4	77	7.5yr5/8 2.5y4/3	20%	25%	10%	Massive	Friable	

Additional Notes:
Weeping at 91-inches.

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-3 (Hole #) 03/06/2020 (Date) 11:00 am (Time) 30/47 Sunny (Weather) 42.175 N (Latitude) -70.887 W (Longitude:)

1. Land Use Single-Family (e.g., woodland, agricultural field, vacant lot, etc.) Grass (Vegetation) ______ Surface Stones (e.g., cobbles, stones, boulders, etc.) 3% Slope (%)

   Description of Location: ______

2. Soil Parent Material: Glacial Stratified Deposits Kame Terrace (Landform) SH (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet Drainage Way >20 feet Wetlands >100 feet

   Property Line >10 feet Drinking Water Well >200 feet Other ______ feet

4. Unsuitable Materials Present: ☒ Yes ☐ No If Yes: ☐ Disturbed Soil ☒ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 91 Depth Weeping from Pit ______ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-57	Fill										Fill depth reduces to 36" deep away from the road
57-108	C	Loamy Sand	10YR5/4	67	7.5yr5/8 2.5y4/3	60%			Massive	Friable	

Additional Notes:
Weeping at 91 inches

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-4 (Hole #) | 03/06/2020 (Date) | 11:50 am (Time) | 30/47 Sunny (Weather) | 42.175 N (Latitude) | -70.887 W (Longitude:)

1. Land Use: Single-Family (e.g., woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | ______ (Surface Stones (e.g., cobbles, stones, boulders, etc.)) | 3% (Slope (%))

   Description of Location: ______

2. Soil Parent Material: Glacial Stratified Deposits | Kame Terrace (Landform) | SH (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >20 feet | Wetlands >100 feet
   Property Line >10 feet | Drinking Water Well >200 feet | Other ______ feet

4. Unsuitable Materials Present: ☒ Yes ☐ No If Yes: ☐ Disturbed Soil ☒ Fill Material ☐ Weathered/Fractured Rock ☒ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: ______ Depth Weeping from Pit ______ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-10	Fill										
10-83	C1	Sand	10YR5/4				25%	10%	Single Grain	Loose	
83-108	C2	Sandy Loam	10YR5/6	83	7.5yr5/8 2.5y4/3	20%	5%		Massive	Friable	

Additional Notes:
Caving Soil.

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-5 (Hole #) | 03/06/2020 (Date) | 10:30 am (Time) | 30/47 Sunny (Weather) | 42.175 N (Latitude) | -70.887 W (Longitude:)

1. Land Use: Single-Family (e.g., woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | ______ Surface Stones (e.g., cobbles, stones, boulders, etc.) | 3% Slope (%)

   Description of Location: ______

2. Soil Parent Material: Glacial Stratified Deposits | Kame Terrace (Landform) | SH (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >20 feet | Wetlands >100 feet
   Property Line >10 feet | Drinking Water Well >200 feet | Other ______ feet

4. Unsuitable Materials Present: ☒ Yes ☐ No If Yes: ☐ Disturbed Soil ☒ Fill Material ☐ Weathered/Fractured Rock ☒ Bedrock

5. Groundwater Observed: ☒ Yes ☐ No If yes: 53 Depth Weeping from Pit ______ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-26	Fill										
26-38	A	Sandy Loam	10YR3/2						Massive	Friable	
38-84	C	Sandy Loam	2.5Y6/2	38	7.5yr5/8 2.5y4/3	25%		15%	Massive	Friable	Gleyed Wetland Soils not suitable for infiltration

Additional Notes:
Weeping at 53 inches. Caving Soil.

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-6 (Hole #) | 03/06/2020 (Date) | 10:30 am (Time) | 30/47 Sunny (Weather) | 42.175 N (Latitude) | -70.887 W (Longitude:)

1. Land Use: Single-Family (e.g., woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | ______ Surface Stones (e.g., cobbles, stones, boulders, etc.) | 3% Slope (%)

   Description of Location: ______

2. Soil Parent Material: Glacial Stratified Deposits | Kame Terrace (Landform) | SH (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >20 feet | Wetlands >100 feet

   Property Line >10 feet | Drinking Water Well >200 feet | Other ______ feet

4. Unsuitable Materials Present: ☒ Yes ☐ No If Yes: ☐ Disturbed Soil ☒ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: ______ Depth Weeping from Pit ______ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-10	Fill										
10-120	C	Loamy Sand	10YR5/4	60	7.5yr5/8 2.5y4/3	many			Massive	Friable	

Additional Notes:
Caving Solis.

Commonwealth of Massachusetts
City/Town of Hingham

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

D. Determination of High Groundwater Elevation

1. Method Used: Obs. Hole # Obs. Hole #

	Obs. Hole #	Obs. Hole #
☐ Depth observed standing water in observation hole	_____ inches	_____ inches
☒ Depth weeping from side of observation hole	_____ inches	_____ inches
☒ Depth to soil redoximorphic features (mottles)	__ inches	inches
☐ Depth to adjusted seasonal high groundwater (S_h) (USGS methodology)	_____ inches	_____ inches

______________________ Index Well Number ______________________ Reading Date

$S_h = S_c - [S_r \times (OW_c - OW_{max})/OW_r]$

Obs. Hole/Well# _____ S_c _____ S_r _____ OW_c _____ OW_{max} _____ OW_r _____ S_h _____

2. Estimated Depth to High Groundwater:

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system?

☒ Yes ☐ No

b. If yes, at what depth was it observed (exclude A and O Horizons)? Upper boundary: inches Lower boundary: ______ inches

c. If no, at what depth was impervious material observed? Upper boundary: ______ inches Lower boundary: ______ inches

Commonwealth of Massachusetts
City/Town of Hingham

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

F. Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

[signature]
Signature of Soil Evaluator

03/20/2020
Date

Hazem Dani/ #13902
Typed or Printed Name of Soil Evaluator / License #

6/30/2022
Expiration Date of License

Chessia Consulting Services, LLC
Name of Approving Authority Witness

Hingham Board of Health
Approving Authority

Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Field Diagrams: Use this area for field diagrams:

Commonwealth of Massachusetts
City/Town of Hingham
Percolation Test
Form 12

Percolation test results must be submitted with the Soil Suitability Assessment for On-site Sewage Disposal. DEP has provided this form for use by local Boards of Health. Other forms may be used, but the information must be substantially the same as that provided here. Before using this form, check with the local Board of Health to determine the form they use.

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

A. Site Information

Merhej And Sons Realty LLC
Owner Name

87 Derby Street
Street Address or Lot #

City/Town	State	Zip Code
Hingham	MA	02043

Contact Person (if different from Owner): ______

Telephone Number: ______

B. Test Results

	Date	Time	Date	Time
	03/06/2020	9:12 am	03/06/2020	9:52 am
Observation Hole #	TP-1		TP-2	
Depth of Perc	24"-42"		26"-44"	
Start Pre-Soak	9:12 am		9:52 am	
End Pre-Soak	9:27 am		10:07 am	
Time at 12”	9:27 am		24 Gallon in less than 15 minutes	
Time at 9”	9:30 am			
Time at 6”	9:35			
Time (9”-6”)	5 minutes			
Rate (Min./Inch)	< 2 minutes/ inch		< 2 minutes/ inch	
	Test Passed: ☒ Test Failed: ☐		Test Passed: ☒ Test Failed: ☐	

Hazem Dani
Test Performed By:

John Chessia
Board of Health Witness

Comments:

Commonwealth of Massachusetts
City/Town of Hingham

Percolation Test

Form 12

Percolation test results must be submitted with the Soil Suitability Assessment for On-site Sewage Disposal. DEP has provided this form for use by local Boards of Health. Other forms may be used, but the information must be substantially the same as that provided here. Before using this form, check with the local Board of Health to determine the form they use.

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A. Site Information

Merhej And Sons Realty LLC
Owner Name

87 Derby Street
Street Address or Lot #

City/Town	State	Zip Code
Hingham	MA	02043

Contact Person (if different from Owner)	Telephone Number

B. Test Results

	Date	Time	Date	Time
	03/06/2020	9:12 am	03/06/2020	12:53 am
Observation Hole #	TP-3		TP-4	
Depth of Perc	36"-54"		21"-39"	
Start Pre-Soak	11:15 am		12:42 am	
End Pre-Soak	11:30 am		12:51 am	
Time at 12”	11:30 am		24 Gallon in less than 15 minutes	
Time at 9”	11:36 am			
Time at 6”	11:42			
Time (9”-6”)	6 minutes			
Rate (Min./Inch)	2 minutes/ inch		< 2 minutes/ inch	
	Test Passed: ☒		Test Passed: ☒	
	Test Failed: ☐		Test Failed: ☐	

Hazem Dani
Test Performed By:

John Chessia
Board of Health Witness

Comments:

Commonwealth of Massachusetts
City/Town of Hingham

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

A. Facility Information

Merhej And Sons Realty LLC
Owner Name

87 Derby Street — Street Address
204-0-9 — Map/Lot #

Hingham — City
MA — State
02043 — Zip Code

B. Site Information

1. (Check one) ☒ New Construction ☐ Upgrade ☐ Repair
2. Soil Survey Available? ☒ Yes ☐ No If yes: USGS and UCDavis — 640B (Soil Map Unit)

   Urban land, till substratum — Soil Name
   Excessively Drained — Soil Limitations

   Urban land, till substratum — Soil Parent material
   Landform:
3. Surficial Geological Report Available? ☒ Yes ☐ No If yes: 2018/ USGS — Year Published/Source
   Map Unit:

   Coarse-Glacial Stratified Deposits — Description of Geologic Map Unit:
4. Flood Rate Insurance Map Within a regulatory floodway? ☐ Yes ☒ No
5. Within a velocity zone? ☐ Yes ☒ No
6. Within a Mapped Wetland Area? ☐ Yes ☒ No If yes, MassGIS Wetland Data Layer: Wetland Type
7. Current Water Resource Conditions (USGS): 02/21/2020 (Month/Day/ Year) Range: ☐ Above Normal ☒ Normal ☐ Below Normal
8. Other references reviewed: MassGIS Oliver

Commonwealth of Massachusetts
City/Town of Hingham

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-7 (Hole #) | 08/28/2020 (Date) | 8:30 am (Time) | 60/79 Sunny (Weather) | 42.175 N (Latitude) | -70.887 W (Longitude:)

1. Land Use: Service Station (e.g., woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | ____ Surface Stones (e.g., cobbles, stones, boulders, etc.) | 2% Slope (%)

   Description of Location: Near Garage Building

2. Soil Parent Material: Glacial Stratified Deposits | Kame Terrace (Landform) | SH (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >100 feet | Wetlands >100 feet
   Property Line >10 feet | Drinking Water Well ____ feet | Other ______ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: ________ Depth Weeping from Pit ______ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-12	Ap	Sandy Loam	10YR 3/3				5		Massive	Friable	
12-28	Bw	Sandy Loam	10YR4/4					10%	Massive	Very Friable	
28-120	C	Fine Gravel and Sand	10YR5/4				25%	10%	Single Grain	Loose	

Additional Notes:

Commonwealth of Massachusetts
City/Town of Hingham

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-8 (Hole #) 08/28/2020 (Date) 9:10 am (Time) 60/79 Sunny (Weather) 42.175 N (Latitude) -70.887 W (Longitude:)

1. Land Use: Service Station (e.g., woodland, agricultural field, vacant lot, etc.) Grass (Vegetation) ______ Surface Stones (e.g., cobbles, stones, boulders, etc.) 2% (Slope (%))

Description of Location: Near Garage Building

2. Soil Parent Material: Glacial Stratified Deposits Delta (Landform) SH (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet Drainage Way >100 feet Wetlands >100 feet
Property Line >10 feet Drinking Water Well ______ feet Other ______ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: ______ Depth Weeping from Pit ______ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA)	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-12	Ap	Sandy Loam	10YR 3/3				5		Massive	Friable	
12-124	C	Gravely Sand	10YR5/4				50%	15%	Single Grain	Loose	

Additional Notes:

C. On-Site Review (*minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-9 (Hole #) | 08/28/2020 (Date) | 10:30 am (Time) | 60/79 Sunny (Weather) | 42.175 N (Latitude) | -70.887 W (Longitude:)

1. Land Use: Service Station (e.g., woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | ______ Surface Stones (e.g., cobbles, stones, boulders, etc.) | 3% (Slope (%))

   Description of Location: ______

2. Soil Parent Material: Glacial Stratified Deposits | Kame Terrace (Landform) | SH (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >20 feet | Wetlands >100 feet

   Property Line >10 feet | Drinking Water Well N/A feet | Other ______ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: ______ Depth Weeping from Pit ______ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-12	Ap	Sandy Loam	10 YR 3/3						Massive	Friable	
12-24	B	Loamy Sand	10YR4/4						Massive	Friable	
24-120	C	Gravel and Sand	10YR 5/4				50%	15%	Single Grain	Loose	

Additional Notes: ______

C. On-Site Review *(minimum of two holes required at every proposed primary and reserve disposal area)*

Deep Observation Hole Number: TP-10 (Hole #) | 08/28/2020 (Date) | 11:30 am (Time) | 60/79 Sunny (Weather) | 42.175 N (Latitude) | -70.887 W (Longitude:)

1. Land Use: Service Station (e.g., woodland, agricultural field, vacant lot, etc.) | Grass (Vegetation) | ______ Surface Stones (e.g., cobbles, stones, boulders, etc.) | 3% Slope (%)

   Description of Location: ______

2. Soil Parent Material: Glacial Stratified Deposits | Kame Terrace (Landform) | SH (Position on Landscape (SU, SH, BS, FS, TS))

3. Distances from: Open Water Body >100 feet | Drainage Way >20 feet | Wetlands >100 feet

   Property Line >10 feet | Drinking Water Well N/A feet | Other ______ feet

4. Unsuitable Materials Present: ☐ Yes ☒ No If Yes: ☐ Disturbed Soil ☐ Fill Material ☐ Weathered/Fractured Rock ☐ Bedrock

5. Groundwater Observed: ☐ Yes ☒ No If yes: ______ Depth Weeping from Pit ______ Depth Standing Water in Hole

Soil Log

Depth (in)	Soil Horizon /Layer	Soil Texture (USDA	Soil Matrix: Color-Moist (Munsell)	Redoximorphic Features			Coarse Fragments % by Volume		Soil Structure	Soil Consistence (Moist)	Other
				Depth	Color	Percent	Gravel	Cobbles & Stones			
0-12	Ap	Sandy Loam	10 YR 3/3						Massive	Friable	
12-19	B	Loamy Sand	10YR4/4						Massive	Friable	
19-120	C	Gravel and Sand	10YR 5/4				50%	15%	Single Grain	Loose	

Additional Notes:

Commonwealth of Massachusetts
City/Town of Hingham

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

D. Determination of High Groundwater Elevation

1. Method Used: Obs. Hole # Obs. Hole #

	Obs. Hole #	Obs. Hole #
☐ Depth observed standing water in observation hole	_____ inches	_____ inches
☐ Depth weeping from side of observation hole	_____ inches	_____ inches
☐ Depth to soil redoximorphic features (mottles)	___ inches	inches
☐ Depth to adjusted seasonal high groundwater (S_h) (USGS methodology)	_____ inches	_____ inches

2. Estimated Depth to High Groundwater: E.S.H.G.W.= 136.46-ft

E. Depth of Pervious Material

1. Depth of Naturally Occurring Pervious Material

a. Does at least four feet of naturally occurring pervious material exist in all areas observed throughout the area proposed for the soil absorption system?

☒ Yes ☐ No

b. If yes, at what depth was it observed (exclude A and O Horizons)? Upper boundary: inches Lower boundary: ______ inches

c. If no, at what depth was impervious material observed? Upper boundary: ______ inches Lower boundary: ______ inches

Form 11 - Soil Suitability Assessment for On-Site Sewage Disposal

F. Certification

I certify that I am currently approved by the Department of Environmental Protection pursuant to 310 CMR 15.017 to conduct soil evaluations and that the above analysis has been performed by me consistent with the required training, expertise and experience described in 310 CMR 15.017. I further certify that the results of my soil evaluation, as indicated in the attached Soil Evaluation Form, are accurate and in accordance with 310 CMR 15.100 through 15.107.

[signature]
Signature of Soil Evaluator

08/31/2020
Date

Hazem Dani/ #13902
Typed or Printed Name of Soil Evaluator / License #

6/30/2022
Expiration Date of License

Chessia Consulting Services, LLC
Name of Approving Authority Witness

Hingham Board of Health
Approving Authority

Note: In accordance with 310 CMR 15.018(2) this form must be submitted to the approving authority within 60 days of the date of field testing, and to the designer and the property owner with Percolation Test Form 12.

Field Diagrams: Use this area for field diagrams:

Commonwealth of Massachusetts
City/Town of Hingham

Percolation Test

Form 12

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A. Site Information

Merhej And Sons Realty LLC
Owner Name

87 Derby Street
Street Address or Lot #

City/Town	State	Zip Code
Hingham	MA	02043

Contact Person (if different from Owner):
Telephone Number:

B. Test Results

Date / Time	08/28/2020 8:30 am	08/28/2020 9:00 am
Observation Hole #	TP-7	TP-8
Depth of Perc	24"-42"	20"-38"
Start Pre-Soak	8:30 am	9:01 am
End Pre-Soak	8:41 am	9:01 am
Time at 12"	24 Gallon in less than 15 minutes	24 Gallon in less than 15 minutes
Time at 9"		
Time at 6"		
Time (9"-6")		
Rate (Min./Inch)	< 2 minutes/ inch	< 2 minutes/ inch
Test Passed:	☒	☒
Test Failed:	☐	☐

Hazem Dani
Test Performed By:

John Chessia
Board of Health Witness

Comments:

Commonwealth of Massachusetts
City/Town of Hingham
Percolation Test
Form 12

Percolation test results must be submitted with the Soil Suitability Assessment for On-site Sewage Disposal. DEP has provided this form for use by local Boards of Health. Other forms may be used, but the information must be substantially the same as that provided here. Before using this form, check with the local Board of Health to determine the form they use.

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A. Site Information

Merhej And Sons Realty LLC
Owner Name

87 Derby Street
Street Address or Lot #

City/Town	State	Zip Code
Hingham	MA	02043

Contact Person (if different from Owner)	Telephone Number

B. Test Results

Date / Time	08/28/2020 / 8:30 am	08/28/2020 / 9:00 am
Observation Hole #	TP-9	TP-10
Depth of Perc	26"-44"	27"-45"
Start Pre-Soak	10:16 am	10:52 am
End Pre-Soak	10:22 am	10:55 am
Time at 12”	24 Gallon in less than 15 minutes	24 Gallon in less than 15 minutes
Time at 9”		
Time at 6”		
Time (9”-6”)		
Rate (Min./Inch)	< 2 minutes/ inch	< 2 minutes/ inch
	Test Passed: ☒ Test Failed: ☐	Test Passed: ☒ Test Failed: ☐

Hazem Dani
Test Performed By:

John Chessia
Board of Health Witness

Comments:

CHA