STORMWATER MANAGEMENT REPORT

For:

PROPOSED LIGHT MANUFACTURING

296 Flanders Road

East Lyme, Connecticut

Prepared for:

296 FLANDERS, LLC

Issued: June 17, 2024

Last revised:

Architecture
Engineering
Environmental
Land Surveying

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ATTACHMENTS

EXECUTIVE SUMMARY

296 Flanders, LLC is seeking to develop the existing parcel located at 296 Flanders Road within the Town of East Lyme, County of New London, Connecticut. The project consists of the construction of a 184,140 square foot light manufacturing facility. The proposed development will include associated parking facilities, utilities and landscaping. The Town Parcel ID is Assessor's Map 31.3, Lot #5 and has a total area of approximately 22.11 acres.

The subject parcel of land is currently undeveloped but was formally in part included in a golf driving range. The site is currently existing as a grass field with woodlands in the western portion of the site. The westerly property line is the centerline of the Pattagansett River. Inland wetlands associated with the river have been field located and are depicted on the project plans. The majority of the site is with FEMA Flood Zone X. However, there is FEMA Flood Zones AE and a regulatory floodway associated with the river. The floodway elevation rages from elevation 42.0 north of the site to 41.0 south of the site.

The total limits of disturbance necessary to construct the proposed site improvements is approximately 17.5 acres. The total wetland regulated activity area is approximately 3.8 acres.

1.0 SITE INFORMATION

Project Description:

The subject parcel is located at 296 Flanders Road in East Lyme. Current site conditions are such that the majority of the site has extremely gentle slopes that convey stormwater runoff primarily west to the Pattagansett River. A smaller portion of the site drains south to the newly constructed State of Connecticut DOT Frontage Road.

The proposed development consists of the construction of a 184,140 square foot warehouse building which will be served by a 369-space passenger vehicle paved parking area, 27 truck loading docks and 30 truck trailer staging spaces. The project will also be served by domestic and fire services from the water main in Frontage Road, a sanitary sewer ejector pump system, electric tele-communications and natural gas all from existing utilities within Frontage Road. The project requires the relocation of the existing Eversource utility poles located on-site. The project will also include a comprehensive stormwater management system, lighting and landscaping.

The site is partially within a CT DEEP Aquifer Protection Area Level A. The division line defining the outer limits of the aquifer protection zone is located at the approximate center of the site. Areas east of the line are within the aquifer protection zone.

SITE LOCATION

SITE SOILS

A site-specific soils report was completed for the limits of the property and is included in Report Appendix G. Offsite soils were mapped using NRCS and are also shown in Report Appendix G.

The soils around the Property are classified by United States Department of Agriculture Natural Resources Conservation Service and consist primarily of type “B”, “C” and “D” rated soils, with “D” rated soils in areas of urban land and wetlands. Please refer to NRCS Soil Survey Map with Hydrologic Soil Group Data, for soils and their classifications in the project area.

Soils located within the project area from the soil report are as follows:

Map Unit Symbol	Map Unit Name	Hydrologic Soil Group Rating
17	Timakwa and Natchaug	B/D
29A & B	Agwam	B
34B	Merrimac	A
38C	Hinckley	A

EXISTING GEOTECHNICAL FINDINGS

A pre-development site characterization and assessment of soil strata of the site was conducted by BL Companies on March 13, 2024.

The soil test results are located in Report Attachment-5.

The underlying soils on-site are predominantly sand and gravel. Mottling was observed between 7' and 9.5' generally where water was observed substantially lower.

INFILTRATION TESTING

The subsurface exploration for stormwater management was performed by BL Companies. There were a series of excavated test pits that were performed to determine the soil strata and the seasonal high groundwater elevation. Infiltration testing was performed as well to obtain the infiltration rates for the hydrologic modeling analysis. Only two (2) infiltration tests were conducted due to the high infiltration rate encountered being far in excess of the maximum rate permitted by the CT DEEP of 5.0 in/hr, additional testing is unwarranted. The maximum infiltration rate of 5.0 Inches per hour (in/hr) was used.

The results of the infiltration testing are presented in the table below.

TABLE 1: INFILTRATION RATES

Test Pit Number	Surface Elevation (Feet)	Infiltration Test Depth (Feet)	Test Elevation (Feet)	Field Tested Infiltration Rate (in/hr)	Infiltration Rate Used (in/hr)
IT-1	53.7	4.83	48.9	274	5.0
IT-2	52.8	4.17	48.6	49.5	5.0

1.1 NATURAL RESOURCES

ENVIRONMENTAL CONCERNS

Due to the historic use of the site as a driving range, there is little concern for any potential level of contamination that would pose a threat to the environment.

ENDANGERED AND TREATENED SPECIES

The Connecticut Department of Energy and Environmental Protection's (CTDEEP) Natural Diversity Data Base (NDDB) compiles maps that are representative of the locations of endangered, threatened and special concern species and significant natural communities in Connecticut. A review of the criteria for concern indicates there are (no) species of environmental concern on-site with the exception of areas immediately adjacent to the Pattagansett River. This review was performed on June 11, 2024, with maps released on June 2024. Reference Report Attachment-1, Figure 6 for more information.

HISTORIC PRESERVATION REVIEW

Per Chapter 184a, section 10-387 of the Connecticut General Statues states that DEEP shall review, in consultation with the State Historic Preservation Office it's policies and practices for consistency with regards to historic and archeological sites. As such, the historic preservation review procedures have been performed for the site on June 11, 2024, using the DECD, CT State Historic Preservation Office ConnCRIS GIS mapping, and the site is not within an area of significance.

1.2 RECEIVING SURFACE WATERS

The project site lies within the Southeast Western Complex drainage basin (CONCAT 22), which is within the Southeast Coast Major Basin. The project site is not located within a public water supply watershed.

A review of CTDEEP Aquifer Protection map for East Lyme, Connecticut reveals that the project is partially located within an aquifer protection area for Gorton's Pond.

This site is not within the Coastal Boundary for the State of Connecticut. As part of the General Stormwater Discharge Permit for Construction Activities the Coastal Management Act.

Site drains to the Pattagansett River located west of the site.

1.3 FEMA FLOODPLAIN

The site is partially located in a FEMA floodplain. Per the FEMA Flood Insurance Rate Map Number 09011C0477J for East Lym, New London County, map effective date: 8/5/2013. The site resides predominantly within Zone X (areas determined to be outside the 0.2% annual chance floodplain). There are Flood Zone AE and a Regulatory Floodway associated with Pattagansett River. The Base Flood Elevation (BFE) associated with the River varies from approximately 41.8' at the north portion and 41.4' at the south portion of the site.

Flood Insurance Rate Maps are included in Report Attachemnt-1 for reference.

2.0 STORMWATER MANGEMENT STANDARDS AND PERFORMACE CRITERIA

2.1 DESIGN CRITERIA

The proposed stormwater management system is designed to be in general conformance with the current Town of East Lyme Inland Wetlands and Watercourses Regulations, the Town of East Lyme Zoning Regulations, the 2023 State of Connecticut Guidelines for Soil Erosion and Sediment Control, the 2023 State of Connecticut Stormwater Quality Manual, and State of Connecticut Department of Transportation Drainage Manual.

The 2023 Stormwater Quality Manual 5 Stormwater Standards are outlined below. Reference the Report Section 6.0 Site Design Summary for further discussion on standards met to the maximum extent achievable.

STANDARD 1: RUNOFF VOLUME AND POLLUTANT REDUCTION

- Retain the Required Retention Volume on site to the maximum extent achievable.
- Preference for non-structural Low Impact Development (LID) measures were used to the maximum extent achievable.

STANDARD 2: STORMWATER RUNOFF QUANTITY CONTROL

- The 2 Year post development peak flow has been reduced to be less than 50% of the pre-development flow to the maximum extent achievable.
- The 10-year post-development flow has been reduced to less than the 10-year pre-development flow.
- The 100-year post development flow has been reduced to less than the 100-year pre-development flow.
- The conveyance system has been designed to adequately flow the 10-year, 24-hour storm.
- Emergency outlet has been designed to safely pass the 100-year post development peak runoff without eroding.

STANDARD 3: CONSTRUCTION EROSION AND SEDIMENT CONTROL PLAN

We have developed a Soil Erosion and Sediment Control (SESC) Plan in general conformance with the local and state regulatory requirements, the Connecticut Guidelines for Soil Erosion Sediment Control Guidelines (as amended), and the requirements of the CT DEEP Construction Stormwater General Permit. This can be found on Design plans and in Section 7 below.

STANDARD 4: POST- CONSTRUCTION OPERATION AND MAINTENANCE

We have developed a long-term Operation and Maintenance (O&M) Plan, which identifies required inspection and maintenance activities for structural stormwater BMPs. This will be submitted under separate cover to the regulatory agencies.

STANDARD 5: STORMWATER MANAGEMENT PLAN

We have prepared Stormwater Management Plan to outlining the stormwater management measures for the proposed development are in general conformance with the stormwater management standards, performance criteria, and design guidelines contained in the Connecticut Stormwater Quality Manual, as well as other local, state, and federal stormwater requirements.

3.0 HYDROLOGIC DESIGN METHODOLOGY

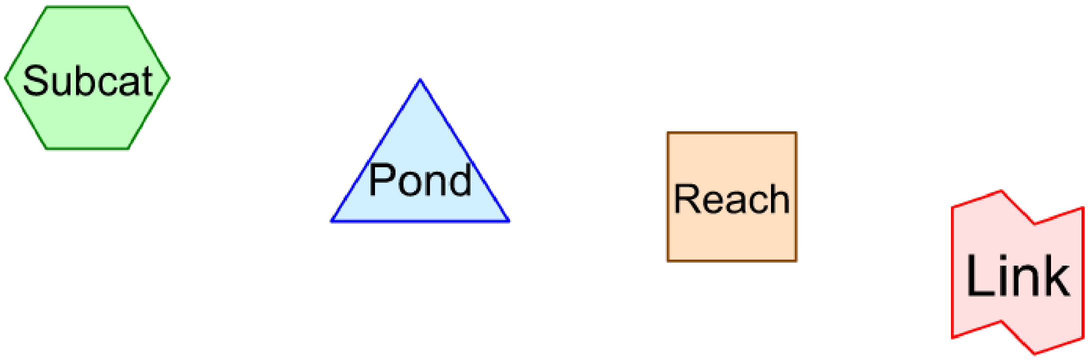
The hydrologic analysis to determine peak stormwater discharge rates was performed using the HydroCAD stormwater modeling system computer program, version 10.00 developed by HydroCAD Software Solutions, LLC. Hydrographs for each watershed were developed using the SCS Synthetic Unit Hydrograph Method. Rainfall depths and distribution per the NOAA Atlas 14 for Volume 10, Version 3 were used for the calculation of peak flow rates and are listed below.

TABLE 2: RAINFALL DEPTHS

Return Period (Year)	24-hour Rainfall Depth
2	3.45"
10	5.16"
25	6.22"
100	7.86"

The Hydrocad printouts use a series of symbols for the various modeling entities. Hydrologic Subcatchment areas are represented by a hexagon, stormwater basins are represented by blue triangles, reaches are represented by squares, and links are represented by irregular octagons. A Reach is used to perform an independent hydrograph routing through an open channel based on normal Manning's flow, and a link is used to hydrolocally add multiple entities together to determine the peak discharge to an analysis point.

The hydrologic modeling results determined the change in peak rates of runoff for a 2-, 10-, 25-, and 100-year storm events. The hydrologic modeling results in the Report Appendix (under separate cover) are the overall analysis summaries from each storm event. The complete hydrographs for each storm and subcatchment can be found in the Hydrologic Report and is available upon request.



4.0 HYDROLOGIC ANALYSIS

The site layout and approach to stormwater management was completed in an integrated manner by attempting to limit the impacts of vegetation loss and soil changes; by incorporating Best Management Practices (BMPs), which includes both structural and non-structural practices; and by considering the overall impacts to the receiving waters.

4.1 PRE-DEVELOPMENT CONDITIONS

Existing runoff from the project site generally drains from the north side of the property to the south to one (1) Design Point (DP), generally described as follows:

- Design Point 1: Pattagansett River wetland flags numbered WA 2 to WA 18
- Design Point 2: Frontage Road

4.1.1 ANALYSIS POINTS

Design Point 1 (DP-1) is the wetland edge associated with Pattagansett River along the western bound of the property. Under the existing condition, the majority of the site (±11.4 acres) discharges to the wetlands. Typically, the ground cover is a dense pasture to the east and wooded areas with moderate understory to the west. This area is not developed under the current conditions.

Design Point 2 (DP-2) is the gutter and closed drainage system in Frontage Road. Under the existing condition there is a substantial portion of the site (±8.6 acres) that discharges to the street. This portion of the site is generally pasture/grass with a sidewalk along the roadway edge.

Report Attachment-4 contains the Existing Conditions Drainage Area Maps.

4.2 POST DEVELOPMENT CONDITIONS

The drainage analysis for the proposed construction encompasses the same tributary drainage area of the 20-acres as described in the existing conditions section. The proposed drainage areas with runoff curve numbers, time of concentration paths and soil types can be found in the hydrologic modeling results in the Report Appendix (under separate cover). The proposed drainage has been designed to reduce peak stormwater discharge rates and volumes to the Maximum Extent Achievable (MEA) leaving the site.

Just as the existing conditions hydrology, discussed above, the project area hydrology is also broken down into two analysis points with 20 acres of contributing Drainage Areas.

Overall, there is a negligible increase in peak flow rate for DP-1 for the 10-year storm and a net reduction in peak discharge and volume from each of the Design Points for the 10-year, 25-year, and 100-year storm events as seen in Table 3 below.

4.3 STORMWATER MANAGEMENT DESIGN SUMMARY

The site consists of Hydrologic Soil Groups A &B soils and the easterly site areas are open pasture areas at very near level grade. The site soil testing resulted in sands and gravels in the underlying strata with a mottling layer between 7' and 9' below grade.

The stormwater management on the eastern portion of the site consists of five (5) subsurface chamber systems. The management on the western portion of the site consists of two (2) subsurface chamber systems and two (2) surface basins.

The eastern portion of the site is with the CT DEEP Level A Aquifer Protection Zone and therefore only roof water may be infiltrated. The roof water subsurface stormwater management system (SWMB P-105) has been designed to infiltrate as much collected runoff as possible. The remaining four (4) subsurface systems on the eastern portion of the site (SWMB P-101, 102, 103 & 104) have been designed to operate as detention facilities only and will include underdrain systems.

The western portion of the site is outside the aquifer protection zone and therefore infiltration is allowed. However, due to the required cut slopes and resulting depth of the drainage conveyance system as well as the updated CT DEEP Water Quality requirement to provide 36" vertical separation between the maximum groundwater and the bottom of the infiltration system, the stormwater basin P-108 cannot infiltrate. Therefore, an underdrain system will be provided. The smaller surface pond (P-109 and both subsurface chamber systems have been designed for infiltration.

4.4 POST-DEVELOPMENT HYDROLOGIC CONCLUSIONS

TABLE 3: PEAK FLOW COMPARISON CHART

Design Point	2-Year Peak Flow (CFS)	10-Year Peak Flow (CFS)	25-Year Peak Flow (CFS)	100-Year Peak Flow (CFS)
DP 1 – Existing Condition	0.16	2.00	4.24	8.79
DP 1 – Proposed Condition	0.14	2.07	3.05	5.70
Difference	-0.02 (12.5%)	+0.07 (3.5%)	-1.19 (28.0%)	-3.09 (35.1%)
DP 2 – Existing Condition	1.68	4.94	7.35	11.40
DP 2 – Proposed Condition	2.24	4.77	6.44	9.12
Difference	+0.56 (33.3%)	-0.17 (3.4%)	-0.91 (12.4%)	-2.28 (20.0%)

TABLE 4: PEAK VOLUME COMPARISON CHART

Design Point	2-Year Volume (CF)	10-Year Volume (CF)	25-Year Volume (CF)	100-Year Volume (CF)
DP 1 – Existing Condition	5,614	26,764	45,580	81,003
DP 1 – Proposed Condition	9,306	20,197	34,156	60,837
Difference	+3,692 (65.8%)	-6,567 (24.5%)	-11,424 (25.1%)	-20,166 (24.9%
DP 2 – Existing Condition	21,222	52,605	75,580	114,544
DP 2 – Proposed Condition	12,802	26,075	35,078	49,686
Difference	-8,420 (39.7%)	-26,530 (50.4%)	-40,502 (53.6%)	-64,858 (56.6%)

Reference Report Section 6.0 Site Design Summary for explanation and justification of minor increases indicated above for the 2-year storm event.

5.0 STORMWATER COMPONENT DESIGNS

5.1 PIPE HYDRAULICS

The hydraulic study of the proposed on-site drainage system has been designed to comply with the requirements set forth in the Town of East Lyme Zoning Regulations and the State of Connecticut Department of Transportation Drainage Manual.

The proposed drainage systems have been sized to convey the 10-year storm event to their respective discharge points without ponding or surcharging above the catch basin / manhole grates. Connecticut Rainfall Intensity-East Lyme was utilized. The site drainage system improvements have been designed to comply with the requirements set forth in the State of Connecticut Department of Transportation Drainage Manual, dated 2000, as amended. Drainage areas contributing to each catch basin are located found in Report Attachmment-2.

The minimum pipe size maintained onsite is 12 inches.

The runoff coefficients for each inlet drainage area have been calculated as the weighted average of impervious and pervious surfaces contributing to the runoff. Impervious surfaces including asphalt pavement, concrete pavement, and building roof area were computed using a rational runoff coefficient of 0.90. Pervious surfaces including lawn and landscaped area were computing using a rational runoff coefficient of 0.30.

Tailwater elevations for the stormwater management areas and flared end sections are based on the 10-year design storm.

StormCAD version 8i by Haestad Methods, utilizing the Rational Method, was used to model the proposed drainage system. Calculation data can be found in the Report Appendix E (under separate cover).

5.2 OUTLET PROTECTION

All drainage surface outlets are to have rip-rap outlet protection. Associated with this project, there are four (4) surface stormwater piping discharges that require outlet protection system designs. The outlet protection will dissipate potentially erosive discharge velocities and permanently stabilize the piping outlet location. The locations that require the design of outlet protection are as follow:

- FES-100: Outlet into surface SWMB P-109 from MH-115 into a riprap spread apron
- FES-101: Outlet into surface SWMB P-108 from OCS-107 into a riprap spread apron
- FES-102: Outlet into surface SWMB P-108 from MH-108 into a riprap spread apron
- FES-103: Outlet from surface SWMB P-108 to existing grade into a riprap spread apron

The outlet protection devices have been sized in accordance with the latest edition of the Connecticut Guidelines for Soil Erosion and Sediment Control Manual for a 10-year design storm. Reference Report Attachment-2 for calculations. Outlet protection rip-rap dimensions (minimum) are as follow:

1. **FES-100:** 18" HDPE flared end outlet to Rip-Rap Apron
   Peak Q-10 = 6.34 cfs at 6.2fps → Modified Riprap: La=12', W1=5', W2=9'

2. **FES-101:** 18" HDPE flared end outlet to Rip-Rap Apron
   Peak Q-10 = 9.99 cfs at 6.50 fps → Modified Riprap: La=18', W1=5', W2=12'
3. **FES-102:** 18" HDPE flared end outlet to Rip-Rap Apron
   Peak Q-10 = 5.57 cfs at 4.82fps → Modified Riprap: La=11', W1=5', W2=9'
4. **FES-103:** 15" HDPE flared end outlet to Rip-Rap Apron
   Peak Q-10 = 0.08 cfs at 1.50 fps → Modified Riprap: La=10', W1=4', W2=8'

5.3 GRASS SWALE

The proposed stormwater management system for this project includes the design of open channel drainage swale to be located on the north side of the proposed development. The runoff swale has been designed to convey the peak rate of runoff for a 25-year storm event. Runoff peak flow rates are calculated using the results from the HydroCAD model. Channel flow rates are calculated using the Manning's Equation. Peak flow velocity is evaluated for proper channel lining characteristics.

The swale will be of trapezoidal geometry of a 12" wide base, 12" depth and 3:1 side slopes.
The swale is approximately 301' long at an average slope of 0.65%
Contributing watershed is PDA-104: 1.15 ac at CN=47
Reference the HydroCAD model results in the Report Appendix-D
Swale full flow capacity = 14.50cfs
25-year peak flow = 0.37cfs → flow depth = 0.18' at maximum velocity = 1.37fps
Grass lining is suitable for V 25-year = 1.37fps

5.4 SUBSURFACE STORMWATER MANAGEMENT BASINS

There are a total of seven subsurface stormwater systems proposed. Five of the subsurface systems (Subsurface SWMB Systems P-101, 102, 103, 104 & 105) are located In the eastern portion of the parcel while subsurface systems SWMB P-106 and P-107 are located In the western portion of the parcel.

Due to the presence of the aquifer protection zone on the east portion of the site, infiltration within the aquifer protection zone is limited to roof water. West of the aquifer protection limit line, infiltration practices are incorporated. Overall, the roof SWMB (P-105) and the westerly subsurface systems (SWMB P-106 &107) have been designed to maximize volume retention and infiltrate stormwater.

Subsurface Infiltration System P-105

Subsurface System P-105 is located east of the proposed building. The watershed area directed to the basin is denoted as PDA-108 (roof areas).

The system consists of 50 rows of 13 SC-310 Chambers

Pretreatment Design: No pretreatment is necessary for roof water.

Water Quality Volume: Per current CT DEEP Water Quality Manual, the design Water Quality Volume (WQV) is to be retained within the basin and infiltrated when possible. The basin has been designed such that the lowest basin outlet is located above the elevation required to retain 100% of the design WQV. Reference Report Attachment 2 for design calculations.

Required WQV = 18,951 cf
Provided WQV = 18,959 cf (below lowest outlet at elevation 50.7)
Lowest outlet at elevation 50.7 or 0.40' above chamber bottom.

Table 5 – P-105 Design Data

Elevation (Ft)	Storage (CF)	Outlet Data
49	0	Bottom of stone
50	8,271	
51	21,240	Low Level 6" Orifice Invert = 50.70
52	31,831	
52.5	35,210	Weir Wall Crest Elevation = 51.00

The basin outflow is discharged first through the low-level orifice at elevation 50.7 and then over the weir wall within the OCS structure at elevation 51.00. The OCS structure is designed to maximize volume retention within the basin and reduce peak flow rates. The OCS structure will handle all the outflow for up to a 100-year storm.

Basin inflow hydrographs have been routed through basin models for the 2, 10, 25 and 100-year storm events. The modeling results are provided in Report Appendix C. A summary of the modeling results is as follow:

Table 6 – P-105 Flow Summary

Storm Event	Peak Flow Into Basin (cfs)	Peak Flow Out of Basin (cfs)	Maximum Water Elevation In Basin (ft)
2-Year	15.96	2.52	50.04
10-Year	24.01	2.95	50.73
25-Year	29.00	4.24	51.13
100-Year	36.69	9.23	51.53

Flows out of these facilities are directed to an 18" HDPE pipe that directs the system outflow to FES-102 into SWMB P-108.

Time to Drain:

The total volume retained and infiltrated in the basin is that volume below the low-level orifice of the basin outlet structure at an elevation of 50.7.

Site infiltration rates exceed the maximum design rate permitted by the CT DEEP Water Quality Manual of 5in/hr so the maximum rate is used.

The storage volume within the basin below the low-level orifice elevation 50.7 = 18,959cf
Infiltration area = basin bottom area = 16,134 sf
Infiltration Outflow Rate (Qinfil) = 5 in/hr = 0.417 ft/hour x 18,134 sf = 6,722 cf/hour
Time to Drain = volume/rate = 18,959 cf / 6,722 cf/hour = 2.82 hours

The basin will drain completely within the required 72-hour time frame.

Subsurface Infiltration System P-106

Subsurface System P-106 is located west of the proposed building in the northern portion of the truck dock area. The watershed area directed to the basin is denoted as PDA-109.

The system consists of 8 rows of 13 SC-310 chambers.

Pretreatment Design: No pretreatment is required. The runoff is directed to the system Isolator Row for stormwater treatment. Reference the ADS StormTech Isolator Row Sizing Chart in Report Attachment-3.

Treated Flow per chamber = 0.11cfs x 13 chambers = 1.43cfs
Design Water Quality Flow (WQF) = 0.13 < 1.43cfs → more than ample treatment

Water Quality Volume: Per current CT DEEP Water Quality Manual, the design Water Quality Volume (WQV) is to be retained within the basin and infiltrated when possible. The basin has been designed such that the lowest basin outlet is located above the elevation required to retain 100% of the design WQV. Reference Report Attachment 2 for design calculations.

Required WQV = 826 cf
Provided WQV = 1,578 cf (below lowest outlet at elevation 47.0)
Lowest outlet at elevation 47.0 or 0.50' above chamber bottom.

Table 7 – P-106 Design Data

Elevation (Ft)	Storage (CF)	Outlet Data
46	0	Bottom of stone
47	1,578	Low Level 6" Orifice Invert = 47.00
48	3,078	Weir Wall Crest Elevation = 47.50
48.3	3,437	

The basin outflow is discharged first through the low-level orifice at elevation 47.0 and then over the weir wall within the OCS structure at elevation 47.5. The OCS structure is designed to maximize volume retention within the basin and reduce peak flow rates. The OCS structure will handle all the outflow for up to a 100-year storm.

Basin inflow hydrographs have been routed through basin models for the 2, 10, 25 and 100-year storm events. The modeling results are provided in Report Appendix C. A summary of the modeling results is as follow:

Table 8 – P-106 Flow Summary

Storm Event	Peak Flow Into Basin (cfs)	Peak Flow Out of Basin (cfs)	Maximum Water Elevation In Basin (ft)
2-Year	3.75	0.94	47.50
10-Year	6.42	5.00	47.93
25-Year	8.08	7.65	48.10
100-Year	10.63	10.15	48.25

Flows out of these facilities are directed to a 15" HDPE pipe that directs the system outflow to OCS-107 and then to FES-101 into SWMB P-108.

Time to Drain:

The total volume retained and infiltrated in the basin is that volume below the low-level orifice of the basin outlet structure at an elevation of 47.0.

Site infiltration rates exceed the maximum design rate permitted by the CT DEEP Water Quality Manual of 5in/hr so the maximum rate is used.

The storage volume within the basin below the low-level orifice elevation 47.0 = 1,578cf
Infiltration area = basin bottom area = 2,698 sf
Infiltration Outflow Rate (Qinfil) = 5 in/hr = 0.417 ft/hour x 2,698 sf = 1,124 cf/hour
Time to Drain = volume/rate = 1,578 cf / 1,124 cf/hour = 1.40 hours

The basin will drain completely within the required 72-hour time frame.

Subsurface Infiltration System P-107

Subsurface System P-107 is located west of the proposed building in the southern portion of the truck dock area. The watershed area directed to the basin is denoted as PDA-110.

The system consists of 12 rows of 13 SC-310 chambers

Pretreatment Design: No pretreatment is required. The runoff is directed to the system Isolator Row for stormwater treatment. Reference the ADS StormTech Isolator Row Sizing Chart in Report Attachment-3.

Treated Flow per chamber = 0.11cfs x 13 chambers = 1.43cfs
Design Water Quality Flow (WQF) = 1.31 < 1.43cfs → more than ample treatment

Water Quality Volume: Per current CT DEEP Water Quality Manual, the design Water Quality Volume (WQV) is to be retained within the basin and infiltrated when possible. The basin has been designed such that the lowest basin outlet is located above the elevation required to retain 100% of the design WQV. Reference Report Attachment 2 for design calculations.

Required WQV = 8,722 cf
Provided WQV = 2,339 cf (below lowest outlet at elevation 47.0)

Lowest outlet at elevation 47.0 or 0.90' above chamber bottom.
The system does not provide enough detention to fully retain the design WQV of 8,722cf. However, the WQV is not only treated in the Isolator Row portion of the system, but outflow is directed to SWMB P-108 for additional storage and treatment.

Table 9 – P-107 Design Data

Elevation (Ft)	Storage (CF)	Outlet Data
46.1	0	Bottom of stone
47.1	2,339	Low Level 6" Orifice Invert = 47.00
48.1	4,559	
48.43	5,089	Weir Wall Elevation = 48.00

The basin outflow is discharged first through the low-level orifice at elevation 51.0 and then over the weir wall within the OCS structure at elevation 51.75. The OCS structure is designed to maximize volume retention within the basin and reduce peak flow rates. The OCS structure will handle all the outflow for up to a 100-year storm.

Basin inflow hydrographs have been routed through basin models for the 2, 10, 25 and 100-year storm events. The modeling results are provided in Report Appendix C. A summary of the modeling results is as follow:

Table 10 – P-107 Flow Summary

Storm Event	Peak Flow Into Basin (cfs)	Peak Flow Out of Basin (cfs)	Maximum Water Elevation In Basin (ft)
2-Year	15.96	2.59	50.16
10-Year	24.01	3.01	50.83
25-Year	29.00	3.50	51.29
100-Year	36.69	5.93	51.98

Flows out of these facilities are directed to an 18" HDPE pipe that directs the system outflow to FES-101 into SWMB P-108.

Time to Drain:

The total volume retained and infiltrated in the basin is that volume below the low-level orifice of the basin outlet structure at an elevation of 47.0.

Site infiltration rates exceed the maximum design rate permitted by the CT DEEP Water Quality Manual of 5in/hr so the maximum rate is used.

The storage volume within the basin below the low-level orifice elevation 47.0 = 2,339cf
Infiltration area = basin bottom area = 3,974 sf

Infiltration Outflow Rate (Qinfil) = 5 in/hr = 0.417 ft/hour x 3,974 sf = 1,657 cf/hour
Time to Drain = volume/rate = 2,339 cf / 1,657 cf/hour = 1.41 hours

The basin will drain completely within the required 72-hour time frame.

Subsurface SWMB Systems P-101, 102, 103 and 104:

Due to being located within the CT DEEP Aquifer Protection Zone, systems SWMB P-101, 102, 103 and 104 have been designed for peak runoff rate reduction only. The systems will include an impervious liner and underdrain system and will not allow infiltration. The systems are designed so that the bottom of each basin is above the maximum groundwater level observed in the test holes.

These systems have been designed to drain completely out the OCS structure. An underdrain is included in the design to drain the system completely. Pretreatment and TSS removal is accomplished through the use of street sweeping, deep sump catch basins with hoods, and hydrodynamic separators.

There is no WQV retention due to lack of infiltration practices. The systems are designed as follows:

Subsurface Infiltration System P-101

Subsurface System P-101 is located east of the proposed building in the northern portion of the parking lot. The watershed area directed to the basin is denoted as PDA-101.

The system consists of 25 rows of 13 SC-310 chambers

Pretreatment Design: System pretreatment is to be comprised of the incorporation of an ADS Barracuda Hydrodynamic Separator (HDS). The HDS systems have a maximum design hydraulic rate which allows for full treatment of the runoff and a level of internal bypass capability for those flows beyond the required treatment flow. The maximum hydraulic rates for the various Barracuda systems is located in Report Attachment-3. System Water Quality Flow (WQF) calculations are also located in Report Attachment-3.

HDS-101 Peak 10-year inflow rate = 5.25cfs
WQF=0.68CFS
Use Barracuda Model S-4
Depth between top of frame to invert = 5.45' (65.4")
Maximum hydraulic rate = 10.5cfs

Table 11 – P-101 Design Data

Elevation (Ft)	Storage (CF)	Outlet Data
47.4	0	Bottom of stone
48	2,282	Low Level 6" Orifice Invert = 48.50
49	7,987	Weir Wall Elevation = 49.10

49.73	10,457	

The basin outflow is discharged first through the low-level orifice at elevation 48.50 and then over the weir wall within the OCS structure at elevation 49.10. The OCS structure is designed to maximize volume retention within the basin and reduce peak flow rates. The OCS structure will handle all the outflow for up to a 100-year storm.

Basin inflow hydrographs have been routed through basin models for the 2, 10, 25 and 100-year storm events. The modeling results are provided in Report Appendix C. A summary of the modeling results is as follow:

Table 12 – P-107 Flow Summary

Storm Event	Peak Flow Into Basin (cfs)	Peak Flow Out of Basin (cfs)	Maximum Water Elevation In Basin (ft)
2-Year	1.66	1.08	47.59
10-Year	3.79	1.49	48.15
25-Year	5.23	1.74	48.51
100-Year	7.56	2.87	49.14

Flows out of these facilities are directed to an 18" HDPE pipe that directs the system outflow to FES-100 into SWMB P-109.

Subsurface Infiltration System P-102

Subsurface System P-102 is located east of the proposed building in the central portion of the parking lot. The watershed area directed to the basin is denoted as PDA-102.

The system consists of 34 rows of 13 SC-310 chambers

Pretreatment Design: System pretreatment is to be comprised of the incorporation of an ADS Barracuda Hydrodynamic Separator (HDS). The HDS systems have a maximum design hydraulic rate which allows for full treatment of the runoff and a level of internal bypass capability for those flows beyond the required treatment flow. The maximum hydraulic rates for the various Barracuda systems is located in Report Attachment-3. System Water Quality Flow (WQF) calculations are also located in Report Attachment-3.

HDS-102 Peak 10-year inflow rate = 4.49cfs
WQF=1.09CFS
Use Barracuda Model S-4
Depth between top of frame to invert = 5.53' (66.4")
Maximum hydraulic rate = 10.5cfs

Table 13 – P-101 Design Data

Elevation (Ft)	Storage (CF)	Outlet Data
47.5	0	Bottom of stone
48	2,425	Low Level 4" Orifice Invert = 48.50
49	10,198	Weir Wall Elevation = 49.15
49.83	14,173	

The basin outflow is discharged first through the low-level orifice at elevation 48.50 and then over the weir wall within the OCS structure at elevation 49.15. The OCS structure is designed to maximize volume retention within the basin and reduce peak flow rates. The OCS structure will handle all the outflow for up to a 100-year storm.

Basin inflow hydrographs have been routed through basin models for the 2, 10, 25 and 100-year storm events. The modeling results are provided in Report Appendix C. A summary of the modeling results is as follow:

Table 14 – P-102 Flow Summary

Storm Event	Peak Flow Into Basin (cfs)	Peak Flow Out of Basin (cfs)	Maximum Water Elevation In Basin (ft)
2-Year	6.30	1.96	48.09
10-Year	9.95	2.38	48.46
25-Year	12.19	2.76	48.71
100-Year	15.63	3.54	49.17

Flows out of these facilities are directed to an 18" HDPE pipe that directs the system outflow to FES-100 into SWMB P-109.

Subsurface Infiltration System P-103

Subsurface System P-103 is located east of the proposed building in the southern portion of the parking lot. The watershed area directed to the basin is denoted as PDA-103.

The system consists of 8 rows of 10 SC-310 chambers

Pretreatment Design: System pretreatment is to be comprised of the incorporation of an ADS Barracuda Hydrodynamic Separator (HDS). The HDS systems have a maximum design hydraulic rate which allows for full treatment of the runoff and a level of internal bypass capability for those flows beyond the required treatment flow. The maximum hydraulic rates for the various Barracuda systems is located in Report Attachment-3. System Water Quality Flow (WQF) calculations are also located in Report Attachment-3.

HDS-103 Peak 10-year inflow rate = 3.29cfs
WQF=0.68CFS
Use Barracuda Model S-3
Depth between top of frame to invert = 4.85' (58.2")
Maximum hydraulic rate = 8.0cfs

Table 15 – P-103 Design Data

Elevation (Ft)	Storage (CF)	Outlet Data
49.8	0	Bottom of stone
50	168	Low Level 8" Orifice Invert = 50.30
51	1,518	Weir Wall Elevation = 51.40
52	2,552	
52.13	2,636	

The basin outflow is discharged first through the low-level orifice at elevation 48.50 and then over the weir wall within the OCS structure at elevation 49.15. The OCS structure is designed to maximize volume retention within the basin and reduce peak flow rates. The OCS structure will handle all the outflow for up to a 100-year storm.

Basin inflow hydrographs have been routed through basin models for the 2, 10, 25 and 100-year storm events. The modeling results are provided in Report Appendix C. A summary of the modeling results is as follow:

Table 16 – P-103 Flow Summary

Storm Event	Peak Flow Into Basin (cfs)	Peak Flow Out of Basin (cfs)	Maximum Water Elevation In Basin (ft)
2-Year	1.98	0.69	50.66
10-Year	3.06	1.36	51.01
25-Year	3.72	1.68	21.27
100-Year	4.47	3.17	51.60

Flows out of these facilities are directed to an 18" HDPE pipe that directs the system outflow to FES-102 into SWMB P-108.

Subsurface Infiltration System P-104

Subsurface System P-104 is located east of the proposed building in the central portion of the parking lot. The watershed area directed to the basin is denoted as PDA-105.

The system consists of 8 rows of 10 SC-310 chambers

Pretreatment Design: System pretreatment is to be comprised of the incorporation of an ADS Barracuda Hydrodynamic Separator (HDS). The HDS systems have a maximum design hydraulic rate which allows for full treatment of the runoff and a level of internal bypass capability for those flows beyond the required treatment flow. The maximum hydraulic rates for the various Barracuda systems is located in Report Attachment-3. System Water Quality Flow (WQF) calculations are also located in Report Attachment-3.

HDS-104 Peak 10-year inflow rate = 2.47cfs
WQF=1.16CFS
Use Barracuda Model S-3
Depth between top of frame to invert = 4.83' (58.96")
Maximum hydraulic rate = 8.0cfs

Table 17 – P-104 Design Data

Elevation (Ft)	Storage (CF)	Outlet Data
48.67	0	Bottom of stone
49	335	Low Level 6" Orifice Invert = 49.17
50	1,790	Weir Wall Elevation = 50.25
51	2,664	

The basin outflow is discharged first through the low-level orifice at elevation 49.17 and then over the weir wall within the OCS structure at elevation 50.25. The OCS structure is designed to maximize volume retention within the basin and reduce peak flow rates. The OCS structure will handle all the outflow for up to a 100-year storm.

Basin inflow hydrographs have been routed through basin models for the 2, 10, 25 and 100-year storm events. The modeling results are provided in Report Appendix C. A summary of the modeling results is as follow:

Table 18 – P-104 Flow Summary

Storm Event	Peak Flow Into Basin (cfs)	Peak Flow Out of Basin (cfs)	Maximum Water Elevation In Basin (ft)
2-Year	1.43	0.43	49.31
10-Year	2.21	0.81	49.58
25-Year	2.69	1.02	49.76
100-Year	3.42	1.29	50.07

Flows out of these facilities are directed to an 18" HDPE pipe that directs the system outflow to FES-100 into SWMB P-109.

5.5 SURFACE STORMWATER MANAGEMENT BASINS

There are two (2) Stormwater Management Basins (SWMB) proposed in association with the project stormwater management system. The SWMB's have been designed to provide stormwater quantity and quality mitigation associated with land development. None of the basin designs include a sediment forebay as all inflow into the basins is from upstream subsurface management basins.

The SWMB designs are as follow:

Surface Stormwater Management Basin SWMB P-108

Due to the elevation of the piping runs that direct flow to the basin, the bottom elevation does not provide the 3 vertical feet of separation from maximum groundwater required by the CT DEEP Water Quality Manual. Therefore, infiltration practices will not be employed for this basin. For this reason, an underdrain system has been provided for the basin.

SWMB-108 is located at the southwestern portion of the site. The watershed area directed to the basin includes outflows for subsurface SWMB's P-103, P-105, P-106 and P-107.

Sediment Forebay Design: No sediment forebay required as all inflows are from upstream SWMB systems.

Water Quality Volume: The required WQV to be retained has been provided in the upstream SWMB's.

Basin areas and outlet structures are as follows:

Table 19 – SWMB P-108 Design Data

Elevation (Ft)	**Area (SF)**	**Outlet Data**
45	0	
46	20,891	
47	43,585	
48	68,141	6" Low Lovel Orifice Inv=48.00
49	94,617	Outflow Grate Elevation = 49.00
50	123,071	Emergency Overflow Spillway: W=10'-0", D=12", Elevation=50.0
51	153,555	

The basin outflow is discharged through the basin underdrain, 6" low level orifice and OCS grate. The basin is designed this way to maximize stormwater runoff retention within the basin to reduce peak runoff volumes. Additional outflow is provided through the emergency overflow spillway.

Underdrainage system:

Due to the existing proximity of the basin bottom to maximum groundwater, the basin has been designed with an underdrain system. To model the outflow from the basin bottom into the underdrain system, an infiltration to underdrain outlet feature has been added to the HydroCAD model.

The basin underdrain is a 6" perforated pipe in a crushed stone trench. There is also approximately 6" of topsoil above the stone trench. Runoff directed into the basin will infiltrate through 6" of topsoil and 6" of crushed stone. To model the flow into the underdrain, an infiltration rate of 0.27 inches/hour is assumed for the topsoil (reference Rawl's rates table for silt loam in Report Attachment-2. The infiltration through the stone will be rapid and therefore would not significantly impede the flow rate.

Note that the underdrain discharges to the proposed SWMB-4 Outlet Control Structure OCS-108 via a 6" PVC drain line. From here to the outlet, the underdrain flows are directed to the 15" HDPE basin outlet piping which directs outflow to FES-103.

Basin inflow hydrographs have been routed through basin models for the 2, 10, 25 and 100-year storm events. The modeling results are provided in Report Appendix C. A summary of the modeling results is as follow:

Table 20 – SWMBP-108 Flow Summary

Storm Event	Peak Flow Into Basin (cfs)	Peak Flow Out of Basin (cfs)	Maximum Water Elevation In Basin (ft)
2-Year	3.17	0.13	45.40
10-Year	16.39	0.14	46.00
25-Year	24.63	0.14	46.57
100-Year	29.00	0.15	47.54

Flows out of these facilities are directed to a 15" diameter flared end (FES-103).

6.0 SITE DESIGN SUMMARY

The proposed Stormwater Management System (SWMS) has been designed to mitigate potential impacts with regard to stormwater quality and quantity associated with the proposed site development features.

All stormwater pipe runs and outlet protection designs have been provided for the design 10-year storm event. The grass swale has been designed for a 25-year storm event. All stormwater detention and infiltration systems (SWMB's) have been designed for the 2, 10, 25 and 100-year, 24-hour Type III storm events.

The proposed SWMS for this development consists of concrete catch basins and manholes, HDPE piping, trench drains at each loading dock, seven (7) subsurface SWMB's and two (2) surface SWMB's.

The eastern portion of the subject site is within the Gorton Pond CT DEEP Aquifer Protection area. For this reason, only roof water may be infiltrated. The remaining four SWMB's in the eastern portion of the site are provided with underdrain systems.

DP-1 2-year storm not meeting Standard 2:
Due to the very near level slopes of the easterly site areas requiring conveyance piping to increase in depth, the resulting bottom elevation of SWMB P-108 is too close to the maximum mottling layer observed during on site soil testing to allow infiltration and requiring an underdrain system. It is the outflow from this underdrain system that results in the project not meeting the post-development peak flow rate reductions and volume reductions for DP-1 as the underdrain outflow cannot be retained or detained. The peak flow rates for the 2-year storm for existing = 0.16cfs and 0.14cfs for post-developed conditions. The outflow of SWMB P-108 underdrain for the 2-year storm is 0.13cfs. The underdrain outflow additionally accounts for the increase in volume for the 2-year storm as well.

DP-2 2-year storm not meeting Standard 2:
The watershed area to Frontage Road has been minimized to the maximum extent feasible. The pre-development watershed area to DP-2 = 8.60 acres. The post-development watershed to DP-2 = 2.78 acres, a 5.8-acre reduction. However, there is a 0.56cfs increase in peak flow rate for the 2-year storm. There is an 8,420 cf reduction in 2-year volume (39.7%reduction from existing). All other storm events indicate a decrease in peak flow rate and volume.

All other storm events are reduced to less than pre-development conditions for both peak rate and volume for all other storm events.

7.0 SITE CONSTRUCTION AND EROSION CONTROLS

A soil erosion and sediment control plan has been developed to protect the adjacent roadways, storm drainage systems, properties and wetland areas and any adjacent water course from sediment laden surface runoff and erosion.

Sediment control will be accomplished through rapid stabilization and by the installation of mechanical devices, including a temporary gravel construction entrance, silt fence, haybales, and storm drain inlet protection and temporary sediment traps. The proposed construction activities will be in accordance with policies and requirements of the Massachusetts Erosion and Sediment Control Guidelines for Urban and Suburban Areas. Permanent stabilization will occur as quickly as possible with site-specific seeding mixtures and as required by local officials.

Structural practices utilized as part of this development will include:

1. Temporary Construction Entrance

A temporary construction entrance shall be installed at the stone construction entrance of the development. Mud and debris shall be washed from all construction vehicles and equipment before leaving the site. The sediment laden water will be diverted to a proposed sediment basin/trap. Water tanks will be used if public water is unavailable.

2. Silt Fence

Silt fence shall be installed downstream of disturbed areas to filter the sediment laden sheet flow. Compost filter sock support will be staked in front of the silt fence where fencing is proposed upstream of wetlands.

3. Inlet Protection

All storm inlets existing and constructed, that could potentially receive sediment laden runoff will have silt sack and/or haybale protection installed until site stabilization is complete.

4. Temporary Diversion Swales

Temporary diversion swales will be installed along the perimeter slopes to direct flow towards temporary sediment basins. The diversion shall be stabilized immediately following installation with temporary vegetation or a structural devise to prevent erosion.

5. Stone Check Dams

Stone check dams will be installed along diversion swales to filter sediment laden runoff being directed into temporary sediment traps.

6. Temporary Sediment Traps and Basin

Temporary sediment traps and basins will be installed to capture and filer sediment laden water throughout the site to the extent practical.

There are two phases of erosion control measures for the proposed development. The first phase proposes the installation of filter socks at existing stormwater inlets, rock construction entrances and silt fence around the proposed area of disturbance prior to the commencement of any earth disturbance activities. At the start of phase 1, two temporary sediment traps and one temporary sediment basin, diversion swales and stone check dams will be installed to capture runoff from the site.

During phase 2 of erosion control sequence, the perimeter measures and rock construction entrances will remain in place and be maintained. All constructed stormwater inlets will have inlet protection installed. All areas that have achieved final grade will need to be immediately covered with 6" of topsoil, seeded and mulched. Slopes that are 3:1 or greater will need to be covered with erosion control matting prior receiving seed and mulch. All erosion control matting will be wildlife friendly, with all-natural material and no photodegradable content

Any topsoil that is stripped will need to be stockpiled onsite to be used later. Stockpiles will need to received temporary seeding and have a filter sock around its base to prevent the loss of materials.

Dewater of any trenches and/or basin will need to be completed in a manner that will avoid creating any areas of accelerated erosion.

During construction of this project, all erosion control measures will need to be inspected weekly and following any major rain event. Any repairs to the erosion control BMPs will need to be completed within 24 hours of any major rain event.

See detail plans for full Construction Sequence.

8.0 CONCLUSIONS & RECOMMENDATION

With the implementation of the stormwater management system designed for this project, there are no negative impacts anticipated on-site, on downstream properties or to off-site storm drainage systems from the proposed development. The rate of stormwater runoff and the volume of stormwater runoff has been decreased to a level close to or less than pre-development conditions for all design storm events to the Maximum Extent Achievable. Existing runoff discharge points will be maintained in the proposed design and appropriate measures are included to ensure that drainage will continue to flow to existing locations using the previously approved rainfall runoff amounts as well as the new NOAA Atlas 14 rainfall runoff rates.

The on-site drainage collection system is sized for the 10-year storm to operate without ponding or surcharging and numerous measures have been implemented to improve stormwater quality including stormwater management basins, hydrodynamic separators, catch basin sumps, and hooded outlets.

This report, as noted above, has been prepared to complement the submitted project plans as well as to represent the technical basis for the designs presented herein. In consideration of the overall project, we conclude that all technical concerns and design parameters set forth by the Town and State, as presently identified, have been fully met to the maximum extent achievable.

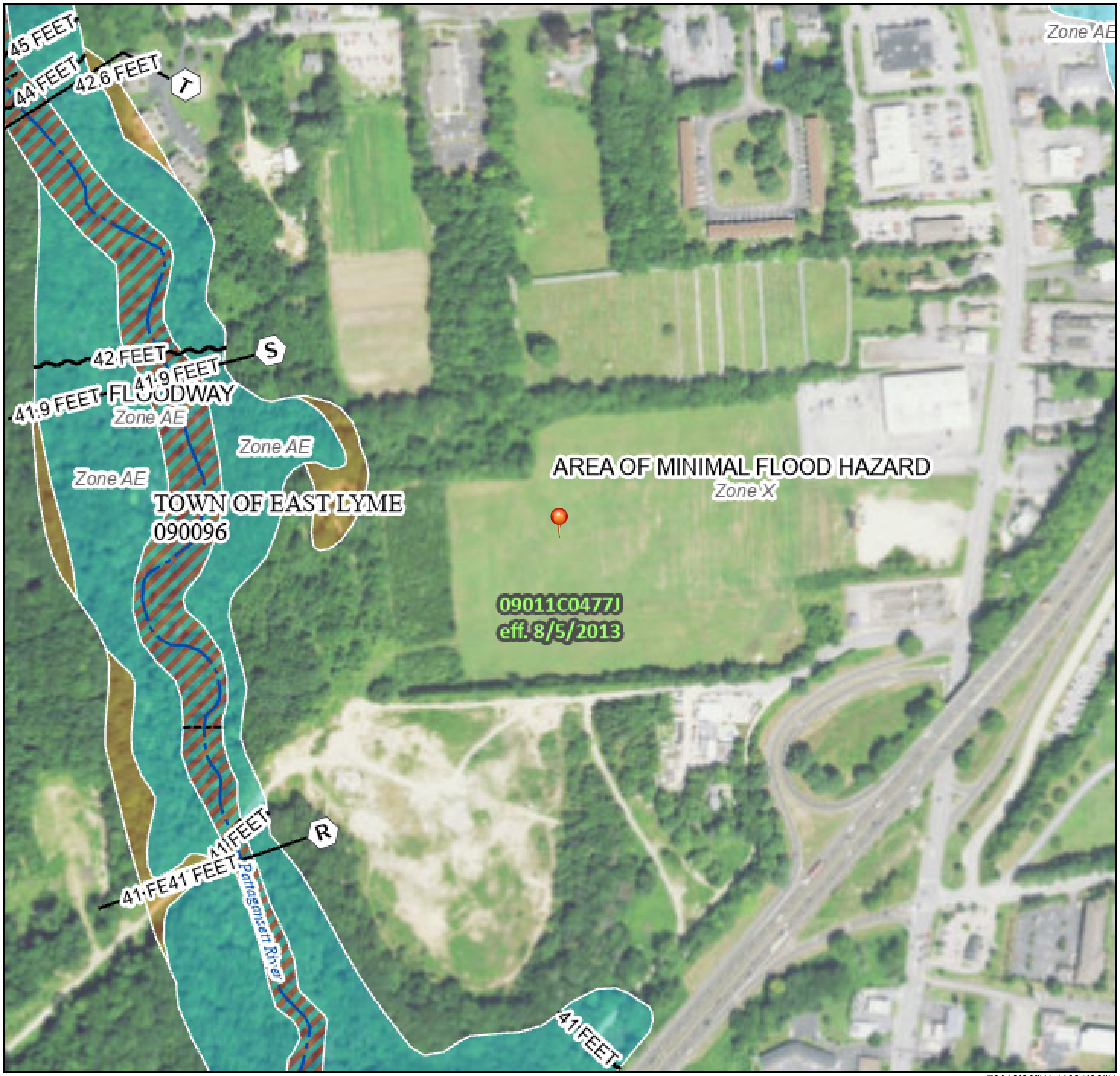
ATTACHMENT-1

FIGURES

National Flood Hazard Layer FIRMette

FEMA

72°13'7"W 41°21'57"N



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

1:6,000

72°12'30"W 41°21'30"N

Basemap Imagery Source: USGS National Map 2023

Legend

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

SPECIAL FLOOD HAZARD AREAS

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

OTHER AREAS OF FLOOD HAZARD

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

OTHER AREAS

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

GENERAL STRUCTURES

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

OTHER FEATURES

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

MAP PANELS

- Digital Data Available
- No Digital Data Available
- Unmapped

N

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

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

The flood hazard information is derived directly from the authoritative NFHL web services provided by FEMA. This map was exported on 6/11/2024 at 7:54 AM and does not reflect changes or amendments subsequent to this date and time. The NFHL and effective information may change or become superseded by new data over time.

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

Soil Map

Map Scale: 1:2,510 if printed on A landscape (11" x 8.5") sheet.

Meters: 0 35 70 140 210

Feet: 0 100 200 400 600

N

Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 18N WGS84

Point precipitation frequency estimates (inches)
NOAA Atlas 14 Volume 10 Version 3
Data type: Precipitation depth
Time series type: Partial duration
Project area: Northeastern States
Location na Connectic USA
Station Name: -
Latitude: 41.3623 Degree
Longitude: -72.2096 Degree
Elevation (USGS): 57 ft

PRECIPITATION FREQUENCY ESTIMATES

by duration	1	2	5	10	25	50	100	200	500	1000
5-min:	0.337	0.403	0.512	0.602	0.726	0.819	0.917	1.03	1.19	1.33
10-min:	0.478	0.572	0.726	0.853	1.03	1.16	1.3	1.46	1.69	1.88
15-min:	0.562	0.672	0.852	1	1.21	1.36	1.53	1.72	1.99	2.21
30-min:	0.793	0.949	1.2	1.41	1.7	1.92	2.15	2.42	2.8	3.11
60-min:	1.02	1.22	1.55	1.83	2.2	2.48	2.78	3.12	3.61	4.01
2-hr:	1.34	1.61	2.04	2.4	2.89	3.26	3.65	4.1	4.78	5.34
3-hr:	1.56	1.87	2.37	2.78	3.35	3.78	4.23	4.76	5.55	6.21
6-hr:	1.98	2.37	3	3.52	4.23	4.76	5.33	6	6.99	7.82
12-hr:	2.46	2.93	3.7	4.33	5.21	5.87	6.56	7.37	8.56	9.56
24-hr:	2.88	3.45	4.38	5.16	6.22	7.01	7.86	8.86	10.3	11.6
2-day:	3.22	3.9	5.01	5.93	7.2	8.14	9.15	10.4	12.3	13.9
3-day:	3.49	4.22	5.42	6.42	7.78	8.8	9.9	11.2	13.3	15
4-day:	3.75	4.51	5.77	6.81	8.24	9.3	10.5	11.8	14	15.8
7-day:	4.47	5.3	6.66	7.78	9.34	10.5	11.7	13.2	15.4	17.3
10-day:	5.18	6.05	7.46	8.64	10.3	11.5	12.8	14.2	16.4	18.2
20-day:	7.36	8.28	9.8	11.1	12.8	14.1	15.5	16.9	18.9	20.4
30-day:	9.17	10.1	11.7	13	14.9	16.3	17.6	19	20.8	22.2
45-day:	11.4	12.4	14.1	15.5	17.4	18.9	20.4	21.7	23.3	24.4
60-day:	13.3	14.4	16.1	17.6	19.6	21.2	22.7	24	25.5	26.4

Date/time (GMT): Tue Mar 12 19:34:58 2024
pyRunTime: 0.00765681266784668

Point precipitation frequency estimates (inches/hour)
NOAA Atlas 14 Volume 10 Version 3
Data type: Precipitation intensity
Time series type: Partial duration
Project area: Northeastern States
Location na Connectic USA
Station Name: -
Latitude: 41.3623 Degree
Longitude: -72.2096 Degree
Elevation (USGS): 57 ft

PRECIPITATION FREQUENCY ESTIMATES

by duration	1	2	5	10	25	50	100	200	500	1000
5-min:	4.04	4.84	6.14	7.22	8.71	9.83	11	12.3	14.3	15.9
10-min:	2.87	3.43	4.36	5.12	6.17	6.95	7.79	8.74	10.1	11.3
15-min:	2.25	2.69	3.41	4.01	4.84	5.46	6.11	6.86	7.95	8.85
30-min:	1.59	1.9	2.41	2.83	3.41	3.85	4.31	4.83	5.59	6.22
60-min:	1.02	1.22	1.55	1.83	2.2	2.48	2.78	3.12	3.61	4.01
2-hr:	0.672	0.804	1.02	1.2	1.45	1.63	1.82	2.05	2.39	2.67
3-hr:	0.52	0.622	0.788	0.926	1.12	1.26	1.41	1.59	1.85	2.07
6-hr:	0.331	0.396	0.5	0.587	0.706	0.796	0.891	1	1.17	1.31
12-hr:	0.204	0.243	0.307	0.36	0.433	0.487	0.545	0.612	0.711	0.794
24-hr:	0.12	0.144	0.183	0.215	0.259	0.292	0.328	0.369	0.431	0.483
2-day:	0.067	0.081	0.104	0.124	0.15	0.169	0.191	0.216	0.255	0.289
3-day:	0.048	0.059	0.075	0.089	0.108	0.122	0.137	0.156	0.184	0.209
4-day:	0.039	0.047	0.06	0.071	0.086	0.097	0.109	0.123	0.145	0.164
7-day:	0.027	0.032	0.04	0.046	0.056	0.062	0.07	0.079	0.092	0.103
10-day:	0.022	0.025	0.031	0.036	0.043	0.048	0.053	0.059	0.068	0.076
20-day:	0.015	0.017	0.02	0.023	0.027	0.029	0.032	0.035	0.039	0.043
30-day:	0.013	0.014	0.016	0.018	0.021	0.023	0.024	0.026	0.029	0.031
45-day:	0.011	0.012	0.013	0.014	0.016	0.018	0.019	0.02	0.022	0.023
60-day:	0.009	0.01	0.011	0.012	0.014	0.015	0.016	0.017	0.018	0.018

Date/time (GMT): Tue Mar 12 19:37:09 2024
pyRunTime: 0.007648944854736328

Natural Diversity Data Base Areas

EAST LYME, CT

June 2024

State and Federal Listed Species

Critical Habitat

Town Boundary

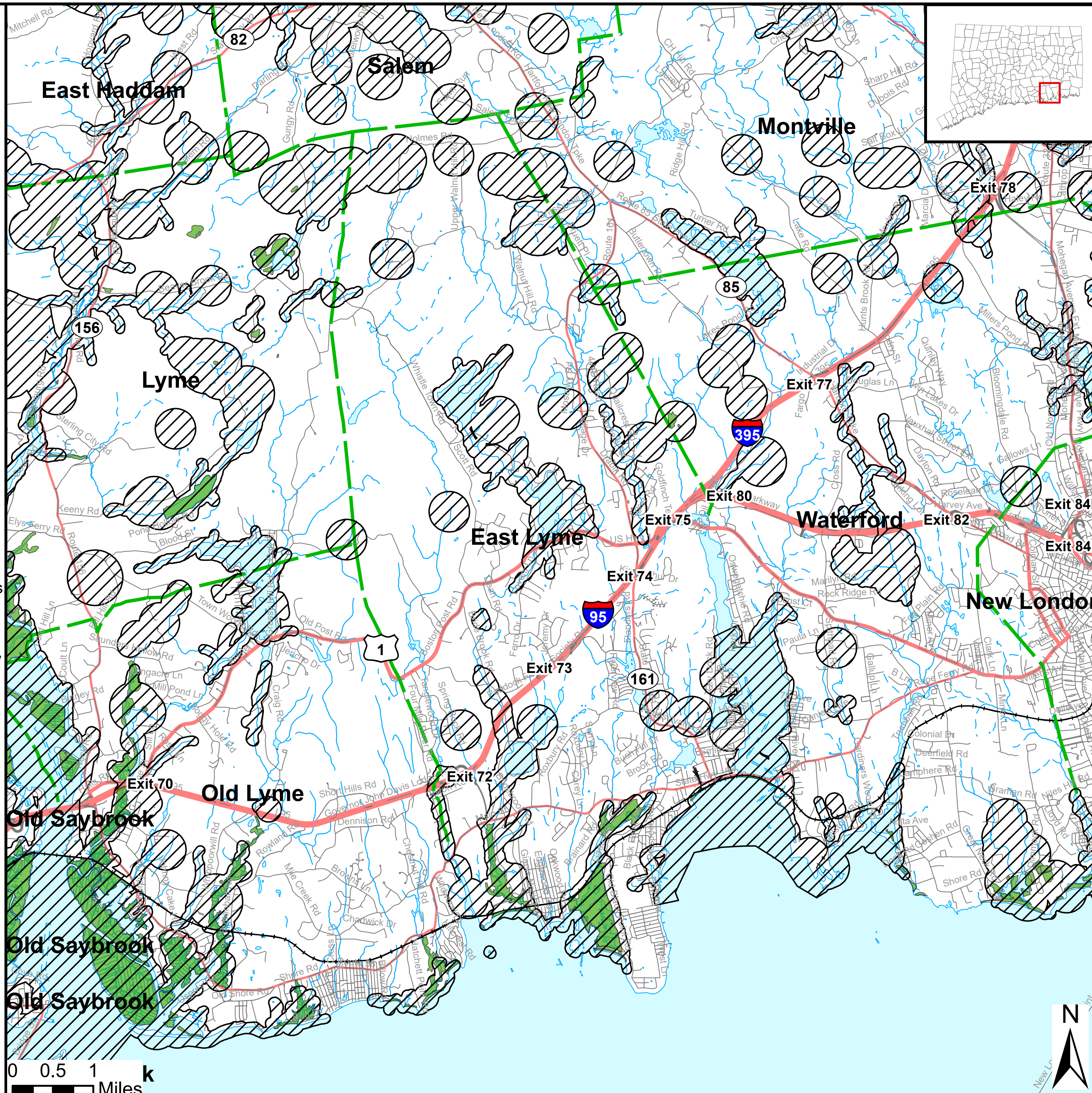
NOTE: This map shows known locations of State and Federal Listed Species and Critical Habitats. Information on listed species is collected and compiled by the Natural Diversity Data Base (NDDB) from a variety of data sources . Exact locations of species have been buffered to produce the generalized locations.

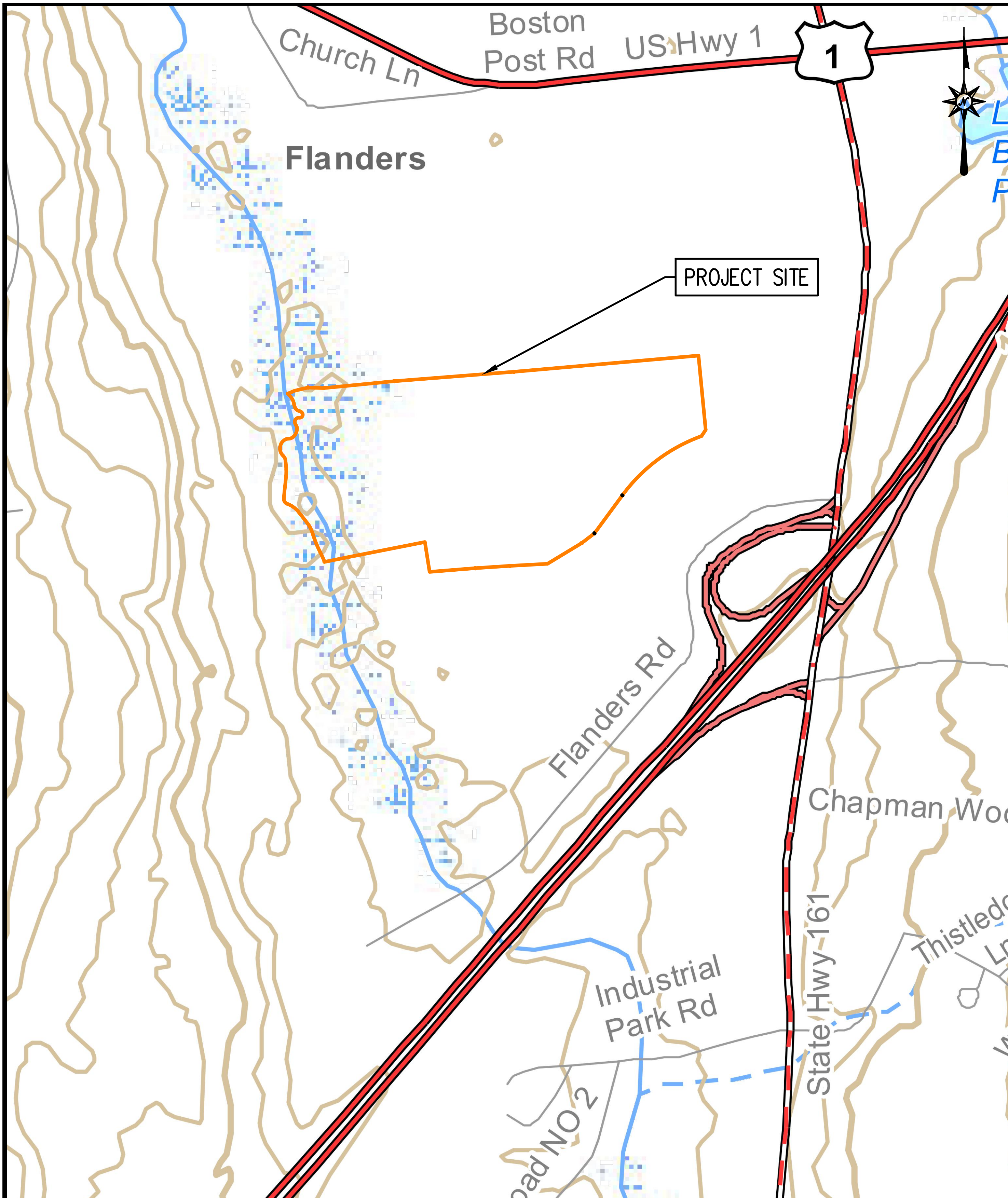
This map is intended for use as a preliminary screening tool for conducting a Natural Diversity Data Base Review Request. To use the map, locate the project boundaries and any additional affected areas. If the project is within a hatched area there may be a potential conflict with a listed species. For more information, use DEEP ezFile https://filings.deep.ct.gov/DEEPPortal/ to submit a Request for Natural Diversity Data Base State Listed Species Review or Site Assessment. More detailed instructions are provided along with the request form on our website.
https://portal.ct.gov/deep-nddbrequest

Use the CTECO Interactive Map Viewers at http://cteco.uconn.edu to more precisely search for and locate a site and to view aerial imagery with NDDB Areas.

QUESTIONS: Department of Energy and Environmental Protection (DEEP)
79 Elm St, Hartford, CT 06106
email: deep.nddbrequest@ct.gov
Phone: (860) 424-3011

Connecticut Department of Energy & Environmental Protection





Architecture
Engineering
Environmental
Land Surveying

PROPOSED LIGHT MANUFACTURING
296 FLANDERS ROAD
EAST LYME, CONNECTICUT

Designed	T.L.B.
Drawn	T.L.B.
Reviewed	R.M.R.
Scale	1"=500'
Project No.	2302349
Date	06/07/2024
CAD File: LOC2302349-01	

FIGURE 1

USGS LOCATION MAP

6/14/2024, TBRAGAW, G:\JOBS23\22\2302349\DWG\LOC2302349-01.DWG,FIGURE 1 8.5X11 2000SC.

6/14/2024, TBRAGAW, G:\JOBS23\22\2302349\DWG\LOC2302349-01.DWG,FIGURE 2 8.5X11 500SC.

Architecture
Engineering
Environmental
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PROPOSED LIGHT MANUFACTURING
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FIGURE 2

AERIAL LOCATION MAP

ATTACHMENT-2

ENGINEERING CALCULATIONS

Groundwater Recharge Volume Calculations

Groundwater Recharge Volume

From CT 2004 Stormwater Quality Manual:

$$GVR = \frac{(D)(A)(I)}{12}$$

GRV Groundwater Recharge Volume (ac-ft)
D = Depth of Runoff to be Recharged (table 7-4)
A = site area in acres
I = impervious cover (decimal)

	A									I							
Area ID	Total Site Area (AC)	Site Area by NRCS Hydrologic Soil Group				Impervious Cover by NRCS Hydrologic Soil Group				Site Imperviousness (Decimel) by NRCS Hydrologic Soil Group				GRV Required		Potential Recharge Pond Volumes Proposed	
		A	B	C	D	A	B	C	D	A	B	C	D	(ac-ft)	(cu ft)	(ac-ft)	(cu ft)
Site	20.17	6.51	13.66	0.00	0.00	3.23	8.58	0.00	0.00	0.16	0.43	0.00	0.00	0.156	6,787	1.882	81,970

Table from 2004 Connecticut Stormwater Quality Manual

Table 7-4
Groundwater Recharge Depth

NRCS Hydrologic Soil Group	Average Annual Recharge	Groundwater Recharge Depth (D)
A	18 inches/year	0.4 inches
B	12 inches/year	0.25 inches
C	6 inches/year	0.10 inches
D	3 inches/year	0 inches (waived)

Source: MADEP, 1997.
NRCS – Natural Resources Conservation Service

NRCS Hydrologic Soil	Groundwater Recharge
A	0.40
B	0.25
C	0.10
D	0.00

Water Quality Calculations

Standard 1 - Determine Water Quality Flow

From CT 2024 Stormwater Quality Manual:

$$CN = \frac{1000}{\left[10 + 5P + 10Q - 10(Q^2 + 1.25QP)^{\frac{1}{2}}\right]}$$

$$Q = \frac{\left[WQV(cubic\ feet) \times [12(inches/foot)] \times \left[\left(\frac{1\ acre}{43{,}560\ square\ feet}\right)\right]\right]}{DrainageArea(acres)}$$

$$WQF = (q_u)(A)(Q)$$

CN = Runoff Curve Number
P = design preciptation, inches, (1.3" for 100% of the WQV and 0.65 inches for 50% of the WQV)
Q = runoff depth (in watershed inches)
T_c = time of concentration
I_a = Initial abstraction, inches, from Table 4-1, Chapter 4, TR-55
q_u = unit peak discharge,
WQF = water quality flow (cfs)
WQV= design Water Quality Volume (100% or 50% of the WQV)

Hydrodynamic Separator	Total Area			Imp Area		Imp Cover	R	WQV	Q	P	CN	T_c		I_a	I_a/P	q_u *	WQF
	ft^2	ac	mi^2	ft^2	ac	%	-	acre-feet	in	in	-	mins	hours	in	-	$cfs/mi^2/in$	cfs
HDS-101	98,017	2.250	0.0035	41,468	0.952	42.31	0.431	0.081	0.43	1.00	93	20.8	0.35	0.151	0.151	450	0.68
HDS-102	87,844	2.017	0.0032	75,345	1.730	85.77	0.822	0.138	0.82	1.00	98	7.2	0.12	0.041	0.041	420	1.09
HDS-103	98,017	2.250	0.0035	41,468	0.952	42.31	0.431	0.081	0.43	1.00	93	5.0	0.08	0.151	0.151	450	0.68
HDS-104	87,844	2.017	0.0032	75,345	1.730	85.77	0.822	0.138	0.82	1.00	98	5.0	0.08	0.041	0.041	450	1.16
P-106	11,483	0.264	0.0004	7,858	0.180	68.18	0.664	0.015	0.68	1.00	97	5.0	0.08	0.062	0.062	450	0.13
P-107	90,871	2.086	0.0033	84,435	1.938	92.91	0.886	0.154	0.89	1.00	99	5.0	0.08	0.041	0.041	450	1.31

Water Quality Calculations

Standard 1 - Determine Water Quality Volume

From CT 2024 Stormwater Quality Manual:

$$WQV = \frac{(1.3")(R)(A)}{12}$$

$$R = 0.05 + 0.009(I)$$

WQV = water quality volume (ft^3)
R = volumetric runoff coefficient
I = post- development impervious area (percent) after application of non-structural LID site planning and design strategies and before application of structural stormwater BMPs
A = post-development total drainage area of site or design point (square feet)

Area ID	Drainage Area	Total Area		Impervious Area		Impervious Cover	Volumetric Runoff Coefficient	Water Quality Volume (WQV) Required	Water Quality Volume Provided
		ac	ft^2	ac	ft^2	%	R	ft^3	ft^3
SWMB P-101	PDA-101	2.250	98,017	0.952	41,468	42.31	0.431	4,577	5,403
SWMB P-102	PDA-102	2.017	87,844	1.730	75,345	85.77	0.822	7,823	6,520
SWMB P-103	PDA-103	0.554	24,111	0.504	21,952	90.97	0.869	2,270	419
SWMB P-104	PDA-105	0.400	17,421	0.367	15,999	91.75	0.876	1,653	419
SWMB P-105	PDA-108	4.227	184,140	4.227	184,140	100.00	0.950	18,951	21,240
SWMB P-106	PDA-109	0.264	11,483	0.180	7,858	68.18	0.664	826	1,578
SWMB P-107	PDA-110	2.086	90,871	1.938	84,435	92.91	0.886	8,722	2,339

Notes: The provided Water Quality Volumes for the Underground Detention Systems were derived from the Stage Volume tables in HydroCAD as the volume below the first orifice elevation for each system.

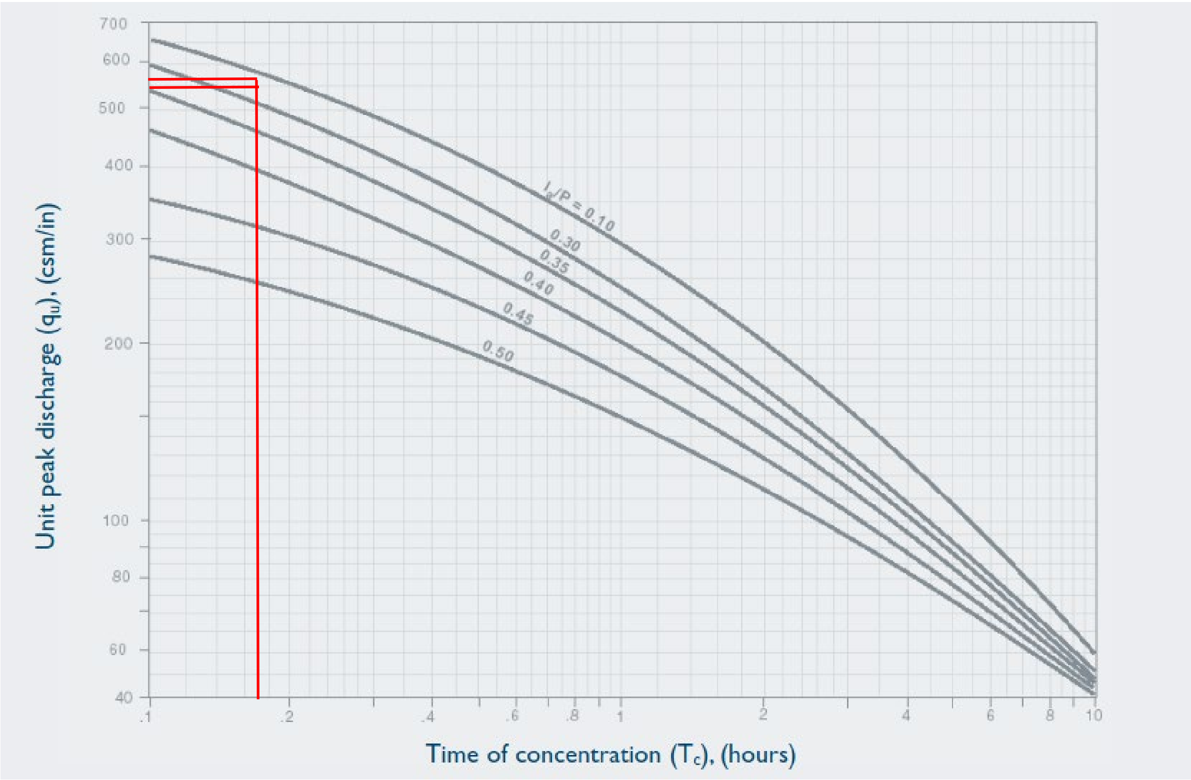
$$WQF = (q_u)(A)(Q)$$

where:

WQF = Water Quality Flow (cubic feet per second, cfs)
q_u = unit peak discharge (cfs, per square mile, per inch of runoff, csm/in)
A = drainage area (square miles)
Q = runoff depth (in watershed inches)

$$Q = \frac{WQV\ (cubic\ feet)}{Drainage\ Area\ (acres)} * \frac{12\ inches}{foot} * \frac{acre}{43{,}560\ square\ feet}$$

Figure 3. Unit Peak Discharge for NRCS Type III Rainfall Distribution



Source: Exhibit 4-III in Chapter 4 of TR-55 (USDA, 1986).

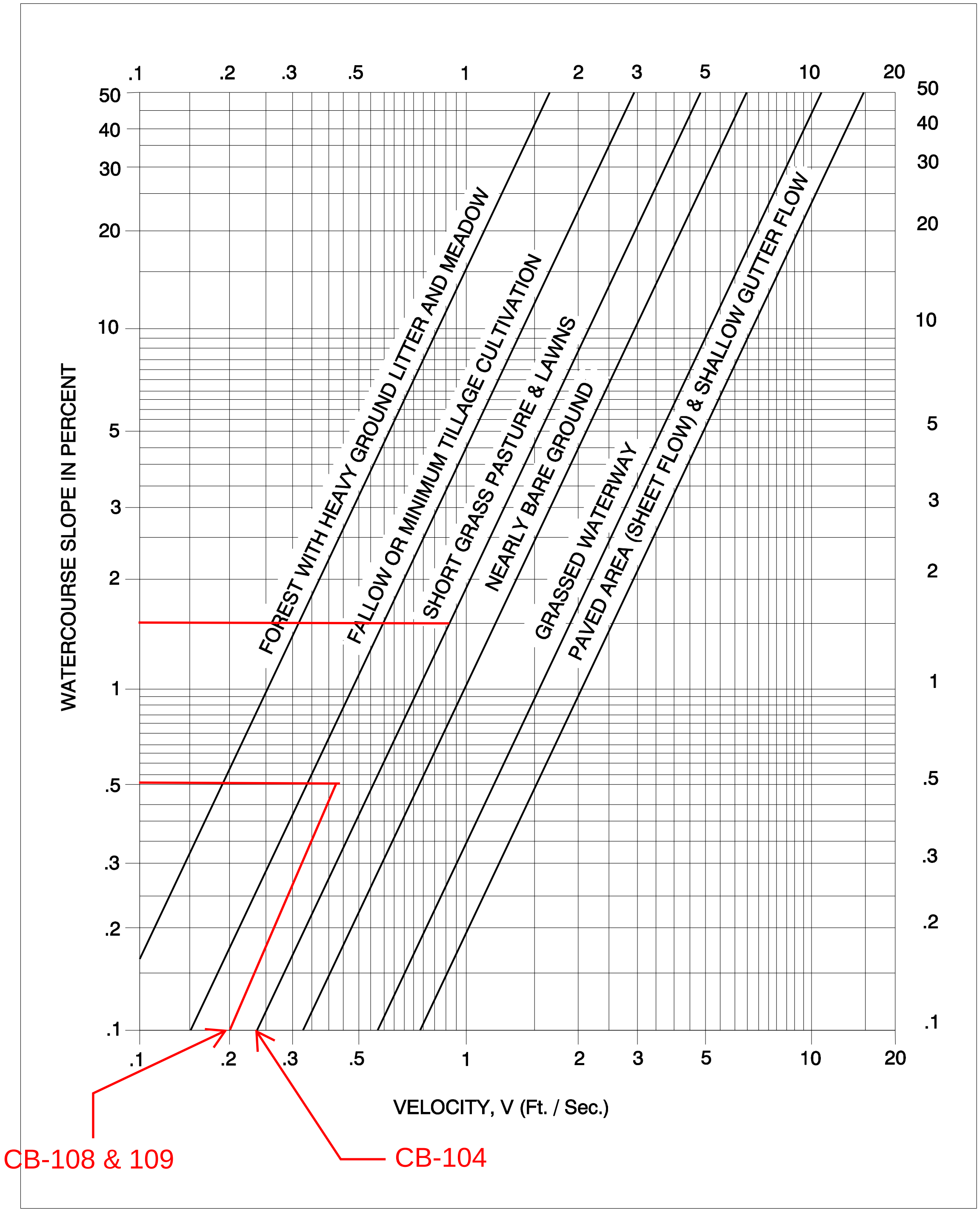


Figure 1 Shallow Concentrated Flow Velocities

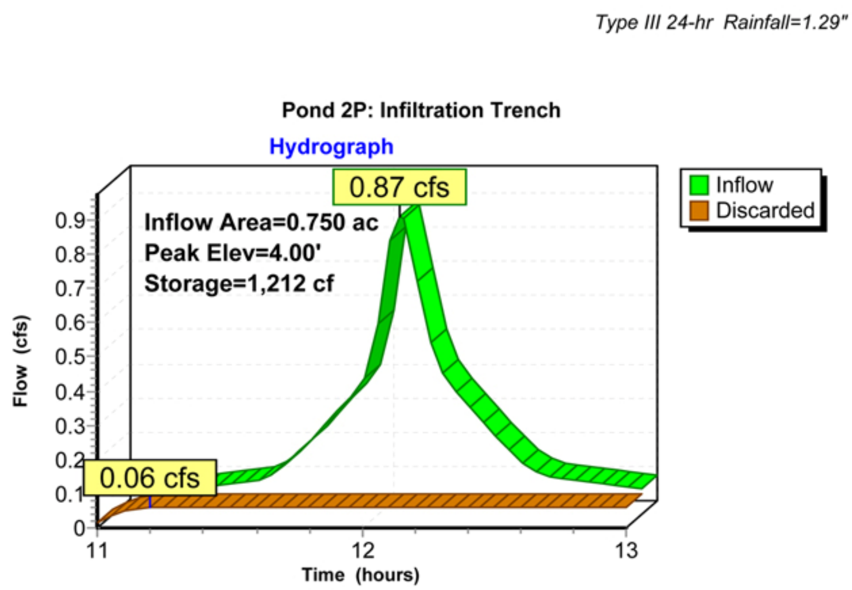


Table 2.3.3. 1982 Rawls Rates[18]

Texture Class	NRCS Hydrologic Soil Group (HSG)	Infiltration Rate Inches/Hour
Sand	A	8.27
Loamy Sand	A	2.41
Sandy Loam	B	1.02
Loam	B	0.52
Silt Loam	C	0.27
Sandy Clay Loam	C	0.17
Clay Loam	D	0.09
Silty Clay Loam	D	0.06
Sandy Clay	D	0.05
Silty Clay	D	0.04
Clay	D	0.02

18 Rawls, Brakensiek and Saxton, 1982

Catch Basin Catchment Areas

Rational Coefficients Used:

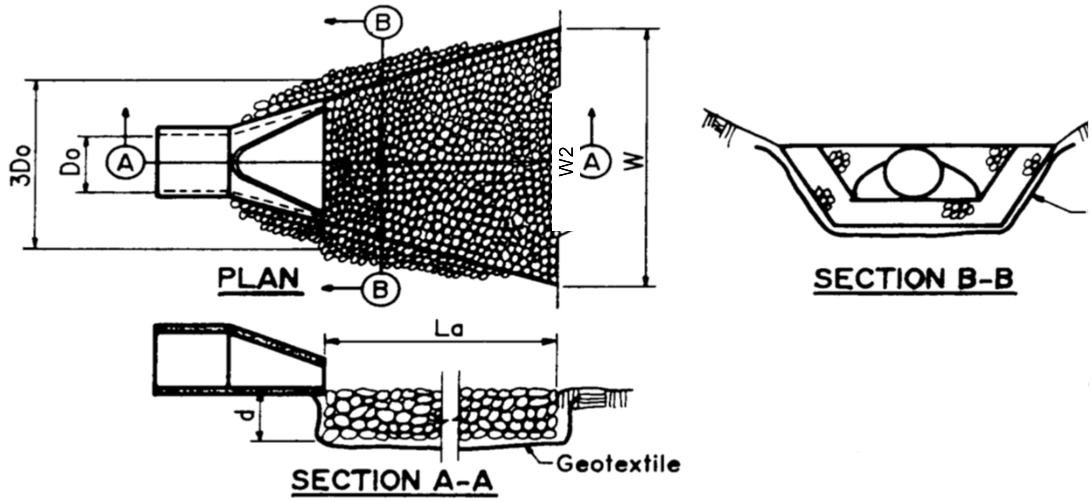
Pavement	0.90
Buidling	0.95
Grass	0.30
Woods	0.25

	Total Area	Pavement	Building	Grass	Woods	C	Tc	CA
CB-101	4,826	4,368	0	458	0	0.84	5.0	0.09
CB-102	18,936	17,675	0	1,261	0	0.86	5.0	0.37
CB-103	5,040	3,840	0	1,200	0	0.76	5.0	0.09
CB-104	54,251	46,579	0	7,672	0	0.82	5.0	1.02
CB-105	17,421	15,999	0	1,422	0	0.85	5.0	0.34
CB-106	26,604	22,961	0	3,643	0	0.82	5.0	0.50
CB-107	6,608	4,775	0	1,833	0	0.73	5.0	0.11
CB-108	40,715	5,873	0	19,744	15,098	0.37	5.0	0.34
CB-109	18,327	2,949	0	15,378	0	0.40	5.0	0.17
CB-110	5,763	4,910	0	853	0	0.81	5.0	0.11
CB-111	4,642	3,892	0	750	0	0.80	5.0	0.09
CB-112	4,975	3,359	0	1,616	0	0.71	5.0	0.08
CB-113	14,937	14,132	0	805	0	0.87	5.0	0.30
CB-114	4,348	3,452	0	896	0	0.78	5.0	0.08
CB-115	2,916	2,486	0	448	0	0.81	5.0	0.05
CB-116	8,549	5,372	0	3,177	0	0.68	5.0	0.13
TOTAL	11,465	7,858	0	3,625	0			
CB-117	10,196	8,406	0	1,790	0	0.79	5.0	0.19
CB-118	7,599	4,902	0	2,697	0	0.69	5.0	0.12
CB-119	22,098	18,294	0	3,804	0	0.80	5.0	0.40
TD-101	7,290	7,290	0	0	0	0.90	5.0	0.15
CB-120	6,757	5,682	0	1,075	0	0.80	5.0	0.12
CB-121	9,536	5,712	0	3,824	0	0.66	5.0	0.14
CB-122	3,068	3,068	0	0	0	0.90	5.0	0.06
CB-123	20,767	19,048	0	1,719	0	0.85	5.0	0.41
CB-124	6,136	5,048	0	1,088	0	0.79	5.0	0.11
CB-125	6,282	4,707	0	1,575	0	0.75	5.0	0.11
CB-126	24,574	22,520	0	2,054	0	0.85	5.0	0.48
TD-102	6,480	6,480	0	0	0	0.90	5.0	0.13
TD-103	6,480	6,480	0	0	0	0.90	5.0	0.13
TD-104	9,264	9,264	0	0	0	0.90	5.0	0.19
TD-105	10,888	10,888	0	0	0	0.90	5.0	0.22
Roof	184,140	92,070	92,070	0	0	0.93	5.0	3.91

Riprap Apron Outlet Protection

PROJECT NAME: Proposed Warehouse
LOCATION: 296 Flanders Road - East Lyme, CT
PREPARED BY: JPD DATE: 6/11/2024
LAST REVISED BY: DATE:

Sp



OUTLET NO.	Sp (Diameter, in.)	Q (CFS)	V (FPS)	Apron Type (letter only)	La (ft.)	W1 (ft.)	W2 (ft.)	Riprap Specification
FES-100	18	6.34	6.20	B	12	5	9	Modified
FES-101	18	9.99	6.50	B	18	5	12	Modified
FES-102	18	5.57	4.82	B	11	5	9	Modified
FES-103	15	0.08	1.50	B	10	4	8	Modified

Note: Riprap apron design calculations based off of standards provided by the Connecticut Department of Transportation Drainage Manual and the Connecticut Guidelines for Soil Erosion and Sediment Control.

Design: Type A: $La=[1.80(Q-5)/Sp^{1.5}] + 10$
$W1=3Sp$
$W2=3Sp + 0.7La$

Type B: $La=[3.0(Q-5)/Sp^{1.5}] + 10$
$W1=3Sp$
$W2=3Sp + 0.4La$

ATTACHMENT-3

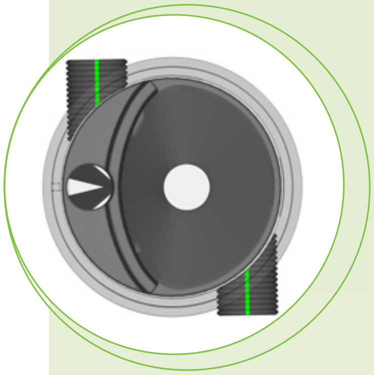
BEST MANAGEMENT PRACTICES DOCUMENTATION

BAYSAVER TECHNOLOGIES

ADS

Barracuda S4

The Barracuda S4 is a market-changing stormwater quality technology. This high performance vortex hydrodynamic separator is designed to remove total suspended solids in order to protect our precious receiving waters. The Barracuda is also an outstanding value that offers multiple pipe configurations, and quick installation.



Inline Configuration

Offline Configuration

FEATURES:

- Single manhole design
- No elevation loss between the inlet and outlet
- Flexible inlet/outlet positions (not just 180 degree orientation)
- Internal bypass for inline installation (where applicable)
- Revolutionary, patent pending "teeth" mitigate turbulence in the sump area to prevent resuspension of captured contaminants.

BENEFITS:

- Internal components are in stock for quick delivery.
- The S4 can be provided within a 48" ADS HP Manhole, to be factory fabricated and delivered complete to the jobsite.
- The S4 can also be installed in a standard 48" precast manhole. The Barracuda "teeth" apparatus is fabricated and designed for quick and easy field assembly.
- Designed for easy maintenance using a vacuum truck or similar equipment.
- Inspection and maintenance are performed from the surface with no confined space entry.

ADS Service: ADS representatives are committed to providing you with the answers to all your questions, including specifications, installation and more.

*THE MOST **ADVANCED** NAME IN WATER MANAGEMENT SOLUTIONS*™

BARRACUDA S4 SPECIFICATION

MATERIALS AND DESIGN

- Concrete Structures: Designed for H-20 traffic loading and applicable soil loads or as otherwise determined by a Licensed Professional Engineer. The materials and structural design of the devices shall be per ASTM C857 and ASTM C858.
- 48" HP Manhole Structures: Made from an impact modified copolymer polypropylene meeting the material requirements of ASTM F2764. The eccentric cone reducer shall be manufactured from polyethylene material meeting ASTM D3350 cell class 213320C. Gaskets shall be made of material meeting the requirements of ASTM F477.
- Separator internals shall be substantially constructed of stainless steel, polyethylene or other thermoplastic material approved by the manufacturer.

PERFORMANCE

- The stormwater treatment unit shall be an inline unit capable of conveying 100% of the design peak flow. If peak flow rates exceed maximum hydraulic rate, the unit shall be installed offline.

- The Barracuda unit shall be designed to remove at least 80% of the suspended solids on an annual aggregate removal basis. Said removal shall be based on full-scale third party testing using OK-110 media gradation or equivalent and 300 mg/L influent concentration. Said full scale testing shall have included sediment capture based on actual total mass collected by the stormwater treatment unit.

  - OR -

  The Barracuda unit shall be designed to remove at least 50% of TSS using a media mix with d_{50}=75 micron and 200 mg/L influent concentration.

  - OR -

  The Barracuda unit shall be designed to remove at least 50% of TSS per current NJDEP/NJCAT HDS protocol .

- The stormwater treatment unit internals shall consist of (1) separator cone assembly, and (1) sump assembly which includes (4) legs with "teeth".

	Manhole Diameter	80% Removal OK-110	50% TSS per NJCAT	Max Hydraulic Rate
Barracuda S4	48"	1.08 CFS	1.25 CFS	6.25 CFS

INSTALLATION

Installation of the stormwater treatment unit(s) shall be performed per manufacturer's installation instructions. Such instructions can be obtained by calling Advanced Drainage Systems at (800) 821-6710 or by logging on to www.ads-pipe.com or www.baysaver.com.

Advanced Drainage Systems, Inc.
4640 Trueman Blvd., Hilliard, OH 43026
1-800-821-6710 www.ads-pipe.com

BOGGS ENVIRONMENTAL CONSULTANTS

Middletown, MD & Morgantown, WV

Administrative Office:
200 W Main Street
Middletown, Maryland 21769

Office (301) 694-5687
Fax (301) 694-9799

BaySaver Technologies, LLC
1030 Deer Hollow Drive
Mount Airy, MD 21771
(301) 679-0640; dfigola@ads-pipe.com

November 13, 2017

ATTENTION: Daniel Figola, General Manager
REFERENCE: Third Party Review of NJCAT Testing Procedures for Barracuda™ Separator at the Mid Atlantic Storm Water Research Center, 1207 Park Ridge Drive, Mount Airy, MD 21771

SUMMARY

Boggs Environmental Consultants, Inc. (BEC) was hired by Advanced Drainage Systems (ADS) in May of 2017, to serve as independent third-party oversight of NJCAT testing of the BaySaver Barracuda S4 Separator test unit for removal of sediment. The device is an insert that can be installed in either Polypropylene plastic pipe or concrete vault, and consists of a cone (vortex separator) and baffles ("teeth"). For the particle size distribution and weighted calculation method required by the NJDEP HDS Protocol, the Barracuda Separator demonstrated greater than 50% TSS removal at an MTFR of 1.25 cfs (559 gpm) under the NJCAT protocol and gained approval by NJDEP.

SCALED RESULTS

All testing and data collection procedures, including sediment blending, were supervised by BEC, and in accordance with the *New Jersey Department of Environmental Protection Laboratory Protocol to Assess Total Suspended Solids Removal by a Hydrodynamic Sedimentation Manufactured Treatment Device* (January 2013) (NJDEP HDS Protocol). Testing flow rates ranged from 0.32 to 1.60 cfs (142 gpm – 720 gpm), with a target influent sediment concentration of 200 mg/L. Based upon New Jersey scaling methodology, the table below represents treatment and device information for the S4, S6, and S8 units.

Table 1: MTFR's and Sizings for BaySaver Barracuda Models

Model[1]	Manhole Diameter[1] (ft)	NJDEP 50% TSS MTFR (cfs)	Treatment Area (ft^2)	Hydraulic Loading rate (gpm/ft^2)	Chamber Depth (ft)	Wet Volume (ft^3)	50% Maximum Sediment Storage[2] (ft^3)
Barracuda S4	4	1.25	12.57	44.6	6.83	75.4	10.47
Barracuda S6	6	2.80	28.27	44.6	6.83	169.7	23.56
Barracuda S8	8	5.00	50.27	44.6	11.03	512.7	41.89

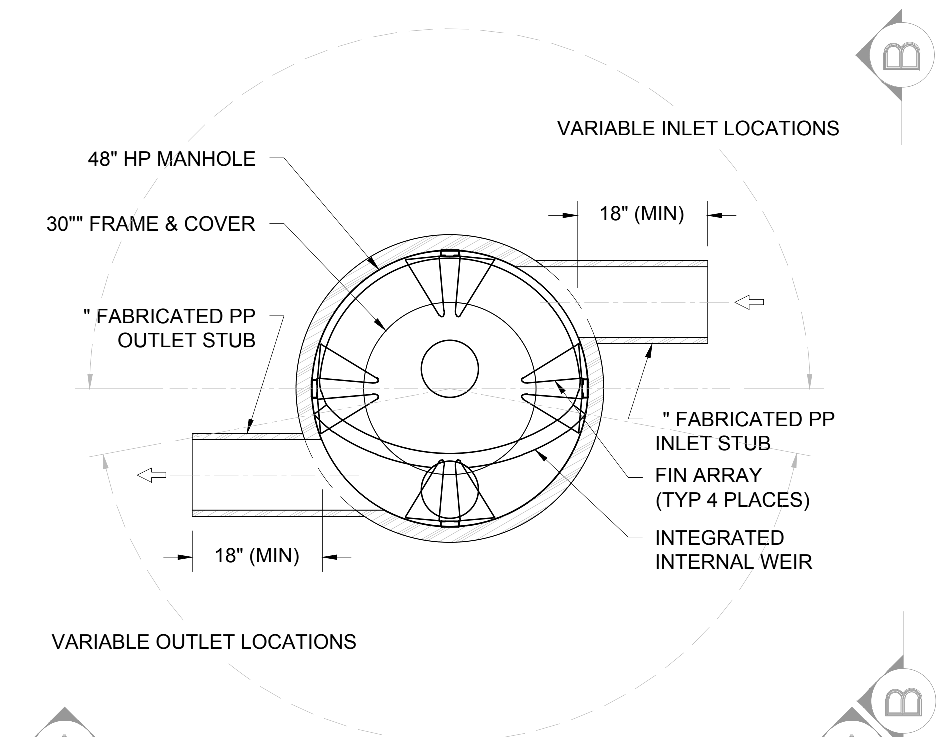
Notes:
1. In some areas Barracuda units are available in additional diameters. Units not listed here are sized not to exceed 44.6 gpm/ft^2 of effective treatment during the peak water quality flow.
2. 50% Sediment Storage Capacity is equal to manhole diameter x 10 inches of sediment depth. Each Barracuda unit has a 20 inches deep sediment sump.

Should you have any questions, contact our office at your earliest convenience.

Sincerely,
BOGGS ENVIRONMENTAL CONSULTANTS, INC.

William R. Warfel
Principal Environmental Scientist

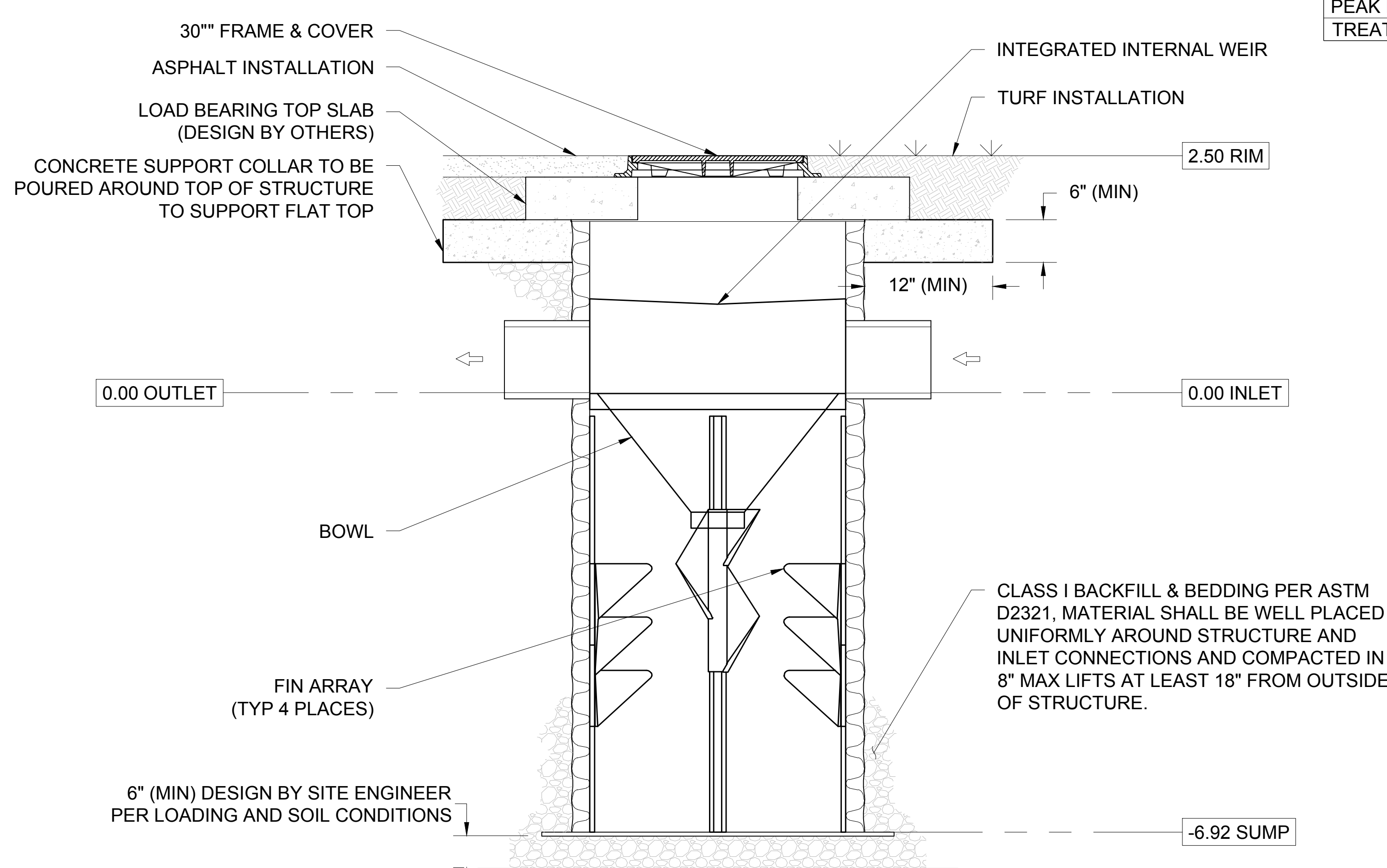
Robin J. Maliszewskyj
Chemical Engineer



PLAN VIEW

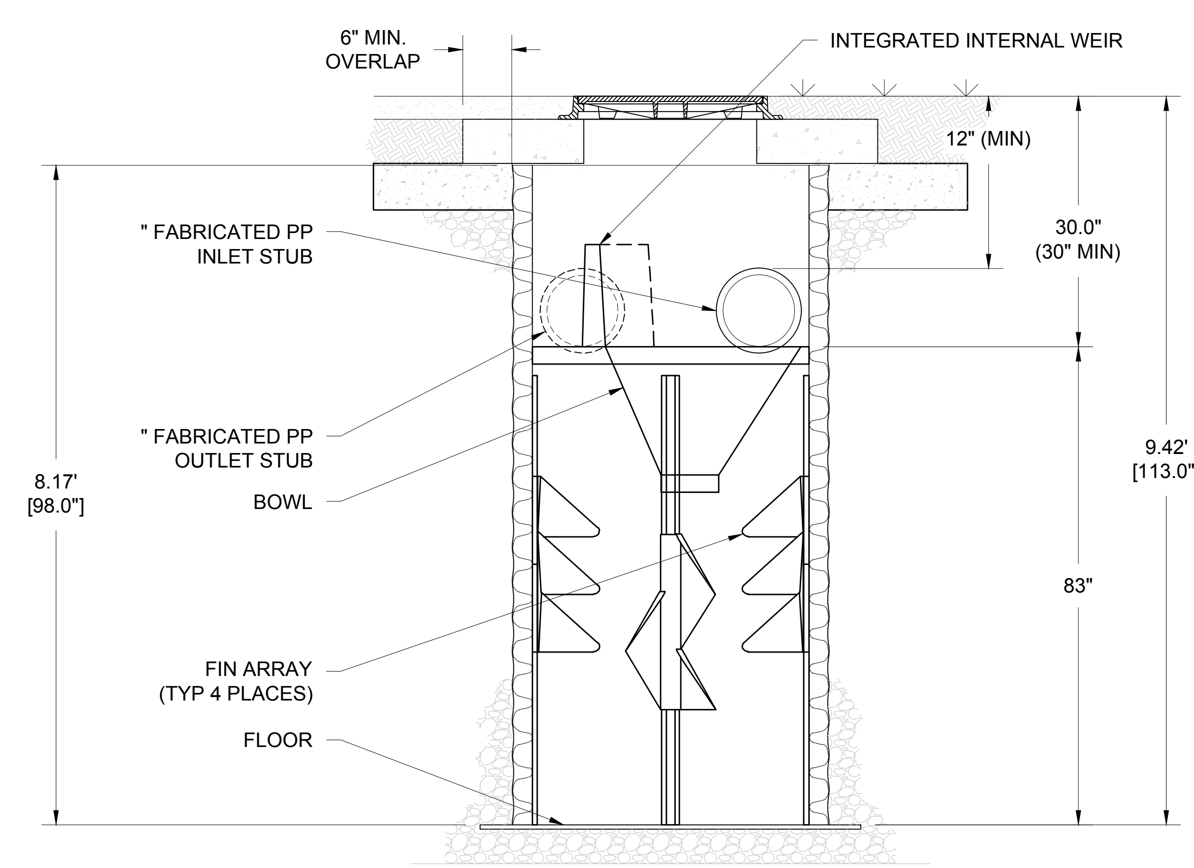
NTS

BARRACUDA S4	
UNIT ID	BMP#1
PEAK FLOW RATE (CFS)	
TREATMENT FLOW RATE (CFS)	1.25 CFS



SECTION VIEW A-A

NTS



SECTION VIEW B-B

NTS

BARRACUDA S4 HP
STANDARD DETAIL

DATE:	10/20/17	DRAWN:	EKH
PROJECT #:		CHECKED:	----

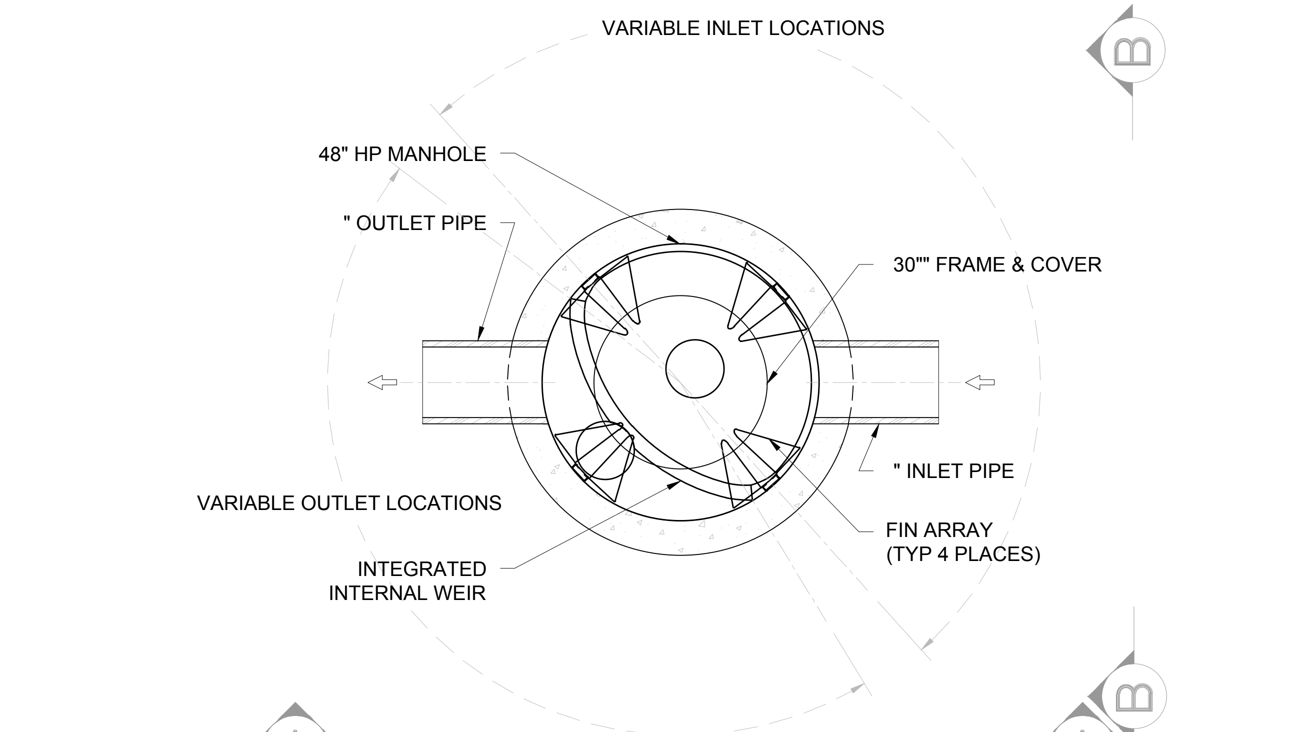
REV	DWN	CKD	DESCRIPTION

Barracuda®
1030 Deer Hollow Drive
Mount Airy, MD 21771
1-800-BAYSAVER
1-800-229-7283

ADS®
ADVANCED DRAINAGE SYSTEMS, INC.
4640 TRUEMAN BLVD
HILLIARD, OH 43026

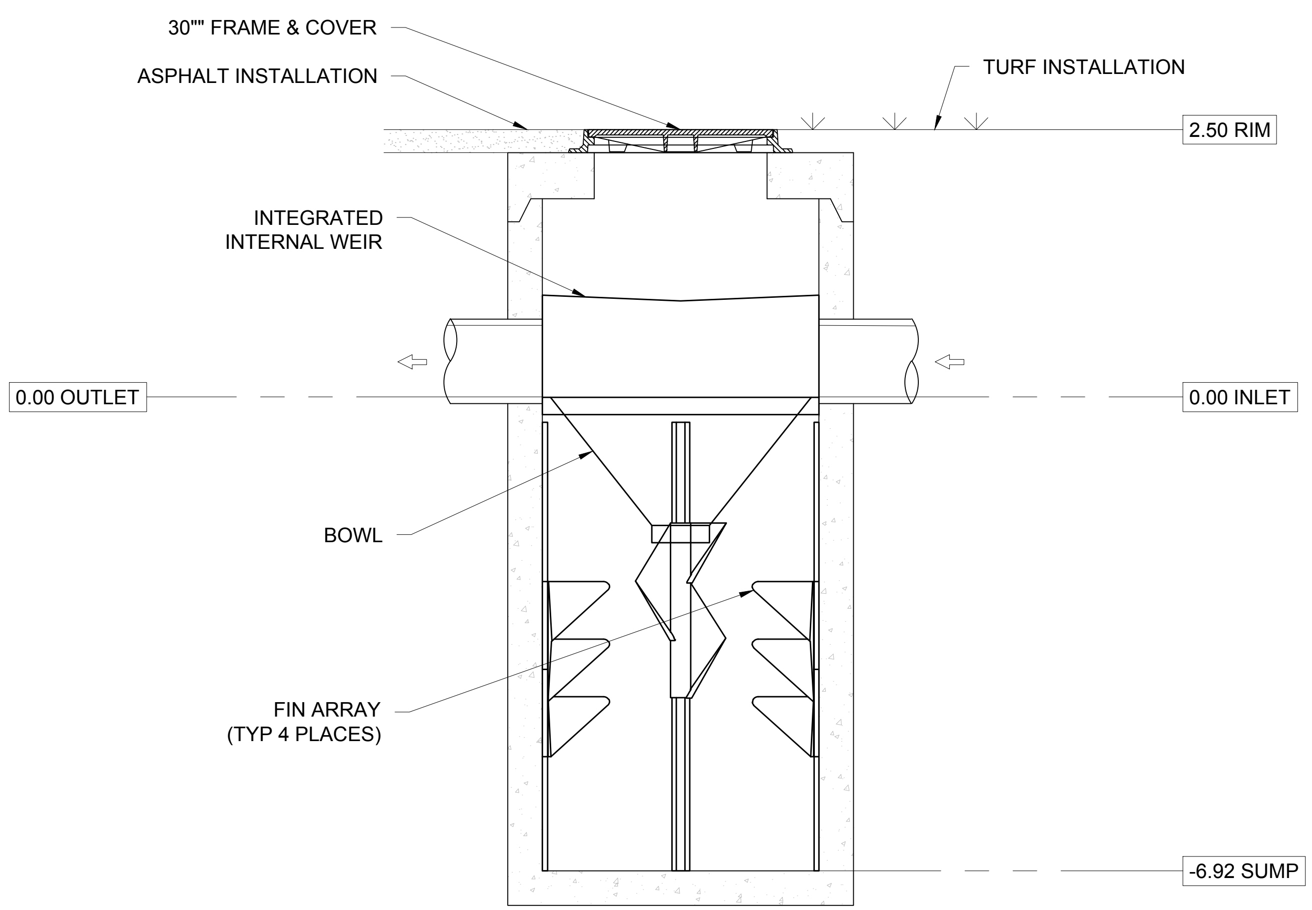
NOT TO SCALE

SHEET 1 OF 1

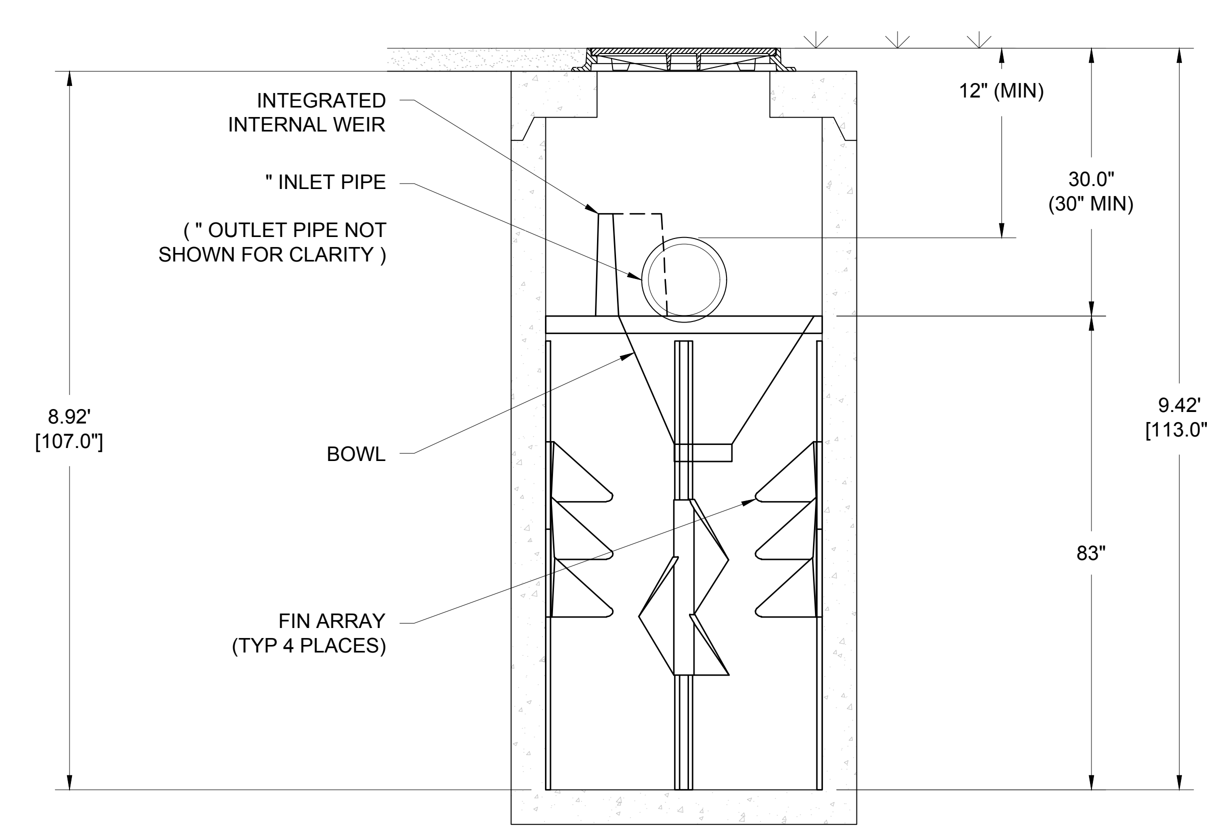


PLAN VIEW
NTS

BARRACUDA S4	
UNIT ID	BMP#1
PEAK FLOW RATE (CFS)	
TREATMENT FLOW RATE (CFS)	1.25 CFS



SECTION VIEW A-A
NTS



SECTION VIEW B-B
NTS

BARRACUDA S4
STANDARD DETAIL

DATE:	10/20/17	DRAWN:	EKH
PROJECT #:		CHECKED:	----

REV	DWN	CKD	DESCRIPTION

1030 Deer Hollow Drive
Mount Airy, MD 21771
Barracuda
1-800-BAYSAVER
1-800-229-7283

ADS
ADVANCED DRAINAGE SYSTEMS, INC.
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HILLIARD, OH 43026

NOT TO SCALE

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SHEET 1 OF 1

Maintenance Guide

BaySaver Barracuda™ — July 2017

One of the advantages of the BaySaver Barracuda is the ease of maintenance. Like any system that collects pollutants, the BaySaver Barracuda must be maintained for continued effectiveness. Maintenance is a simple procedure performed using a vacuum truck or similar equipment. The systems were designed to minimize the volume of water removed during routine maintenance, reducing disposal costs.

Contractors can access the pollutants stored in the manhole through the manhole cover. This allows them to gain vacuum hose access to the bottom of the manhole to remove sediment and trash. There is no confined space entry necessary for inspection or maintenance.

The entire maintenance procedure typically takes from 2 to 4 hours, depending on the size of the system, the captured material, and the capacity of the vacuum truck.

Local regulations may apply to the maintenance procedure. Safe and legal disposal of pollutants is the responsibility of the maintenance contractor. Maintenance should be performed only by a qualified contractor.

Inspection and Cleaning Cycle

Periodic inspection is needed to determine the need for and frequency of maintenance. You should begin inspecting as soon as construction is complete and thereafter on an annual basis. Typically, the system needs to be cleaned every 1-3 years.

Excessive oils, fuels or sediments may reduce the maintenance cycle. Periodic inspection is important.

Determining When to Clean

To determine the sediment depth, the maintenance contractor should lower a stadia rod into the manhole until it contacts the top of the captured sediment and mark that spot on the rod. Then push the probe through to the bottom of the sump and mark that spot to determine sediment depth.

Maintenance should occur when the sediment has reached the levels indicated in the Storage Capacity Chart.

BaySaver Barracuda Storage Capacities

Model	Manhole Diameter	Treatment Chamber Capacity	Standard Sediment Capacity (20” depth)	NJDEP Sediment Capacity (50% of standard depth)
S3	36”	212 gallons	0.44 cubic yards	0.22 cubic yards
S4	48”	564 gallons	0.78 cubic yards	0.39 cubic yards
S5	60”	881 gallons	1.21 cubic yards	0.61 cubic yards
S6	72”	1269 gallons	1.75 cubic yards	0.88 cubic yards
S8	96”	3835 gallons	3.10 cubic yards	1.55 cubic yards
S10	120”	7496 gallons	4.85 cubic yards	2.43 cubic yards

Maintenance Instructions

1. Remove the manhole cover to provide access to the pollutant storage. Pollutants are stored in the sump, below the bowl assembly visible from the surface. You’ll access this area through the 10” diameter access cylinder.

2. Use a vacuum truck or other similar equipment to remove all water, debris, oils and sediment. See figure 1.
3. Use a high pressure hose to clean the manhole of all the remaining sediment and debris. Then, use the vacuum truck to remove the water.
4. Fill the cleaned manhole with water until the level reaches the invert of the outlet pipe.
5. Replace the manhole cover.
6. Dispose of the polluted water, oils, sediment and trash at an approved facility.
   - Local regulations prohibit the discharge of solid material into the sanitary system. Check with the local sewer authority for authority to discharge the liquid.
   - Some localities treat the pollutants as leachate. Check with local regulators about disposal requirements.
   - Additional local regulations may apply to the maintenance procedure.

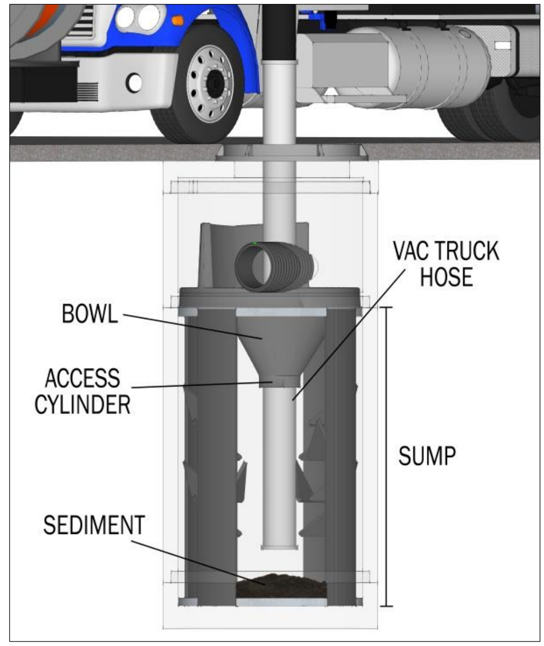

Figure 1

StormTech®
Detention • Retention • Water Quality
Division of ADS

STORMTECH ISOLATOR ROW SIZING CHART

	SC-160LP	SC-310	SC-740	DC-780	MC-3500	MC-4500
Chamber Area (Sq.Ft.)	11.4	20	27.8	27.8	43.2	30.1
Treated Flow Rate per chamber (CFS)	0.055	0.11	0.15	0.15	0.24	0.17

NOTE: *Testing of the Isolator Row verified by NJCAT.It has shown to have a TSS removal efficiency of 84% for SIL-CO-SIL 250. MASTEP verification of up to 83% TSS of the OK-110.*

NJCAT verified Treated Flow Rate (GPM / Sq.Ft.) 2.5

NJCAT TECHNOLOGY VERIFICATION

StormTech® Isolator™ Row

August 2007

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1. Introduction

1.1 New Jersey Corporation for Advanced Technology (NJCAT) Program

NJCAT is a not-for-profit corporation to promote in New Jersey the retention and growth of technology-based businesses in emerging fields such as environmental and energy technologies. NJCAT provides innovators with the regulatory, commercial, technological and financial assistance required to bring their ideas to market successfully. Specifically, NJCAT functions to:

- Advance policy strategies and regulatory mechanisms to promote technology commercialization;
- Identify, evaluate, and recommend specific technologies for which the regulatory and commercialization process should be facilitated;
- Facilitate funding and commercial relationships/alliances to bring new technologies to market and new business to the state; and
- Assist in the identification of markets and applications for commercialized technologies.

The technology verification program specifically encourages collaboration between vendors and users of technology. Through this program, teams of academic and business professionals are formed to implement a comprehensive evaluation of vendor specific performance claims. Thus, suppliers have the competitive edge of an independent third party confirmation of claims.

Pursuant to N.J.S.A. 13:1D-134 et seq. (Energy and Environmental Technology Verification Program), the New Jersey Department of Environmental Protection (NJDEP) and NJCAT have established a Performance Partnership Agreement (PPA) whereby NJCAT performs the technology verification review and NJDEP certifies that the technology meets the regulatory intent and that there is a net beneficial environmental effect by using the technology. In addition, NJDEP/NJCAT work in conjunction to develop expedited or more efficient timeframes for review and decision-making of permits or approvals associated with the verified/certified technology.

The PPA also requires that:

- The NJDEP shall enter into reciprocal environmental technology agreements concerning the evaluation and verification protocols with the United States Environmental Protection Agency (USEPA), other local or national environmental agencies, entities or groups in other states and New Jersey for the purpose of encouraging and permitting the reciprocal acceptance of technology data and information concerning the evaluation and verification of energy and environmental technologies; and

- The NJDEP shall work closely with the State Treasurer to include in State bid specifications, as deemed appropriate by the State Treasurer, any technology verified under the Energy and Environment Technology Verification Program.

1.2 Technology Verification Report

In December 2006 StormTech®, LLC (20 Beaver Road, Suite 104, Wethersfield, Connecticut, 06109) submitted a formal request for participation in the NJCAT Technology Verification Program. The technology proposed, the StormTech® Isolator™ Row, filters sand, and silt sized particles from stormwater runoff from developed sites. It is considered a post-development BMP (best management practice) that is potentially an additional tool to meet the State's stormwater quality objectives.

The request (after pre-screening by NJCAT staff personnel in accordance with the technology assessment guidelines) was accepted into the verification program. This verification report covers the evaluation based upon the performance claims of the vendor, StormTech® (see Section 4). This verification report is intended to evaluate StormTech®'s initial performance claims for the technology based primarily on laboratory studies. This project included the evaluation of company manuals and laboratory testing reports to verify that the StormTech® Isolator™ Row meets the performance claims of StormTech®.

1.3 Technology Description

1.3.1 Technology Status

In 1990 Congress established deadlines and priorities for USEPA to require permits for discharges of stormwater that are not mixed or contaminated with household or industrial wastewater. Phase I regulations established that a NPDES (National Pollutant Discharge Elimination System) permit is required for stormwater discharge from municipalities with a separate storm sewer system that serves a population greater than 100,000 and certain defined industrial activities. To receive a NPDES permit, the municipality or specific industry has to develop a stormwater management plan and identify best management practices for stormwater treatment and discharge. Best management practices (BMPs) are measures, systems, processes or controls that reduce pollutants at the source to prevent the pollution of stormwater runoff discharge from the site. Phase II stormwater discharges include all discharges composed entirely of stormwater, except those specifically classified as Phase I discharge.

The StormTech® subsurface chamber system for stormwater management provides underground detention, retention, and storage of stormwater. This subsurface chamber system eliminates the need for surface detention ponds and optimizes space. The StormTech® chamber system for stormwater management can be used in commercial, residential, recreational, agricultural, and highway drainage applications. The StormTech® chamber system is accompanied by the StormTech® Isolator™ Row, which enhances total suspended solids (TSS) removal, as well as provides for inspection and maintenance of the chamber system.

The Isolator™ Row is a row of StormTech® chambers that is surrounded with filter fabric and connected to a manhole. The chambers allow for settling and filtration of sediment as stormwater rises within the Isolator™ Row and passes through the filter fabric. The open bottom chambers and the perforated sidewalls allow stormwater to flow in both a vertical and horizontal direction out of the chambers. Sediments are then captured in the Isolator™ Row, thereby protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

1.3.2 Specific Applicability

The Isolator™ Row can be designed on a volume basis or flow rate basis depending on regulatory requirements. An upstream manhole can typically include a high flow weir such that stormwater flow rates or volumes that exceed the capacity of the Isolator™ Row overtop the overflow weir and discharge through a manifold to the other chambers.

1.4 Project Description

This project included the evaluation of company manuals and laboratory testing reports to verify that the StormTech® Isolator™ Row meets the performance claims of StormTech®.

1.5 Key Contacts

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2. Evaluation of the Applicant *(As provided by David J. Mailhot, P.E. on 1/19/07)*

2.1 Corporate History

StormTech® was founded in the late 1990s by Jim Nichols to provide subsurface chamber systems exclusively for stormwater applications. Mr. Nichols, a mechanical engineer and entrepreneur, is known for successfully developing a plastic chamber system for on-site sanitary sewage applications and for ultimately creating the market for chambers.

Since a primary motivation for engineers and developers locating stormwater storage under ground is often to create more parking spaces, subsurface chamber applications are typically under parking lots and roadways. In these demanding applications, structural integrity is vital. StormTech® recognized the need for a structurally robust chamber and began a product development program to turn this vision into a reality.

StormTech®'s product development program spanned more than four years at a cost of over $7 million. Early chambers were thermoformed from sheets of polyethylene and installed in sixteen locations around the country for observation. Although the early chambers performed well, it became apparent that maintaining uniform wall thickness in the product was an important structural concern that could not be controlled using the thermoforming process. So StormTech® moved on, investing more money and time developing the means to injection mold chambers.

At about the same time as StormTech®'s move to injection molding, Dr. Timothy McGrath, P.E. of Simpson, Gumpertz & Heger was developing new design specifications for buried pipe under the National Cooperative Highway Research Program (NCHRP). After years of research and collaboration with others conducting state of the art work for flexible pipe design, Dr. McGrath framed the design requirements for flexible structures based on strain limits for long term loads and a time-dependent material modulus. Dr. McGrath's NCHRP work was adopted by the American Association of State Highway and Transportation Officials (AASHTO) and incorporated into the AASHTO LRFD Bridge Design Specifications. This design method is now the standard for structures buried under vehicle travel ways.

StormTech® seized an opportunity to hire Dr. McGrath as a consultant for their chamber development program. From that point forward, the chamber development would be evaluated under a higher standard, AASHTO. Dr. McGrath oversaw extensive field testing of the buried chambers using state-of-the-art instrumentation. The testing included several shallow cover tests under AASHTO H20 design vehicle loads for various structural aggregate gradations as well as deep cover tests that spanned months in duration. Test results were used to validate finite element analysis models and to verify structural safety factors.

The result of the product development program was a chamber that was designed in accordance with the same AASHTO specifications that structural engineers use in the design of highway structures. The product was unique since it was the only chamber produced from virgin, impact modified polypropylene, the only injection molded chamber and, at approximately 75 pounds, was the largest injection-molded, one-piece thermoplastic structure produced anywhere.

In 2002, with Jim Nichols as President and David Click as Vice President and General Manager, StormTech®, Inc. began manufacturing and distributing two models of yellow chambers called the StormTech® SC-740 and the StormTech® SC-310. However, StormTech®'s resources were limited to a small force of six outside sales personnel. Although the chamber system was proving to be a more cost effective alternative for underground stormwater storage than competing systems such as polyethylene pipe, it was clear that sales and distribution would need to be ramped up fast to realize the business potential of this product line.

In 2003 Jim Nichols and David Click found the perfect partner and StormTech®, Inc. became StormTech®, LLC as the result of a joint venture agreement between two corporate owners. The new joint venture partner was Advanced Drainage Systems (ADS). ADS brought access to an outside sales force of over 200 personnel, field engineers, an established distribution system and a fleet of trucks to move the product. Ronald Vitarelli was appointed President and General Manager and StormTech®, LLC was positioned as an independently operated, privately owned business.

Under Mr. Vitarelli, StormTech® is committed to a safe, conservative design philosophy. This is accomplished by strict adherence to national standards. StormTech® chamber systems are not only designed to AASHTO specifications, but the chamber itself is produced to ASTM standards. StormTech® played a key role in driving the development of ASTM F2418 "Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers." This standard ensures that each chamber produced meets minimum standards for raw materials, dimensional consistency and overall product quality. The robust design and adherence to national standards separates StormTech® chambers from various other flexible structures and positions StormTech® with classes of established buried structures like reinforced concrete and high density polyethylene pipe.

With the creation of StormTech®, LLC, the outside sales group immediately transitioned into a team of Regional Product Managers who provide technical support and management to the ADS sales team.

Shortly after the inception of StormTech®, LLC, Mr. Vitarelli brought David J. Mailhot, P.E. to StormTech® to establish a technical department and the small inside sales team was replaced with a technical team comprised of engineers and technicians. David Mailhot brings many years of engineering experience from the flexible pipe industry including work with researchers to apply soil-structure interaction principles to flexible drainage structure design and also includes work with water quality systems for stormwater treatment. The technical team includes engineering for product development and the Technical Services Department which provides CAD services and specifications to the consulting engineers who specify StormTech® chambers and to the contractors who install StormTech® chambers.

Also in 2003, StormTech® introduced an innovative yet simple system to capture and remove sediments from stormwater called the Isolator™ Row. Removing the sediments from the incoming stormwater prevents sediments from accumulating in the chambers and in the surrounding aggregate. Since the chamber system utilizes the storage volume in the stone porosity, as well as the volume within the chambers, it is important to prevent any loss of void space. The Isolator™ Row intercepts sediments before they reach the surrounding stone voids and provides a means to inspect and conduct maintenance.

The Isolator™ Row is a row or rows of chambers that are completely wrapped by geotextile fabrics. Stormwater is directed into the Isolator™ Row so that flow must pass through the fabric before reaching the surrounding stone. Sediments are filtered out onto the fabric where they can later be jetted out and vactored from the access manhole upstream.

Since 2003, StormTech® chambers have gained wide acceptance as a stormwater detention method. The Isolator™ Row is a recent extension of this technology to address water quality.

In the spring of 2004, StormTech®, LLC received an award from The Society of the Plastics Industry, Inc. Structural Plastics Division for the "Stormwater Chamber & End Caps Model 740." This award was recognition for the sophistication and technology of the mold design for the production of what may be the largest injection molded structural part.

2005 was an important year for StormTech® and for the chamber industry. In early 2005, StormTech®'s significant investment in materials research paid dividends as StormTech® validated a short term materials test for creep modulus determination. This new testing technique enables StormTech® the ability to ensure that raw materials not only meet the initial properties that are commonly measured by resin suppliers, but also the 50-year creep modulus property that is an essential component of long-term design requirement in the AASHTO design specification. StormTech®'s materials research remains an important leg of the Company's leadership position in the Industry.

In the fall of 2005, ASTM F 2418 "Standard Specification for Polypropylene (PP) Corrugated Wall Stormwater Collection Chambers" was passed by ASTM and became the standard for polypropylene chambers and the model specification for the chamber industry. StormTech® chambers are marked with the "ASTM F 2418" designation and with the ASTM F 4101 materials designation "PP0330B99945" as required by the ASTM standard.

Also in 2005, Tennessee Technological University completed the first series of laboratory tests for the Isolator™ Row and reported total suspended solids (TSS) removal efficiencies of over 95% for the manufactured silica product, US Silica OK-110. This testing resulted in an approval of the Isolator™ Row as a water quality BMP in the state of Maine. However, currently applications are more limited since the new Maine standards require other BMP techniques. The Ontario (Canada) Ministry of the Environment also has reviewed the Isolator™ Row testing by Tennessee Tech University and has issued a Certificate of Technology Assessment.

Currently StormTech® has 26 employees. Approximately 500,000 chambers are installed around the word in over 2,600 projects. Only a small percentage (less than 10%) of chambers nationwide are being used for water quality purposes. The large percentage of chambers is used for retention or detention applications. The Isolator™ Row concept with one-layer of geotextile fabric is used on approximately 90% of StormTech® projects. However, historically the primary application has been as a maintenance feature where sediments and debris are captured and prevented from entering the stone voids. In these applications, the objectives are to prevent accumulation of sediment in the stone voids in detention systems and to minimize occlusion at infiltration surfaces in retention systems.

2.2 Organization and Management

The Company is headquartered in Wethersfield, Connecticut with ten regional sales offices in the United States. StormTech® is also represented in Europe, Australia and the Middle East.

Ronald Vitarelli is the President and General Manager of StormTech®, LLC and reports to a Board of Directors consisting of executives from each of two corporate owners. Other members of the management team include: David J. Mailhot, P.E., Engineering Manager, Susan McNamee, Operations Manager, David K. Click, Director of International Sales & Southern Zone Manager, Daniel Hurdis, Northeastern Zone Manager and Mark Moeller, P.E., Western Zone Manager.

2.3 Technical Resources, Staff and Capital Equipment

StormTech® benefits from several technical resources. StormTech® has five registered professional Civil Engineers on staff, three non-registered degreed Civil Engineers, a geologist, a polymer scientist and a construction engineer. Several of the engineers have advanced degrees. StormTech® engineers bring with them decades of experience in buried structures from the drainage pipe industry and decades of experience from the water quality industry. Water quality experience includes design and sales of vortex separators, gravity grit separators, gravity filters and various media filters.

The corporate owners lead their respective industries in pipe extrusion and injection molding technologies. StormTech® owns multiple molds for injection molding chambers and end caps. Together with their corporate owners and outside consultants, StormTech® uses state-of-the-art molding techniques and has advanced the industry with their developmental work of materials test methods for the determination of long-term thermoplastic mechanical properties.

StormTech® retains Simpson, Gumpertz & Heger, Inc. (SGH) for structural analysis relative to applications and product design. SGH is uniquely qualified in areas of buried pipe design and soil-structure interaction systems including buried flexible structure behavior. StormTech® contracts with Dr. Vincent Neary, P.E., from Tennessee Technological University for water quality testing of the Isolator™ Row.

2.4 Patents

In January of 2006, the United States Patent Office issued a patent for the Isolator™ Row, Patent No: US 6,991,734 B1 entitled "Solids Retention in Stormwater System."

3. Treatment System Description

StormTech®, LLC is the owner and producer of two brand names of subsurface chambers that are designed for use under paved and unpaved surfaces for stormwater applications. The brand names are StormTech® and LandSaver. Respective chambers are identical in every way but are branded by name and color. LandSaver chambers are blue and StormTech® chambers are yellow. Identical chamber models are listed below.

- StormTech® SC-740 is the same as LandSaver LS-3051
- StormTech® SC-310 is the same as LandSaver LS-1633

The StormTech® SC-740 is 85.4" x 51.0" x 30.0" (L x W x H) and has a chamber storage of 45.9 ft^3. The StormTech® SC-310 is 85.4" x 34.0" x 16.0" (L x W x H) and has a chamber storage of 14.7 ft^3.

The Isolator™ Row is a row of StormTech® chambers (either SC-740 or SC-310 models) that is surrounded with filter fabric and connected to a manhole. The chambers allow for settling and filtration of sediment as stormwater rises within the Isolator™ Row and passes through the filter fabric. The open bottom chambers and the perforated sidewalls allow stormwater to flow in both a vertical and horizontal direction out of the chambers. Sediments are then captured in the Isolator™ Row, thereby protecting the storage areas of the adjacent stone and chambers from sediment accumulation (See Figure 1).

Typically, some level of pre-treatment of the stormwater is required prior to entry into the system. Pre-treatment devices differ greatly in complexity, design and effectiveness. Options include a simple deep sumped manhole with a 90º bend on its outlet, baffle boxes, swirl concentrators, sophisticated filtration devices and devices that combine these processes. Some of the most effective pre-treatment options combine engineering site grading with vegetation such as bio-swales or grass filter strips.

The Isolator™ Row is designed to capture the "first flush," and it can be sized on a volume basis or flow rate basis. The Isolator™ Row is designed with a manhole with an overflow weir at its upstream end (See Figure 1). The manhole is connected to the Isolator™ Row with a short 12" to 24" diameter pipe set near the bottom of the end cap. The diversion manhole provides access to the Isolator™ Row for inspection and maintenance. The overflow weir with its crest set even with the top of the chamber allows stormwater in excess of the Isolator™ Row's storage/conveyance capacity to bypass the chamber system through the downstream eccentric header/manifold system (See Figure 2). This diversion manhole is the only mechanism used to control flow into the system.

The Isolator™ Row typically rests on a 6-18 inch foundation of No. 3 gravel overlaid with a woven geotextile filter fabric (GEOTEX® 315 ST – see Appendix for product data sheet). A double-layer of fabric was introduced to address the need for removal of finer sediments in accordance with NJDEP requirements. StormTech® implemented the double layer approach to enhance protection of infiltration surfaces by targeting finer particles for removal. The individual slit films are woven together in such a manner as to provide dimensional stability relative to each other. This geotextile fabric provides a media for stormwater filtration and also provides a durable surface for maintenance operations. In addition, this geotextile fabric is designed to prevent scour of the underlying stone and is designed to remain intact during high pressure jetting. A non-woven fabric is also used for the Isolator™ Row (GEOTEX® 601 – see Appendix for product data sheet). GEOTEX® 601 is a polypropylene, staple fiber, needle-punched, non-woven geotextile. The fibers are needled to form a stable network that retains dimensional stability relative to each other. The 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 chamber has two rows of perforations along the side with the lowest row 2 ¾ inches above the base woven geotextile fabric. As head increases in the chamber, water is discharged through these perforations as it continues to be discharged through the underlying stone bed. The non-woven geotextile fabric provides some filtering capacity for the water exiting the system through the side perforations.

Since the majority of the StormTech® installations are detention systems, they are designed to have some type of outlet structure. These systems are installed on angular stone that has a porosity of 40% and the systems are designed to discharge stormwater through this stone bed. The water in the stone bed can either be allowed to percolate into the underlying soil or perforated piping can be embedded within the stone to collect and discharge the treated stormwater.

4. Technical Performance Claims

Claim 1: A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 2.5 gpm/ft^2 of bottom area, using two layers of woven geotextile fabric under the base of the system and one layer of non-woven fabric wrapped over the top of the system and a mean event influent concentration of 270 mg/L (range of 139 – 361 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of at least 60% for SIL-CO-SIL 106, a manufactured silica product with an average particle size of 22 microns, in laboratory studies using simulated stormwater.

Claim 2: A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 2.5 gpm/ft^2 of bottom area, using two layers of woven geotextile fabric under the base of the system and one layer of non-woven fabric wrapped over the top of the system and a mean event influent concentration of 318 mg/L (range of 129 – 441 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of 84% for SIL-CO-SIL 250, a manufactured silica product with an average particle size of 45 microns, in laboratory studies using simulated stormwater.

Claim 3: A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 6.5 gpm/ft^2 of bottom area, using a single layer of woven geotextile fabric under the base of the system and one layer of non-woven fabric wrapped over the top of the system and a mean event influent concentration of 371 mg/L (range of 116 – 614 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of greater than 95% for OK-110, a manufactured silica product with an average particle size of 110 microns, in laboratory studies using simulated stormwater.

5. Technical System Performance

A StormTech® SC-740 Isolator™ Row was tested in a full-scale laboratory study by the Department of Civil and Environmental Engineering at Tennessee Technological University, Cookeville, TN. Three different silica-water slurry influent streams were used in the experiment. The first consisted of SIL-CO-SIL 106 with a median particle size of approximately 22 microns. The second consisted of SIL-CO-SIL 250 with a median particle size of approximately 45 microns. For both silica-water slurries, the system was tested at a hydraulic loading rate of 3.2 gpm/ft^2 of filter area. The SIL-CO-SIL 250 was also tested at a hydraulic loading rate of 1.7

gpm/ft^2 of filter area. Finally, a third silica-water slurry using US Silica OK-110 with a median particle size of 110 microns was tested in the laboratory at a range of hydraulic loading rates with maximum rates of 4.8 gpm/ft^2 and 8.1 gpm/ft^2. The removal efficiencies measured in these laboratory experiments were then used to calculate SSC removal efficiency to verify the claims presented above (See Section 4).

5.1 Test System Description

The main components of the laboratory set-up are shown in the design drawings (See Figure 3). Two (2) SC-740 chambers were secured to a wooden frame and laid over a 12-in. bed of No. 3 angular stone (AASHTO M43 #3) with a porosity of 40% contained in a wooden flume with interior W x L x H dimensions, 6.25-ft x 16.22-ft x 3-ft.

The chambers were covered with GEOTEX® 601 non-woven geotextile fabric with a thickness of 60 mils and an apparent opening size of 0.212 mm (see attached product data sheet). Two layers of GEOTEX® 315 ST woven geotextile fabric, each layer with a thickness of 20 mils and an apparent opening size of 0.212 mm (see Appendix for product data sheet), were placed at the bottom of the chamber to stabilize the stone foundation and to prevent scouring of the stone base. Both the nonwoven fabric covering the chamber and the woven fabric placed at the bottom provided filtration media for the Isolator™ Row. During testing, the water depth varied upstream to downstream from 3.5 inches to 4.75 inches, with an average depth of 4 inches. Variations in depth of ±20% were due to the roughness and non-uniformity of the gravel substrate underneath the geotextile fabric.

An 8-inch pipe fed the silica-water mixture through an expansion into the 12-inch inlet pipe of the Isolator™ Row. The target SSC influent concentration was set to 200 mg/L. A 1.5 lb/gal silica-water slurry was introduced to the 8-inch pipe from a 35-gallon mixing tank using a Watson-Marlow 323S/RL (220 rpm) pump. The silica–water slurry enters a 3/8″ feed tap located 10 inches upstream of a butterfly valve, which introduces turbulence and promotes uniform mixing of the influent stream. The Isolator™ Row resides in the recirculating flume, which collects and drains water discharged by the chamber to the stone substrate through an 8-inch drain that discharges to the laboratory trench and sump. The water was recirculated with a 25 horsepower Allis Chalmers (model AC7V) variable speed pump. A 1-micron filter, designed for flows up to 1.5 cfs, was placed at the end of the outlet, which was intended to trap all sediment that was not removed by the chambers.

For the OK-110 testing, the chambers were covered with Mirafli 160N non-woven geotextile fabric, meeting AASHTO M288 Class 2 standards. The Mirafli 160N geotextile has an apparent opening size of 0.212 mm. Mirafli 600X woven geotextile fabric, which meets ASSHTO's M288 Class 1 requirements, was placed at the bottom of the chamber to stabilize the stone foundation and to prevent scouring of the stone base. The Miralfi 600X fabric has an apparent opening size of 0.425 mm (see Appendix for product data sheet).

Flow rates were measured with a Thermo Electron Corporation Polysonic DCT 7088 portable digital correlation transit time flow meter placed on the 8″ aluminum water line. The DCT 7088 was factory calibrated by the manufacturer and was guaranteed accurate to ±0.5%.

The removal efficiency, η, for the Isolator™ Row was calculated as:

$$\eta = \frac{SSC_{Influent} - SSC_{Effluent}}{SSC_{Influent}} x100$$

where SSC is the suspended sediment concentration of the influent and the effluent grab samples, which were staggered by one detention time.

5.2 Procedure

Test runs for both SIL-CO-SIL 106 and SIL-CO-SIL 250 were completed at a treatment flow rate of 180 gpm (0.4 cfs), which corresponds to a hydraulic loading rate of 3.2 gpm/ft^2. Five (5) test runs were completed with SIL-CO-SIL 106 silica slurry. One (1) test run was completed with a SIL-CO-SIL 250 silica-water slurry. Additionally one (1) test run was completed with a SIL-CO-SIL 250 silica-water slurry at a treatment flow rate of 94 gpm (0.21 cfs), which corresponds to a hydraulic loading rate of 1.7 gpm/ft^2. All tests lasted fifteen detention times with sampling beginning after three detention times. Flow rates were regulated by an inlet valve.

Test runs for the OK-110 were completed at a range of treatment flows from 44.9 to 539 gpm (0.1 to 1.2 cfs), which corresponds to hydraulic loading rates of 0.4 to 4.8 gpm/ft^2. This experiment used four of the StormTech® Isolator™ Chambers. The experiment was then modified using two chambers with a maximum design hydraulic loading rate of 8.1 gpm/ft^2. Since the system was half the size (two chambers instead of four), the experiment could be run at higher flows.

Table 1 includes the results for the SIL-CO-SIL 106 test runs. The influent concentrations were generally above the target concentration of 200 mg/L, which suggests that the one-micron filter sock at the outlet was only partially effective at trapping the finer SIL-CO-SIL 106 particles. This was supported by visual observations, which noted that the trench went from clear to cloudy in less than one detention time. The average influent concentration was 270±59 mg/L, with a minimum value of 139 mg/L and a maximum value of 361 mg/L. The average effluent concentration was 109±35 mg/L, with a minimum value of 66 mg/L and a maximum value of 182 mg/L.

Table 2 shows how the average removal efficiency decreased on average with detention time during each test run as a result of recirculation. The removal efficiencies were calculated by averaging all influent and effluent samples with the same sample number, respectively (e.g., all influent samples with sample No. 1 and all effluent samples with sample No. 2). The results indicate that at the beginning of the test recirculation did not significantly increase influent concentrations above the target level of 200 mg/L. The average influent concentration for sample No. 1 was 219 mg/L. In addition, as discussed below, one can speculate that the recirculation of predominantly fine particles has not reduced the particle size distribution of the influent significantly. Under these conditions, the average removal efficiency (based solely on the first samples of each test run) is 66%. However, as the test progresses and recirculation of fines increases, the removal efficiency is reduced.

During the SIL-CO-SIL 106 tests, grab samples of the effluent were collected and sent to the laboratory for grain size analysis. These analyses indicated that the effluent sediments consisted mainly of very fine particles, 84% of which were 10 microns or smaller.

The observed variability in the influent and effluent concentrations was mainly due to the recirculation of fine grained particles not trapped by the filter sock. It was apparent starting with the first test (9-July) that the filter sock was not effective at trapping the fine effluent sediments and preventing their recirculation. As a result, there is a trend of increasing influent and effluent SSC concentrations with increasing detention time during each test run. Additionally, sediments occluded within the woven fabric and trapped in the gravel cannot be removed between each test run. As a result, the initial condition cannot be reestablished once testing has begun, and the sediments trapped in previous test runs may washout, raising effluent and influent SSC concentrations at latter test runs. One potential benefit of sediment occlusion and deposition over time may be increased removal efficiency as the geotextile fabric clogs and a filter cake develops on the Isolator™ Row bottom. (Note: The depth of accumulated sediment varies along the bottom of the Isolator™ Row.) Eventually, however, the cake will begin to reduce the flow through the bottom fabric and direct more flow through the chamber sides.

Note that removal efficiencies were calculated using the "indirect method" only, which relies on influent and effluent concentrations. The material trapped in the isolator row was intentionally not removed to allow the filter cake to develop with time. A rough estimate can be made by determining the total amount of sediment influent and effluent mass over the testing period. The difference is the amount trapped on the surface of the geotextile fabric, occluded in the fabric, and within the gravel substrate. A rough estimate indicates that about 50% of the total sediment trapped was on the surface of the fabric, with the remaining 50% occluded and within the gravel substrate.

Furthermore, the above "50%-50%" estimate is in fact an estimate for only the fine particle test runs since the testing was by indirect method and the sediment captured on the fabric is based on a rough measurement of the depth observed on the fabric at the conclusion of testing. The depth varied across the bottom of the test system. Earlier testing of the OK-110 by direct testing demonstrated 80% removal on the fabric. This is significant since the frequency of maintenance is driven very much by the accumulation of larger particles on the fabric based on the measured 80% capture.

In the SIL-CO-SIL 106 tests, the water depth varied from upstream to downstream from 3.5 inches to 4.75 inches, with an average depth of 4 inches. Variations in depth of ±20% were due to the roughness and nonuniformity of the gravel substrate underneath the geotextile fabric.

Results for the one SIL-CO-SIL 250 test are summarized in Tables 3 and 4. Recirculation of fine sediments was observed and would have reduced the particle size distribution of the influent concentrations below the mean particle size of D_{50}=45 microns. However, particle size analyses of influent sediments were not obtained as was done for the SIL-CO-SIL 106 experiment. The average removal efficiency was 71±14%, with a minimum value of 47% and a maximum value of 82% at 3.2 gpm/ft^2 and 88±1% at 1.7 gpm/ft^2. Compared to the results for the SIL-CO-SIL

106, these values appear reasonable since one would expect higher removal efficiencies when the particle size distribution is greater.

The results for the OK-110 tests at a range of hydraulic loading rates ranging from 0.1 to 1.2 cfs (0.4 to 4.8 gpm/ft^2) are summarized in Table 5. The scaled experiment is also presented in Table 5 for the hydraulic loading rate of 8.1 gpm/ft^2. Two types of influent sampling were conducted during the experiment: discrete sampling and grab sampling. These influent samples are greatly different in concentration. The removal rates exceed 95% for all samples.

5.3 Verification Procedures for All Claims

All the data provided to NJCAT were reviewed to fully understand the capabilities of the StormTech® Isolator™ Row. To verify the StormTech® claim for the Isolator™ Row, the laboratory data were reviewed and compared to the NJDEP TSS laboratory testing procedure.

5.3.1 NJDEP Recommended TSS Laboratory Testing Procedure

The NJDEP has prepared a TSS laboratory testing procedure, primarily designed for hydrodynamic devices, to help guide vendors as they prepare to test their stormwater treatment systems prior to applying for NJCAT verification. The testing procedure has three components:

1. Particle size distribution
2. Full scale laboratory testing requirements
3. Measuring treatment efficiency

1. Particle size distribution:

The following particle size distribution will be utilized to evaluate a manufactured treatment system (See Table 6) using a natural/commercial soil representing the USDA definition of a sandy loam material. This hypothetical distribution was selected as it represents the various particles that would be associated with typical stormwater runoff from a post construction site. NJDEP now requires that filter based BMPs be tested with SIL-CO-SIL 106.

2. Full Scale lab test requirements:
    - A. At a minimum, complete a total of 15 test runs including three (3) tests each at a constant flow rate of 25, 50, 75, 100, and 125 percent of the treatment flow rate. These tests should be operated with initial sediment loading of 50% of the unit's capture capacity.
    - B. The three tests for each treatment flow rate will be conducted for influent concentrations of 100, 200, and 300 mg/L.
    - C. For an online system, complete two tests at the maximum hydraulic operating rate. Utilizing clean water, the tests will be operated with initial sediment loading at 50% and 100% of the unit's capture capacity. These tests will be utilized to check the potential for TSS re-suspension and washout.
    - D. The test runs should be conducted at a temperature between 73-79 degrees Fahrenheit (°F) or colder.

3. Measuring treatment efficiency:
    - A. Calculate the individual removal efficiency for the 15 test runs.

B. Average the three test runs for each operating rate.
C. The average percent removal efficiency will then be multiplied by a specified weight factor (See Table 7) for that particular operating rate.
D. The results of the five numbers will then be summed to obtain the theoretical annual TSS load removal efficiency of the system.

5.3.2 Laboratory Testing for the StormTech® Isolator™ Row

The results of the laboratory testing that were performed by Tennessee Tech are presented later in Tables 1, 2, 3, 4 and 5. Testing was performed for two different silica-water slurry influent streams at a target SSC influent concentration of 200 mg/L. The tests using the SIL-CO-SIL 106 slurry were performed at 3.2 gpm/ft^2, which was set to be 125% of the treatment operating rate. The tests using the SIL-CO-SIL 250 slurry were performed at 1.7 gpm/ft^2 and 3.2 gpm/ft^2, which were assumed to be 62.5% and 125% of the treatment operating rate, respectively. The tests using the OK-110 slurry were performed for a range of hydraulic loading rates (0.4 to 8.1 gpm/ft^2).

For the SIL-CO-SIL 106, laboratory testing shows a 60% removal efficiency at 3.2 gpm/ft^2 for an average SSC influent concentration of 270 mg/L. Since only one operating rate was tested, the 3.2 gpm/ft^2 was set to be 125% of the treatment operating rate. Since other verifications of pre-manufactured systems have indicated that as the operating rate increases, removal efficiency decreases, the 60% removal efficiency at 3.2 gpm/ft^2 was assumed as the minimum removal of this system at this operating rate. Therefore, the NJDEP weighting system can be used to determine an overall removal efficiency of the system by assuming that removal efficiency observed at the 125% treatment operating rates would also be applicable for the lower operating rates. Since the 3.2 gpm/ft^2 is set to be 125% of the treatment operating rate, the SSC removal efficiency for the system would be based upon 2.56 gpm/ft^2, which would be 100% of the treatment operating rate (see Table 8 and Figure 4).

For the SIL-CO-SIL 250, laboratory testing demonstrates a 71% removal efficiency at 3.2 gpm/ft^2 for an average SSC influent concentration of 211 mg/L and an 88% removal efficiency at 1.7 gpm/ft^2 for an average SSC influent concentration of 424 mg/L. Once again, the 3.2 gpm/ft^2 was set to be 125% of the treatment operating rate, and 1.7 gpm/ft^2 was set to be 62.5% of the treatment operating rate. These removal efficiencies, which were input into the NJDEP weighting system, can be used to determine an overall removal efficiency of the system. Since the 3.2 gpm/ft^2 is set to be 125% of the treatment operating rate, the SSC removal efficiency for the system would be based upon 2.56 gpm/ft^2, which would be 100% of the treatment operating rate (see Table 9 and Figure 5).

For the OK-110, laboratory testing data that are presented in Table 5 were used with the NJDEP protocol to develop an NJDEP weighted removal efficiency for the hydraulic loading rates of 4.8 and 8.1 gpm/ft^2 (see Tables 10 and 11). These loading rates were set to be 125% of the treatment operating rate. Removal efficiencies for 25, 50, 75, and 100% of the treatment operating rate were interpolated from the data presented in Table 5. The NJDEP weighted removal efficiencies were determined to be 98.8 and 98.4% for the hydraulic loading rates of 3.87 and 6.48 gpm/ft^2, respectively.

5.4 Inspection and Maintenance

The StormTech® Isolator™ Row requires minimal routine inspection and maintenance. However, it is important that the system be inspected at regular intervals and cleaned when necessary to ensure optimum performance. Initially, the StormTech® Isolator™ Row should be inspected every six months until information can be gathered to develop an inspection and maintenance routine for the particular site. The rate at which the system collects pollutants will depend more on site activities than on the size of the unit (i.e., heavy winter sanding will cause the lower chamber to fill more quickly, but regular sweeping will slow accumulation). The JetVac process can be used to clean the system. However, the JetVac process, as per StormTech® should only be performed on StormTech® Isolator™ Rows that have AASHTO class 1 woven geotextile over their angular base stone. When the average depth of sediment exceeds three inches, clean-out should be conducted.

The frequency of cleanout is related to the number of chambers in the Isolator™ Row. StormTech®'s cleanout experience includes systems receiving flows from paved areas that were cleaned in advance of actual need and systems that received construction sediments and were cleaned after a sedimentation event.

StormTech® does not recommend that the Isolator™ be used for construction sediments. Where erosion of disturbed sites is possible which could cause sedimentation of the subsurface system, StormTech® recommends plugging inlet pipes to both the Isolator™ Row and high flow manifolds until the site is stabilized and the post development conditions established.

A 20-chamber Isolator™ Row in Portland, Maine was cleaned after one year in service. Approximately 1/8" to 1/4" of sediment had accumulated and StormTech® cleaned the system as a maintenance demonstration. Four passes of a jet nozzle cleaned the Isolator™ Row to bare fabric. The nozzle pressure reached approximately 2200 psi. The fabric was not impacted by the jetting.

Other experience, for all Isolator™ Rows receiving flows from paved areas, indicates that a 1-year maintenance interval is too frequent. Only Isolator™ Rows that 1) have received construction sediments or 2) received sediments from gravel parking areas required maintenance within the first year.

In each cleaning event observed, solids were successfully moved from the fabric bottom to the access manhole and vactored. The solids movement includes both clumps of solids and slurry. Since murky water is produced, it is reasonable to assume that some amount of the clay size particles that go into suspension may be lost through the fabric during the cleanout process. Actual sediment removal is expected to include the larger particle sizes targeted during performance tests and some percentage of finer particles that are moved in the solid cake clumps and slurry that is vactored from the manhole.

5.4.1 Solids Disposal

Solids recovered from the StormTech® Isolator™ Row can typically be land filled or disposed of at a waste water treatment plant.

5.4.2 Damage Due to Lack of Maintenance

It is unlikely that the StormTech® Isolator™ Row will become damaged due to lack of maintenance since there are no fragile internal parts. However, adhering to a regular maintenance plan ensures optimal performance of the system, since filter cake build-up will eventually reduce treatment flow rate through the double layer bottom fabrics.

StormTech® has no reported clogged infiltration systems. The typical StormTech® design includes Isolator™ Rows downstream of all inlets with high flow bypasses to the balance of the chamber system. Therefore the infiltration surface is preserved while the Isolator™ Row collects sediments. Flow through the Isolator™ Row bottom material is expected to decrease over several years. As the bottom occludes and head builds, flow increases through perforations and joints which are covered with a single layer of filter fabric.

6. Technical Evaluation Analysis

6.1 Verification of Performance Claims

Claim 1: A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 2.5 gpm/ft^2 of bottom area, using two layers of woven geotextile fabric under the base of the system and one layer of non-woven fabric wrapped over the top of the system and a mean event influent concentration of 270 mg/L (range of 139 – 361 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of 60% for SIL-CO-SIL 106, a manufactured silica product with an average particle size of 22 microns, in laboratory studies using simulated stormwater.

- *Since the claim laboratory test was performed at 3.2 gpm/ft^2 and this was set to be 125% of the treatment operating rate, the treatment operating rate in Claim 1 should be adjusted to reflect the true operation rate (100% value or 2.56 gpm/ft^2). Claim 1 is verified.*

Claim 2: A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 2.5 gpm/ft^2 of bottom area, using two layers of woven geotextile fabric under the base of the system and one layer of non-woven fabric wrapped over the top of the system and a mean event influent concentration of 318 mg/L (range of 129 – 441 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of 84% for SIL-CO-SIL 250, a manufactured silica product with an average particle size of 45 microns, in laboratory studies using simulated stormwater.

- *For a treatment operating rate of 2.56 gpm/ft^2 and a mean event influent concentration of 318 mg/L (measured as SSC) the data at 3.20 gpm/ft^2 and 1.7 gpm/ft^2 were used to conservatively determine a TSS removal efficiency of 84% for SIL-CO-SIL 250, verifying Claim 2. The average influent concentration of 318 mg/L is simply the average concentration of the two sets of experiments that were run using the SIL-CO-SIL 250.*

Claim 3: A StormTech® SC-740 Isolator™ Row, sized at a treatment rate of no more than 6.5 gpm/ft^2 of bottom area, using a single layer of woven geotextile fabric and a mean event influent concentration of 371 mg/L (range of 116 – 614 mg/L) has been shown to have a TSS removal efficiency (measured as SSC) of greater than 95% for OK-110, a manufactured silica product with an average particle size of 110 microns, in laboratory studies using simulated stormwater.

- *Since the experiment was run at 8.1 gpm/ft^2, which was set at 125% of the treatment operating rate, Claim 3 is valid with 100% of the treatment operating rate of 6.5 gpm/ft^2. The weighted removal efficiency at rates of 8.1 gpm/ft^2 and 4.8 gpm/ft^2 exceeded 98% so a removal efficiency greater than 95% is valid.*

6.2 Limitations

6.2.1 Factors Causing Under-Performance

If the StormTech® Isolator™ Row is designed and installed correctly, there is minimal possibility of failure. There are no moving parts to bind or break, nor are there parts that are particularly susceptible to wear or corrosion. Lack of maintenance may cause the system to operate at a reduced efficiency, and it is possible that eventually the system will become totally filled with sediment.

6.2.2 Pollutant Transformation and Release

The StormTech® Isolator™ Row should not increase the net pollutant load to the downstream environment. However, pollutants may be transformed within the unit. For example, organic matter may decompose and release nitrogen in the form of nitrogen gas or nitrate. These processes are similar to those in wetlands but probably occur at slower rates in the StormTech® Isolator™ Row due to the absence of light and mixing by wind, thermal inputs, and biological activity. Accumulated sediment should not be lost from the system at or under the design flow rate.

6.2.3 Sensitivity to Heavy Sediment Loading

Heavy loads of sediment will increase the needed maintenance frequency.

6.2.4 Mosquitoes

Although the StormTech® Isolator™ Row normally drain completely, designs may include standing water in a sump in the diversion manhole, which can be a breeding site for mosquitoes. StormTech® advises that the sump is not a necessity for proper Isolator™ Row operation and maintenance. The sump can be eliminated or designed with drain holes where the intent is to preclude mosquito breeding sites. In addition, StormTech® advises that the stone is designed to drain so as to not leave standing water. Small amounts of water that may not drain due to depressions in the otherwise flat bottom would infiltrate.

7. Net Environmental Benefit

Once the StormTech® Isolator™ Row has been verified and granted interim approval use within the State of New Jersey, StormTech® will then proceed to install and monitor systems in the field for the purpose of achieving goals set by the Tier II Protocol and final certification. At that time a net environmental benefit evaluation will be completed. However, it should be noted that the StormTech® technology requires no input of raw material, has no moving parts, and therefore, uses no water or energy.

8. References

Christensen, A. and V. Neary. 2005. *Hydraulic Performance and Sediment Trap Efficiency for the StormTech® SC-740 Isolator™ Row*. Department of Civil and Environmental Engineering, Tennesee Technological University. February 23, 2005.

Neary, V. 2006. *Performance Evaluation of Sediment Removal Efficiency StormTech® Isolator™ Row*. Department of Civil and Environmental Engineering, Tennessee Tech University. October 20, 2006.

Patel, M. 2003, *Draft Total Suspended Solids Laboratory Testing Procedures*, December 23, 2003, New Jersey Department of Environmental Protection, Office of Innovative Technology and Market Development.

StormTech® Subsurface Stormwater Management Technical Resources CD: Product Literature, Design Tools, Isolator™ Row, Project Installation Video. April 2006.

FIGURES

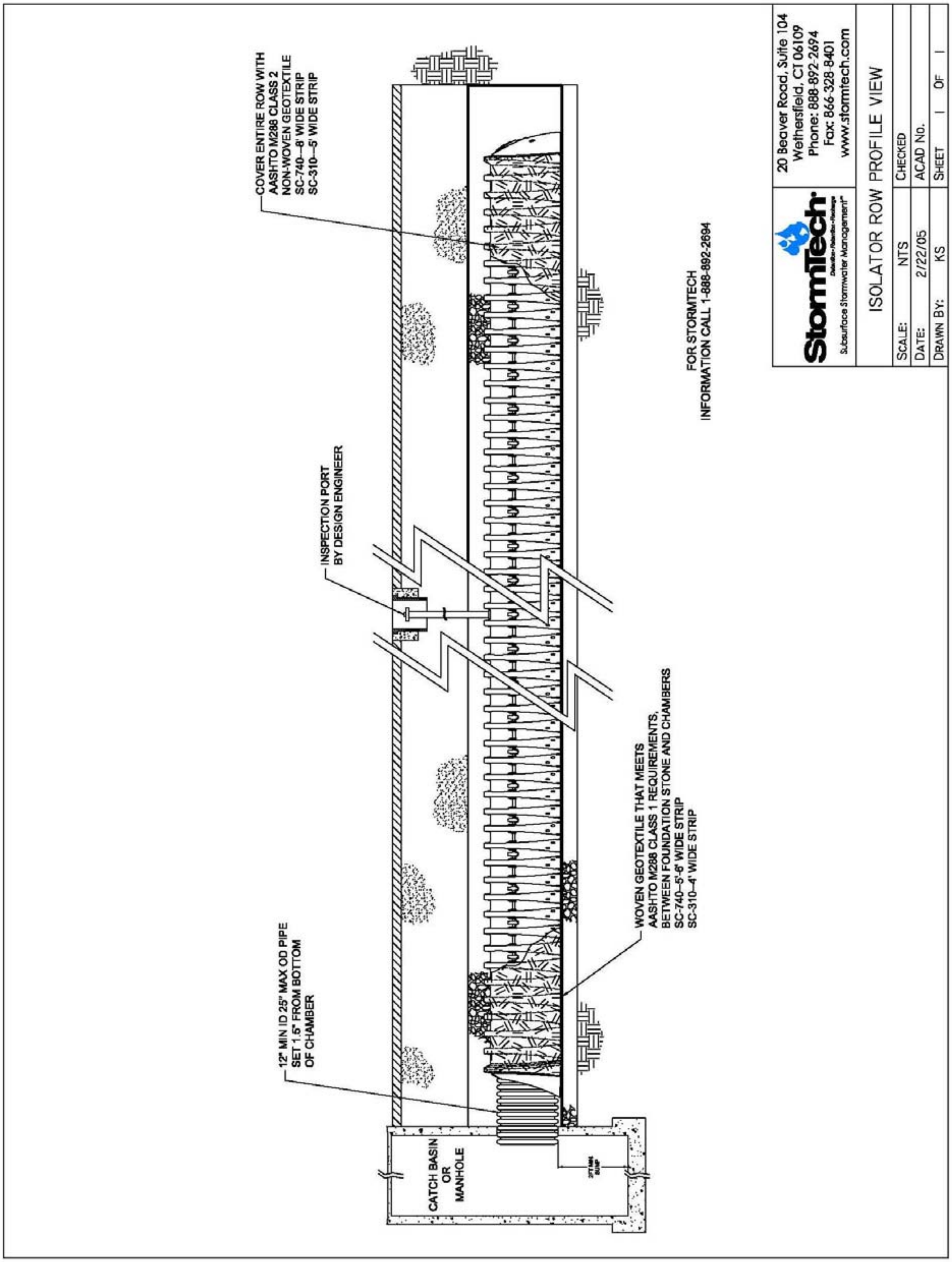

Figure 1. Isolator™ Row Profile View

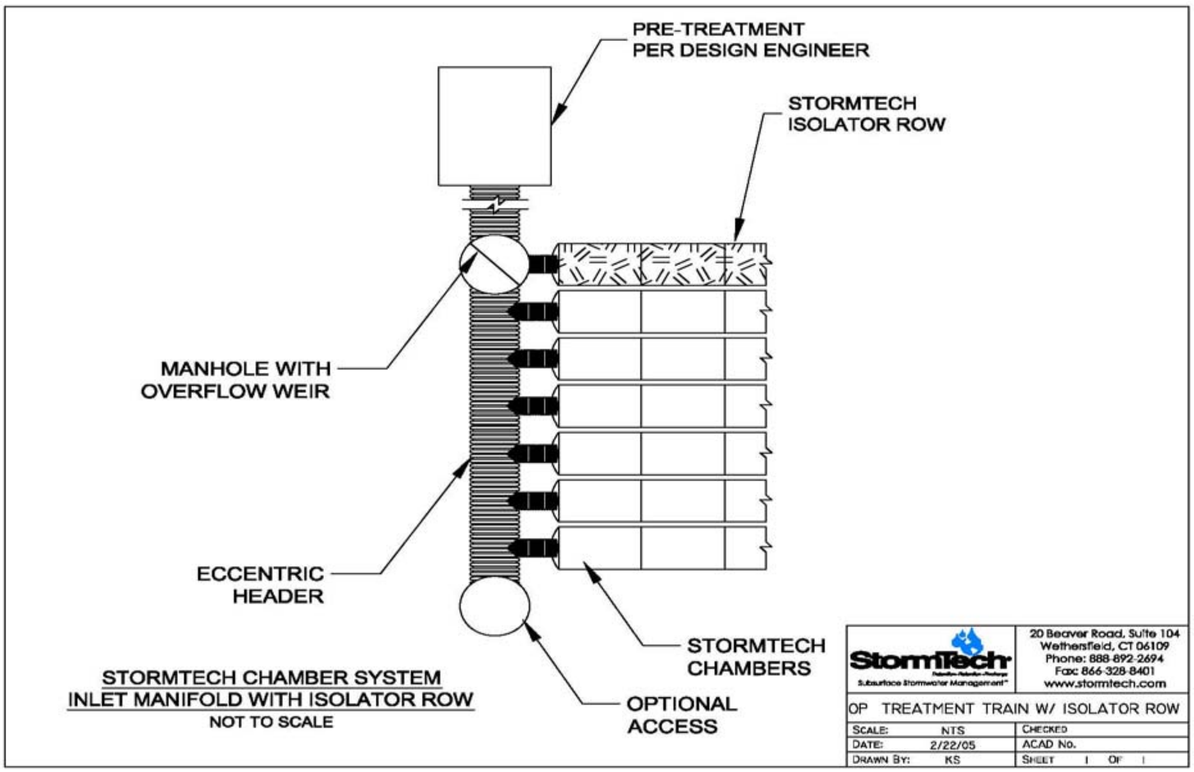

Figure 2. Treatment Train with Isolator™ Row
One StormTech® Recommended Configuration

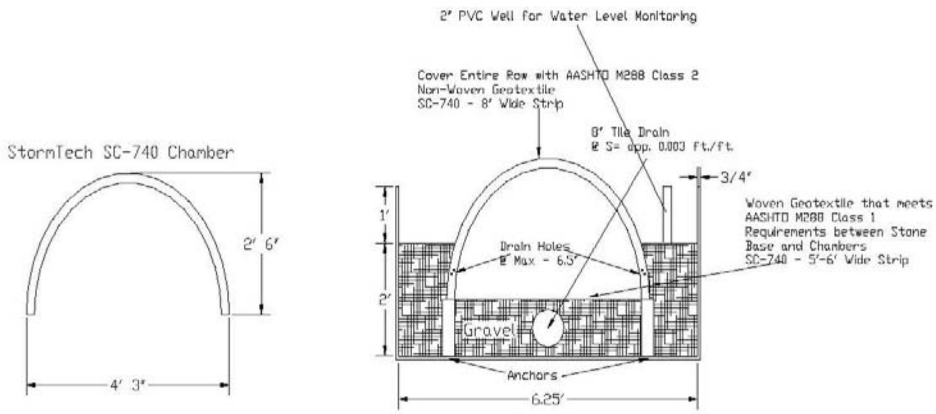

Figure 1.1: Section View of StormTech® Isolator™ Row as Installed in Lab

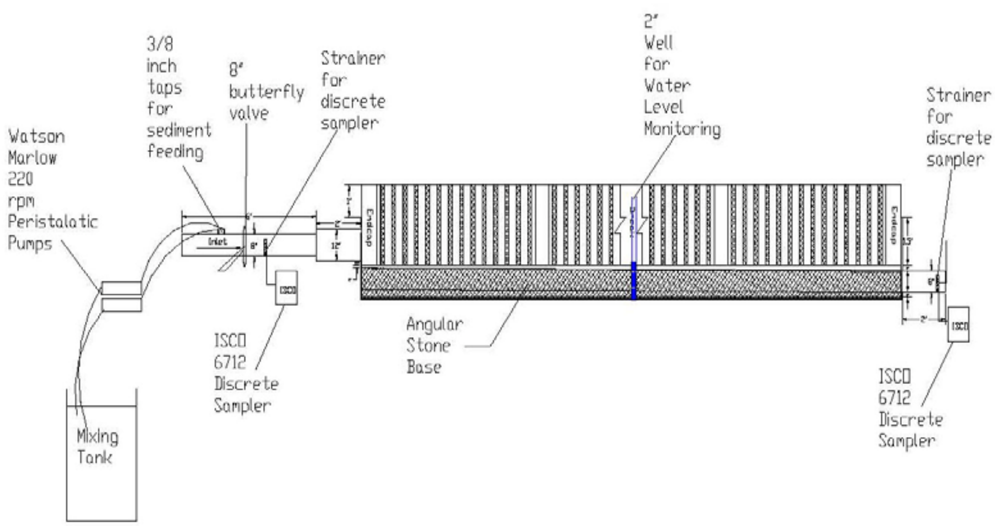

Figure 1. 2: Profile View of StormTech® Isolator™ Row as Installed in Lab.
Flow left to right.

Figure 3. Section and Profile Views of StormTech®Isolator™ Row as Installed in the Laboratory

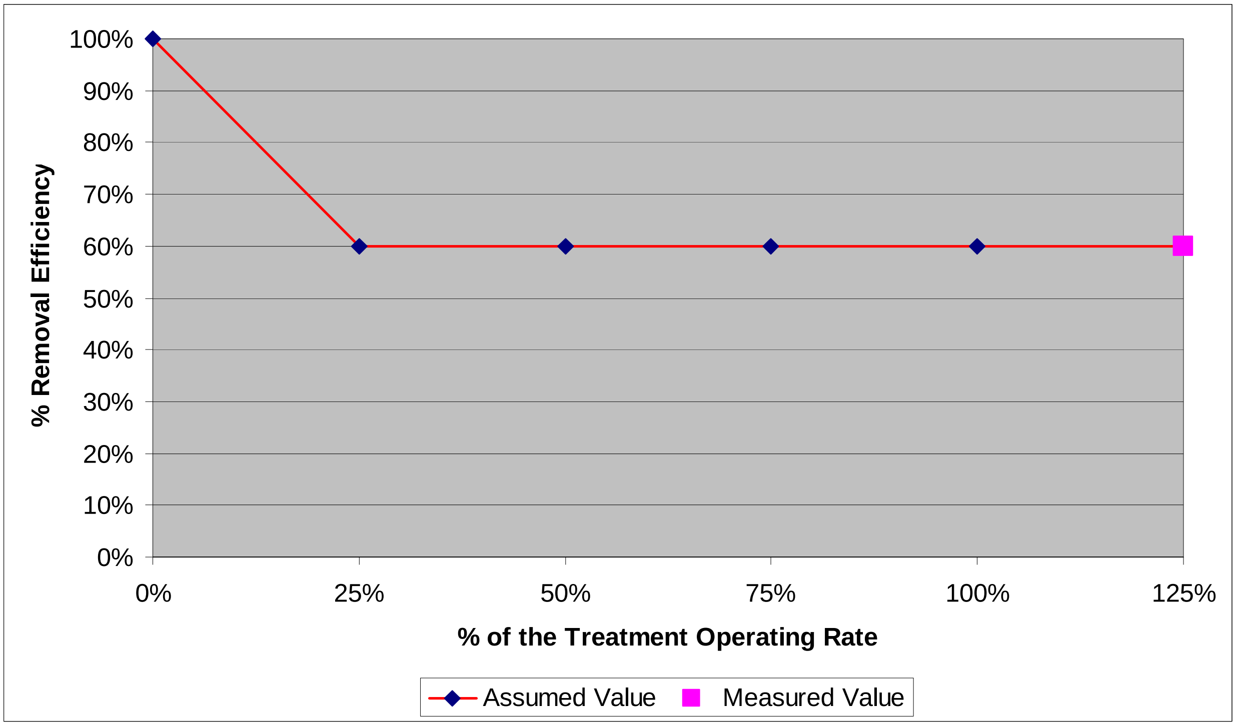

Figure 4. SSC Removal Efficiency for 2.56 gpm/ft^2 for SIL-CO-SIL 106 (assuming efficiency does not increase as flowrate decreases)

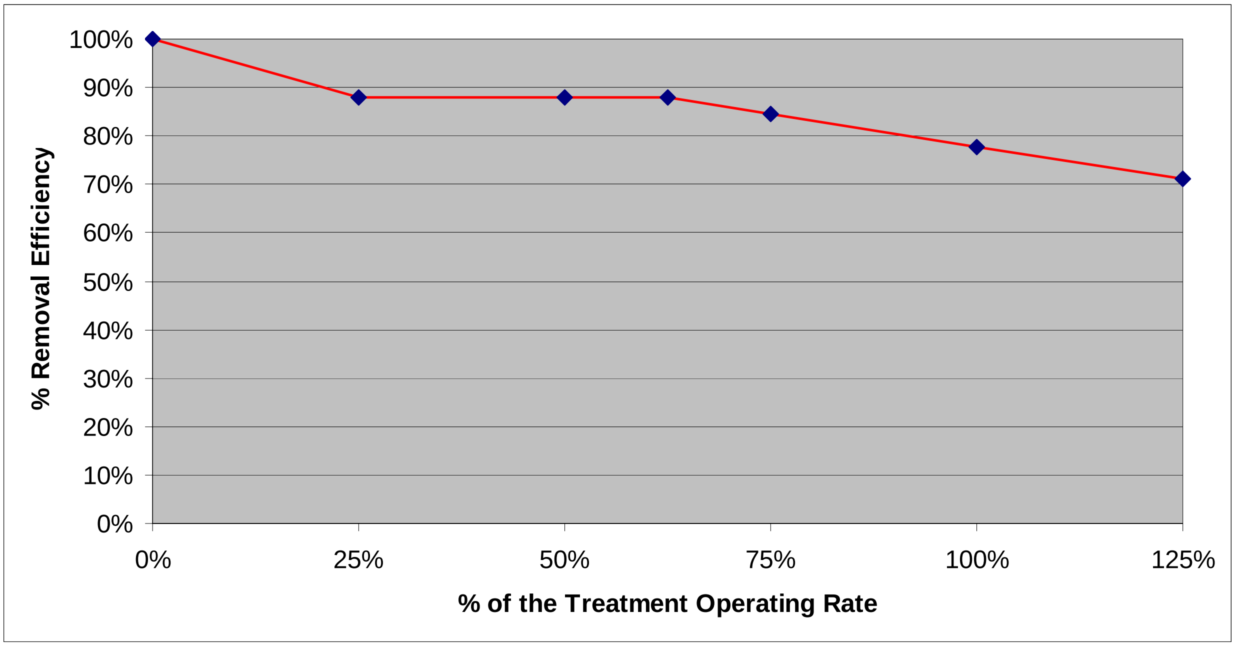

Figure 5. SSC Removal Efficiency for 2.56 gpm/ft^2 for SIL-CO-SIL 250

TABLES

Table 1. Results: SIL-CO-SIL 106 Tests

Date	Influent SSC (mg/L)	Effluent SSC (mg/L)	% Removal
9-Jul	180	81	55
9-Jul	177	100	44
9-Jul	292	122	58
9-Jul	315	147	53
9-Jul	318	162	49
17-Jul	212	72	66
17-Jul	266	95	64
17-Jul	278	135	51
25-Jul	236	77	67
25-Jul	229	66	71
25-Jul	139	74	47
25-Jul	293	87	70
1-Aug	240	70	71
1-Aug	290	124	57
1-Aug	294	144	51
1-Aug	341	146	57
1-Aug	361	132	63
28-Aug	227	74	67
28-Aug	266	67	75
28-Aug	328	137	58
28-Aug	308	100	68
28-Aug	353	182	48
Average:	**270**	**109**	**60**
Std. Deviation:	**59**	**35**	**9**
Minimum:	**139**	**66**	**44**
Maximum:	**361**	**182**	**75**

Table 2. Reduction of Removal Efficiency with Detention Time

Sample No.	No. of Detention Times	Influent SSC (mg/L)	Effluent SSC (mg/L)	% Removal
1	3	219	75	66
2	6	246	90	63
3	9	305	134	56
4	12	311	132	57
5	15	331	141	58

Table 3. Results: SIL-CO-SIL 250 Tests at 3.2 gpm/ft^2 (July 19, 2006)

Sample No.	Influent SSC (mg/L)	Effluent SSC (mg/L)	% Removal
1	226	40	82
2	169	47	72
3	244	53	78
4	288	67	77
5	129	68	47
Average:	**211**	**55**	**71**
Std. Deviation:	**63**	**12**	**14**
Minimum:	**129**	**40**	**47**
Maximum:	**288**	**68**	**82**

Table 4. Results: SIL-CO-SIL 250 Tests at 1.7 gpm/ft^2 (July 19, 2006)

Sample	Influent SSC (mg/L)	Effluent SSC (mg/L)	% Removal
1	416	27	89
2	407	44	88
3	441	48	87
4	417	56	89
5	441	61	87
Average:	**424**	**47**	**88**
Std. Deviation:	**16**	**13**	**1**
Minimum:	**407**	**27**	**87**
Maximum:	**441**	**61**	**89**

Table 5. Results: OK-110 Tests

Flow (cfs)	Hydraulic Loading Rate (gpm/ft^2)	Influent - Discrete SSC (mg/L)	Influent – Grab SSC (mg/L)	Effluent - Discrete SSC (mg/L)	% Removal - Discrete	% Removal - Grab
0.1	0.4	613.8	86.2	1.08	99.82%	98.75%
0.2	0.81	324.4	192.0	2.56	99.21%	98.67%
0.4	1.61	514.6	207.7	3.14	99.39%	98.49%
0.6	2.42	411.8	175.0	3.34	99.19%	98.09%
0.8	3.23	325.4	193.0	2.80	99.14%	98.55%
1.0	4.04	525.6	137.2	1.96	99.63%	98.57%
1.2	4.84	116.4	178.6	3.18	97.27%	98.22%
0.2	0.81	398.2	108.8	1.78	99.55%	98.37%
0.4	1.61	358.8	85.7	1.96	99.45%	97.71%
0.6	2.42	329.5	200.0	3.41	98.97%	98.30%
1.2	4.84	227.5	164.4	2.00	99.12%	98.79%
1.0 (scaled)	8.1	302.0	241.8	11.00	96.36%	95.45%
Average:		**370.7**	**164.2**	**3.18**	**99.14%**	**98.06%**
Minimum:		**116.4**	**85.7**	**1.08**	**96.36%**	**95.45%**
Maximum:		**613.8**	**241.8**	**11.0**	**99.82%**	**98.79%**

Table 6. Particle Size Distribution

Particle Size (microns)	Sandy loam (percent by mass)
500-1,000 (coarse sand)	5.0
250-500 (medium sand)	5.0
100-250 (fine sand)	30.0
50-100 (very fine sand)	15.0
2-50 (silt)	(8-50 µm, 25%) (2-8 µm, 15%)*
1-2 (clay)	5.0

Notes:
Recommended density of particles ≤2.65 g/cm^3
*The 8 µm diameter is the boundary between very fine silt and fine silt according to the definition of American Geophysical Union. The reference for this division/classification is: Lane, E. W., et al. (1947). "Report of the Subcommittee on Sediment Terminology," Transactions of the American Geophysical Union, Vol. 28, No. 6, pp. 936-938.

Table 7. Weight Factors for Different Treatment Operating Rates

Treatment operating rate	Weight factor
25%	0.25
50%	0.30
75%	0.20
100%	0.15
125%	0.10

Notes:
Weight factors were based upon the average annual distribution of runoff volumes in New Jersey and the assumed similarity with the distribution of runoff peaks. This runoff volume distribution was based upon accepted computation methods for small storm hydrology and a statistical analysis of 52 years of daily rainfall data at 92 rainfall gages.

Table 8. NJDEP Weighted Removal Efficiency for 2.56 gpm/ft^2 for SIL-CO-SIL 106 (assuming efficiency does not increase as flowrate decreases)

Treatment Operating Rate	NJDEP Weight Factor	Loading Rate (gpm/ft^2)	% SSC Removal	NJDEP Weighted % Removal
25%	0.25	0.64	60	15
50%	0.30	1.28	60	18
75%	0.20	1.92	60	12
100%	0.15	2.56	60	9
125%	0.10	3.20	60	6
Total:				**60**

Table 9. NJDEP Weighted Removal Efficiency for 2.56 gpm/ft^2 for SIL-CO-SIL 250

Treatment Operating Rate	NJDEP Weight Factor	Loading Rate (gpm/ft^2)	% SSC Removal	NJDEP Weighted % Removal
25%	0.25	0.64	0.88	0.22
50%	0.30	1.28	0.88	0.264
62.5		1.70	0.88	
75%	0.20	1.92	0.846	0.1692
100%	0.15	2.56	0.778	0.1167
125%	0.10	3.20	0.71	0.071
Total:				**84**

Table 10. NJDEP Weighted Removal Efficiency for 4.8 gpm/ft^2 for OK-110

Treatment Operating Rate	NJDEP Weight Factor	Loading Rate (gpm/ft^2)	% SSC Removal	NJDEP Weighted % Removal
25%	0.25	0.97	98.9	24.7
50%	0.30	1.94	98.7	29.6
75%	0.20	2.90	98.7	19.7
100%	0.15	3.87	98.9	14.8
125%	0.10	4.84	98.4	9.8
Total:				**98.8**

Table 11. NJDEP Weighted Removal Efficiency for 8.1 gpm/ft^2 for OK-110

Treatment Operating Rate	NJDEP Weight Factor	Loading Rate (gpm/ft^2)	% SSC Removal	NJDEP Weighted % Removal
25%	0.25	1.62	98.8	24.7
50%	0.30	3.24	98.8	29.7
75%	0.20	4.86	98.3	19.7
100%	0.15	6.48	98.3	14.8
125%	0.10	8.10	95.9	9.6
Total:				**98.4**

SI® Geosolutions

Product Data Sheet

GEOTEX® 315 ST

GEOTEX 315ST is a woven slit film geotextile manufactured at one of SI Corporations' facilities. The individual slit films are woven together in such a manner as to provide dimensional stability relative to each other. The construction of the geotextile makes **GEOTEX 315ST** ideal for soil separation and stabilization. The geotextile is resistant to ultraviolet degradation and to biological and chemical environments for normally found in soils. GEOTEX 315ST conforms to the property values listed below[1] which have been derived from quality control testing performed by one of SI Corporations' GAI-LAP accredited laboratories:

PROPERTY	TEST METHOD	ENGLISH (MARV[2])	METRIC (MARV[2])
Physical			
Mass/Unit Area	ASTM D5261	6.5 oz/yd²	220 g/m²
Thickness	ASTM D5199	20 mils	.5 mm
Mechanical			
Tensile Strength (Grab)	ASTM D4632	315 x 315 lbs	1,400 x 1,400 N
Elongation	ASTM D4632	15 x 15%	15 x 15%
Wide Width Tensile	ASTM D4595	175 x 200 lbs/in	30.6 x 35.0 kN/m
Wide Width Elongation	ASTM D4595	10 x 8%	10 x 8%
Puncture	ASTM D4833	125 lbs	555 N
Mullen Burst	ASTM D3786	650 psi	4475 kPa
Trapezoidal Tear	ASTM D4533	120 x 120 lbs	530 x 530 N
CBR Burst	GRI-GSI	1075 lbs	4780 N
Endurance			
UV Resistance	ASTM D4355	90%	90%
Hydraulic			
Apparent Opening Size (AOS)	ASTM D4751	70 US Std. Sieve	0.212 mm
Permittivity	ASTM D4491	0.05 sec⁻¹	0.05 sec⁻¹
Permeability	ASTM D4491	.003 cm/sec	.003 cm/sec
Water Flow Rate	ASTM D4491	4 gpm/ft²	161 l/min/m²
Roll Sizes		12.5 ft x 360 ft 15.0 ft x 300 ft 17.5 ft x 258 ft	3.81 m x 109.73 m 4.57 m x 91.44 m 5.33 m x 78.64 m

NOTES:

1. **The property values listed above are effective 03/24/2006 and are subject to change without notice.**
2. Values for machine (warp) and cross-machine (fill), respectively, under dry or saturated conditions. Minimum average roll values (MARV) are calculated as the typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any samples taken from quality assurance testing will exceed the value reported.

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SI® Geosolutions

Product Data Sheet

GEOTEX® 601

GEOTEX 601 is a polypropylene, staple fiber, needlepunched nonwoven geotextile manufactured at one of SI Geosolutions' facilities that has achieved ISO-9002 certification for its systematic approach to quality. The fibers are needled to form a stable network that retains dimensional stability relative to each other. The geotextile is resistant to ultraviolet degradation and to biological and chemical environments normally found in soils. GEOTEX 601 conforms to the property values listed below[1] which have been derived from quality control testing performed by one of SI Geosolutions' GAI-LAP accredited laboratories:

		MARV[2]	
PROPERTY	TEST METHOD	ENGLISH	METRIC
Physical			
Mass/Unit Area	ASTM D5261	5.0 oz/yd^2	170 g/m^2
Thickness	ASTM D5199	60 mils	1.5 mm
Mechanical			
Grab Tensile Strength	ASTM D4632	160 lbs	712 N
Grab Elongation	ASTM D4632	50%	50%
Puncture Strength	ASTM D4833	85 lbs	378 N
Mullen Burst	ASTM D3786	280 psi	1930 kPa
Trapezoidal Tear	ASTM D4533	60 lbs	267 N
Wide Width Tensile	ASTM D4595	720 lbs/ft	10.5 kN/m
Endurance			
UV Resistance @ 500 hrs	ASTM D4355	70%	70%
Hydraulic			
Apparent Opening Size (AOS)[3]	ASTM D4751	70 US Std. Sieve	0.212 mm
Permittivity	ASTM D4491	1.30 sec^{-1}	1.30 sec^{-1}
Permeability	ASTM D4491	0.24 cm/sec	0.24 cm/sec
Water Flow Rate	ASTM D4491	110 gpm/ft^2	4480 l/min/m^2
Typical Roll Sizes		150 in x 100 yds	3.81 m x 91.5 m
		180 in x 100 yds	4.57 m x 91.5 m

NOTES:

1. **The property values listed below are effective 12/2003 are subject to change without notice.**
2. Values shown are in weaker principal direction. Minimum average roll values are calculated as the typical minus two standard deviations. Statistically, it yields a 97.7% degree of confidence that any samples taken from quality assurance testing will exceed the value reported.
3. Maximum average roll value. Statistically, it yields a 97.7% degree of confidence that samples taken from quality assurance testing will be below the value reported.

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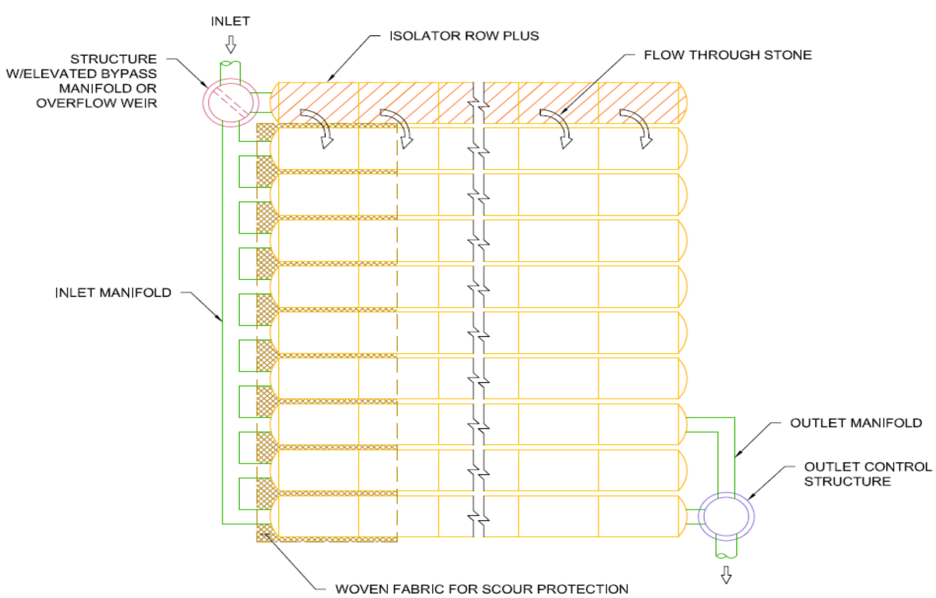
StormTech Isolator Row PLUS – Pollutant Removal

The following information is intended to provide a general overview of the pollutant removal capability of the StormTech Isolator™ Row PLUS, which is a patented filtration type BMP manufactured by StormTech, LLC. The StormTech Isolator Row PLUS is covered under several US and International patents.

I. Description:

The StormTech Isolator Row PLUS is a row or rows of thermoplastic chambers that sit on a layer of ADS PLUS fabric and are connected to a closely located structure for easy access. The chambers provide for settling and filtration of sediment and other contaminants as stormwater rises in the Isolator Row PLUS and ultimately passes through the fabric. The open-bottom chambers allow stormwater to flow out of the chambers. Sediment is captured in the Isolator Row PLUS, protecting the storage areas of the adjacent stone and chambers from sediment accumulation.

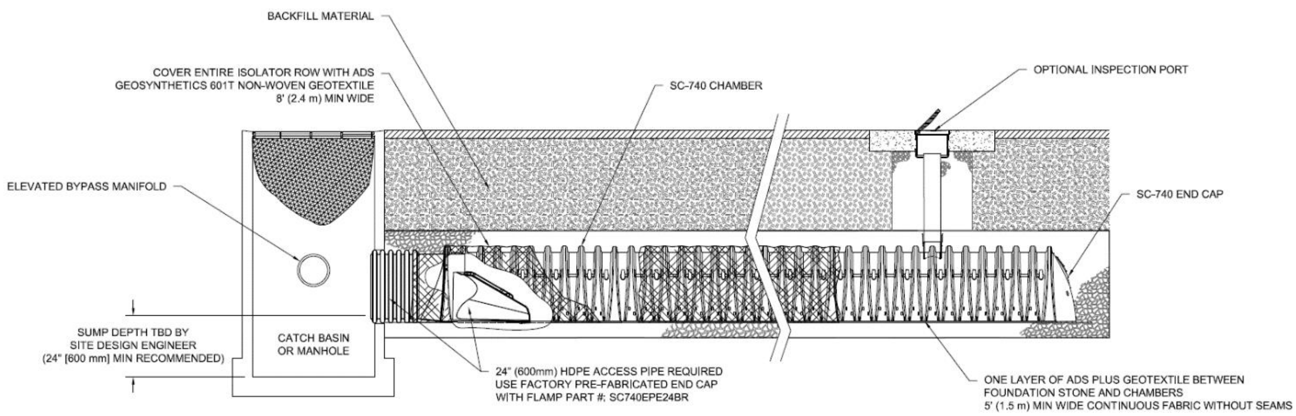
The StormTech Isolator Row PLUS is designed to capture the "first flush" and offers the versatility to be sized on a volume basis or a flow-rate basis. An upstream manhole not only provides access to the Isolator Row but includes a high low/concept such that stormwater flow rates or volumes that exceed the capacity of the Isolator Row bypass through a manifold to the other chambers. This is achieved with either a high-flow weir or an elevated manifold. This creates a differential between the Isolator Row PLUS and the manifold, thus allowing for settlement time in the Isolator Row PLUS.



Schematic of the StormTech Isolator Row PLUS System

Some of the unique features of the Isolator Row that contribute to its effectiveness and practicality include:

- Vast filtration surface area
- Large sediment storage volume
- Easily maintainable by most pipe and sewer maintenance companies
- Large network of ADS personnel that can help with designs and provide onsite guidance
- A state-of-the-art structural design that meets ASTM standards and incorporates AASHTO safety factors for both live loads and permanent dead loads



Isolator Row PLUS Cross Section Detail

II. Applicable Sites:

The Isolator Row PLUS can be effectively used for essentially all developed sites. The most common applications are highly impervious sites such as paved parking areas, roads as well as developed sites that include grassy or other landscaped areas. It is not intended to be used for construction sediments.

III. StormTech System & Isolator Row Testing:

October 2006 – Tennessee Tech University's Civil and Environmental Department prepared the "Performance Evaluation of Sediment Removal Efficiency – StormTech Isolator Row". Testing on a full-scale Isolator Row in a laboratory was done to determine the sediment removal efficiency with two different silica-water slurries in accordance with NJCAT protocols. In August of 2007, the technology was verified by NJCAT. Results are shown in Table 1.

September 2010 – The University of New Hampshire Stormwater Center released the "Final Report on Field Verification Testing of the StormTech Isolator Row Treatment Unit". Testing consisted of determining the water quality performance for multiple stormwater pollutants in accordance with TARP Tier II protocol. Testing was done for a system only consisting of the StormTech Isolator Row. Data was recorded for 23 storm events. Results are shown in Table 1.

January 2020 – BaySaver Technologies prepared the "NJCAT Technology Verification of Isolator Row PLUS". Testing on a full-scale Isolator Row PLUS in a laboratory was done to determine the sediment removal efficiency with a silica-water slurry in accordance with the updated NJCAT protocols. In July of 2020, the technology was verified by NJCAT. Results are shown in Table 1.

June 2020 – North Carolina State University Department of Biological and Agricultural Engineering prepared the technical report "An Evaluation of the StormTech Isolator Row and Subsurface Stormwater Management System at Capital Oaks Retirement Resort, Raleigh, North Carolina". 14 months of monitoring and over 73 precipitation events were completed to study the hydrologic and water quality performance of a StormTech MC-4500 system in Raleigh, NC. Results are shown in Table 1.

Table 1: StormTech Isolator Row 3rd Party Pollutant Removal Efficiency Data

Pollutant	University of New Hampshire (Isolator Row Only) Median	Raleigh, North Carolina (StormTech system with Isolator Row)	Tennessee Tech University (Isolator Row Only)	NJCAT Verification (Isolator Row PLUS only)
Total Suspended Solids	83%*	91%*	84%*	81%**
Total Phosphorus	33%	68%	Not Tested	Not Tested
Total Nitrogen	Not Tested	35%	Not Tested	Not Tested
Total Zinc	81%	Not Tested	Not Tested	Not Tested
Total Petroleum Hydrocarbons	91%	Not Tested	Not Tested	Not Tested

*Based on a flow rate of 2.5 gpm/sf (Isolator Row)

** Based on a flow rate of 4.1 gpm/sf (Isolator Row PLUS)

IV. Product Performance and Design

Minimum 80% TSS removal is achieved by sizing the Isolator Row PLUS to treat the water quality at a specific flow rate per chamber floor area using a single layer of ADS PLUS fabric. The design flow rates for each chamber size are listed below.

Model	Specific Flow Rate	Bottom Area	Flow Per Model
StormTech SC-160LP	4.1 gpm/sf	11.45 sf	0.11 cfs
StormTech SC-310	4.1 gpm/sf	17.7 sf	0.16 cfs
StormTech SC-740	4.1 gpm/sf	27.8 sf	0.26 cfs
StormTech DC-780	4.1 gpm/sf	27.8 sf	0.26 cfs
StormTech MC-3500	4.1 gpm/sf	42.9 sf	0.40 cfs
StormTech MC-4500	4.1 gpm/sf	30.1 sf	0.28 cfs

V. StormTech Isolator Row Approvals:

The StormTech Isolator Row and Isolator Row PLUS have been approved on a project by project basis for tens of thousands of projects around the world. Following are some examples:

- The Isolator Row PLUS is a verified filtration manufactured treatment device by the New Jersey Corporation for Advanced Testing (NJCAT) in accordance with NJDEP Filter Protocols.
- In Ohio, the Isolator Row is approved per the Ohio EPA as a pretreatment to underground storage and can be used for both storage volume and pretreatment as the water quality volume all passes through the Isolator Row.
- The Metropolitan St. Louis Sewer District (MSD) has approved the StormTech Isolator Row as a standalone post-construction stormwater Best Management Practice.
- In Massachusetts, approvals for the State DEP requirement of 80% TSS removal on an annual load basis are issued at the Conservation Commission level, and the Isolator Row is commonly used to meet these criteria.
- In Oregon, the Rogue Valley Storm Water Advisory Team (SWAT) has incorporated the StormTech Isolator Row into their Stormwater Design Manual as a pre-approved proprietary device for stormwater quality treatment.
- The Kansas City Metro Chapter of the American Public Works have included the StormTech Isolator Row wit a value rating of 3.0 in their Manual of Best Management Practices for Stormwater Quality.
- Maine DEP has approved the Isolator Row pollutant removal efficiency based on laboratory testing of 110 micron (US Silica OK-110) particle size
- In Texas, the City of Houston PWE as well as Harris county, has recognized the Isolator Row as an official water quality device.
- Under the New Environmental Technology Evaluation program, the Ontario (Canada) Ministry of the Environment has evaluated the Isolator row and issued a Certificate of Technology Assessment
- The Isolator Row PLUS is currently being evaluated for Canadian Environment Technology Verification (ETV) by VerifiGlobal.

V. Isolator Row Maintenance:

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, public, residential), anticipated pollutant load, percent imperviousness, climate, rainfall data, 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 schedule 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.

The Isolator Row was designed to reduce the cost of periodic maintenance. By "isolating" sediment 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.

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 sediment. 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 200 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 fabric specified by StormTech over their angular base stone.

Complete details of the design, operation, and maintenance of the Isolator Row PLUS can be found in the StormTech Isolator Row and Isolator Row PLUS O&M Manuals.

TECHNICAL NOTE

Barracuda® Maximum Hydraulic Rates and Required Rim to Outlet Invert Difference

TN 1.09
January 2020

Introduction

The Barracuda is a single manhole hydrodynamic separator designed to remove total suspended solids and other contaminants from stormwater. The device employs a cone structure with a vertical weir wall separating the inlet(s) and outlet pipes. This weir wall allows the unit to bypass excessive stormwater flows internally once the inletting rates exceed the designed treatment rate. This document describes the maximum hydraulic rate (MHR), or bypass capacity of the device based on unit size and rim to invert elevation difference. MHR should not be confused with Maximum Treatment Rate (MTR) which would be the flow rate at which the device meets prescribed treatment criteria.

Maximum Hydraulic Rate & Rim to Outlet Invert Difference

The maximum hydraulic rate (bypass) is governed in part by the space between the outlet invert elevation and the rim elevation of the structure, accounting for freeboard (air space). The inlet(s) and outlet invert for Barracudas are typically at the same elevation. The table below assumes a 4” tall frame mounted on an 8” thick top slab. Contact Application Engineering for applications that require rim to invert differences shallower than the minimums shown in Table 1, or for bypass rates higher than the maximums listed in Table 1.

The Barracuda can also be configured as an offline system utilizing a diversion structure for higher bypass flow rates, or at the design engineer’s discretion to meet design objectives or to minimize resuspension.

Figure 1
Barracuda Standard Detail

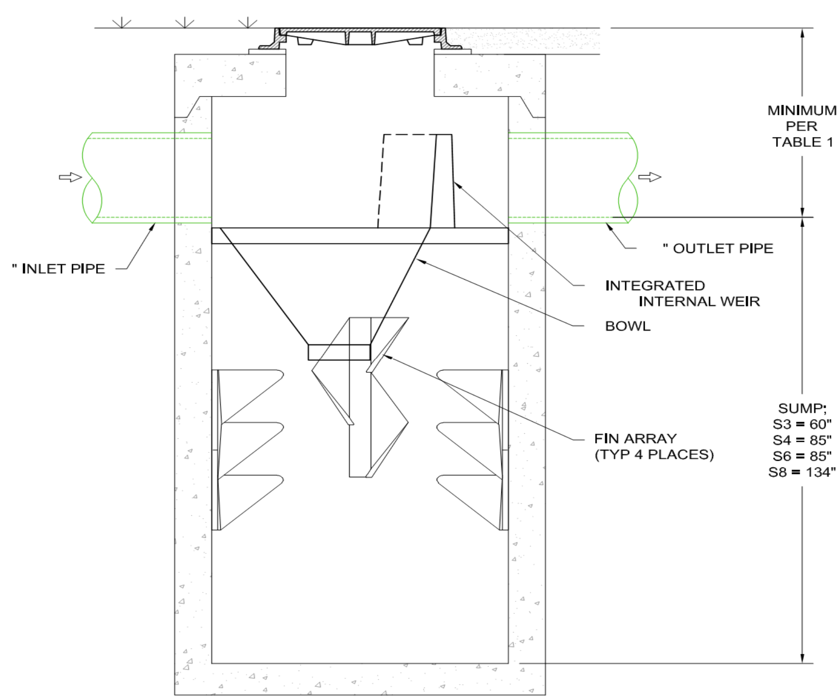


Table 1
Maximum Hydraulic Rate & Rim to Outlet Invert Difference

Barracuda S3 (36" Manhole)	
Maximum Hydraulic Rate (Bypass) cfs (L/s)	Required Rim to Outlet Invert Difference in (mm)
1.4 (39.6)	36 (914)
3.7 (104.8)	40 (1016)
5.5 (155.7)	42 (1066)
8.0 (226.5)	44 (1117)

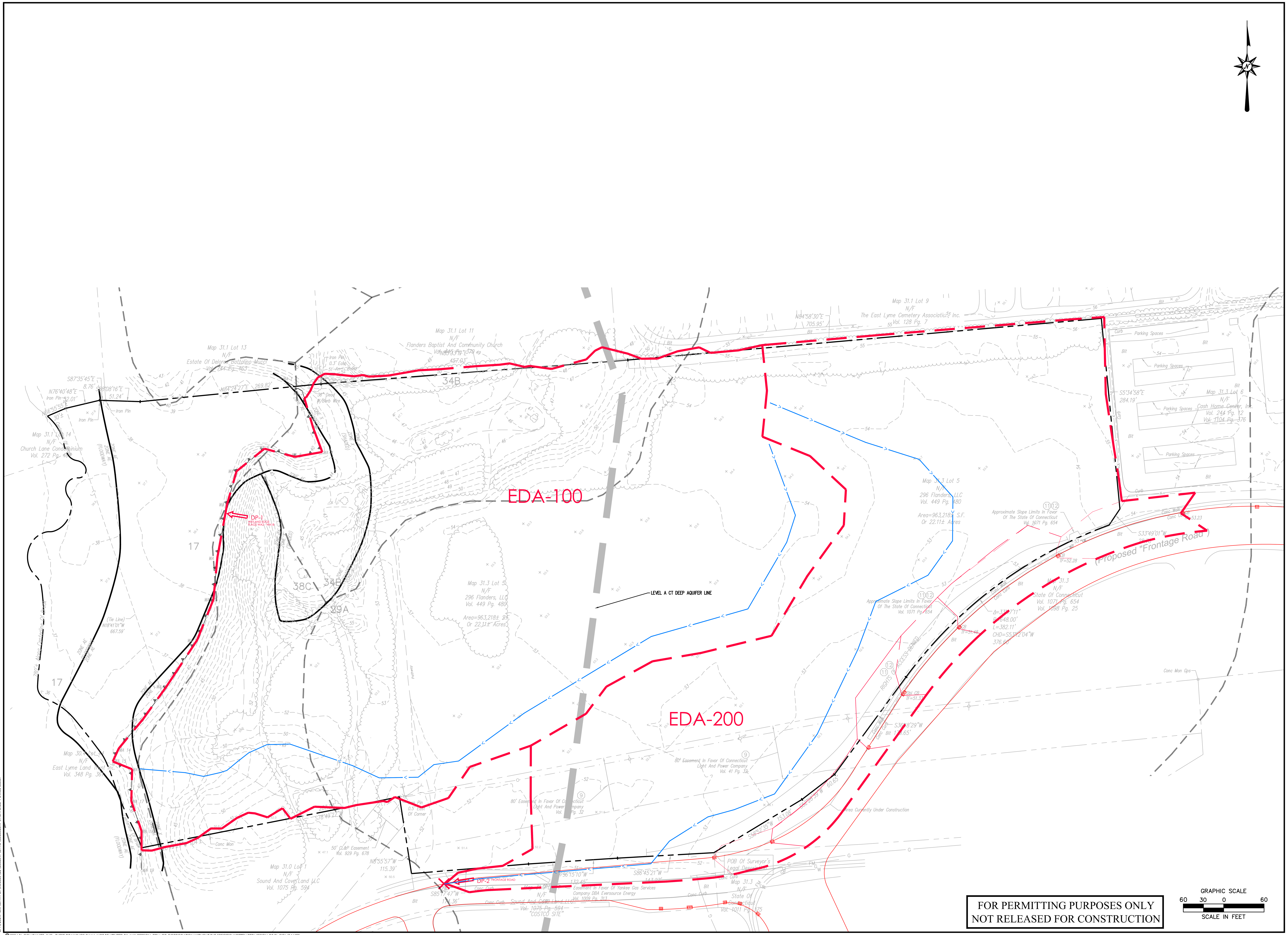
Barracuda S4 (48" Manhole)	
Maximum Hydraulic Rate (Bypass) cfs (L/s)	Required Rim to Outlet Invert Difference in (mm)
3.5 (99.1)	36 (914)
5.0 (141.5)	40 (1016)
7.75 (219.4)	42 (1066)
10.5 (297.3)	44 (1117)

Barracuda S6 (72" Manhole)	
Maximum Hydraulic Rate (Bypass) cfs (L/s)	Required Rim to Outlet Invert Difference in (mm)
9.5 (269.0)	39 (990)
12.5 (353.9)	41 (1041)
16.0 (453.0)	43 (1092)
20.0 (566.3)	45 (1143)

Barracuda S8 (96" Manhole)	
Maximum Hydraulic Rate (Bypass) cfs (L/s)	Required Rim to Outlet Invert Difference in (mm)
13.0 (368.1)	41 (1041)
15.5 (438.9)	44 (1117)
21.0 (594.6)	46 (1168)
28.0 (792.8)	48 (1219)

ATTACHMENT-4

WATERSHED PLANS



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Hartford, CT 06103
(860) 249-2200

PROPOSED LIGHT MANUFACTURING
296 FLANDERS ROAD
EAST LYME, CONNECTICUT

REVISIONS

No.	Date	Desc.

Designed	J.P.D.
Drawn	T.L.B.
Reviewed	R.M.R.
Scale	1"=60'
Project No.	2302349
Date	06/17/2024
CAD File:	ED2302349-01

Title
EXISTING CONDITIONS HYDROLOGY MAP

Sheet No.
ED-1

Xref (s): ; XB2302349-00 ; XY2302349O1 ; XC2302349-21 ; SK2300234910 ; XZ12C3964-D01_Aerial

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BL Companies

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10th Floor
Hartford, CT 06103
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Title
PROPOSED CONDITIONS HYDROLOGY MAP

Sheet No.
PD-1

ATTACHMENT-5

ON-SITE SOIL TEST REPORT

Architecture
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Companies

An Employee-Owned Company

Soil Test Results Report
for

Proposed Warehouse
296 Flanders Road
East Lyme, CT 06333

Date: March, 2024

Executive Summary

Soil testing was conducted on the subject property located at 296 Flander Road in the town of East Lyme, Connecticut by BL Companies on March 13, 2024. Test locations are depicted on the project site plan sheets.

The site soils substratum consists of sand/gravel mix and coarse to medium coarse sands of relatively loose compaction. Soil redox was evident between 6.5' to 10'. Water was observed between 5.5' and 14.5'.

In-situ infiltration testing was performed using the Turf-Tech Infiltrometer, which is approved by the CT DEEP for in-situ infiltration testing at elevations at or near the anticipated bottom of the proposed stormwater management subsurface systems. Due to the porous nature of the existing soils, the infiltration rates encountered are much faster than the maximum allowable design rate of 5.0 inches/hour as decreed in the 2024 CT DEEP Water Quality Manual. In consideration of the similarity of the soil substratum across the entire site being sand/gravel mix and sand in combination with the test infiltration rate being excessively higher than the maximum design rate allowed: it was determined that further infiltration testing is unwarranted.

Site soil test results are as follow:

Test Holes

TP-1

Depth	Description
0" - 18"	Topsoil
18" - 46"	Tan/brown sandy loam
46" - 76"	Tan sand and gravel, loose
76" - 120"	Tan coarse-medium sand, loose

Mottling at 84"
Water at 103"
No Refusal

TP-2

Depth	Description
0" - 10"	Topsoil
10" - 27"	Tan/brown sandy loam
27" - 82"	Tan sand & gravel, loose
82" - 130"	Tan coarse sand, loose

Mottling at 84”
Water at 106”
No Refusal

TP-3

Depth	Description
0” - 10”	Topsoil
10” - 30”	Tan/brown sandy loam
30” - 98”	Tan sand & gravel, loose
98” - 127”	Tan coarse sand, loose

Mottling at 94”
Water at 107”
No Refusal

TP-4

Depth	Description
0” - 10”	Topsoil
10” - 28”	Orange-brown sandy silt
28” - 72”	Tan sand & gravel, loose
72” - 124”	Tan coarse sand, loose

Mottling at 79”
Water at 120”
No Refusal

TP-5

Depth	Description
0” - 15”	Topsoil
15” - 32”	Orange-brown sandy silt
32” - 64”	Tan sand & gravel, loose
64” - 124”	Tan coarse sand, loose

Mottling at 118”
Water at 188”
No Refusal

TP-6

Depth	Description
0” - 17”	Topsoil
17” - 32”	Orange-brown sandy silt
32” - 75”	Tan sand & gravel, loose
75” - 138”	Tan coarse sand, loose

Mottling at 119”
Water at 129”
No Refusal

TP-7

Depth	Description
0” - 12”	Topsoil
12” - 27”	Orange-brown sandy silt
27” - 72”	Tan sand & gravel, loose
72” - 142”	Tan coarse sand, loose

Mottling at 117”
Water at 131”
No Refusal

TP-8

Depth	Description
0” - 15”	Topsoil
15” - 30”	Orange-brown sandy silt
30” - 66”	Tan sand & gravel, loose
66” - 104”	Tan coarse/medium sand, loose

Mottling at 102”
Water at 140”
No Refusal

TP-9

Depth	Description
0" - 18"	Topsoil
18" - 42"	Orange-brown sandy silt
42" - 72"	Tan sand & gravel, loose
72" - 146"	Tan coarse sand, loose

Mottling at 106"
Water at 138"
No Refusal

TP-10

Depth	Description
0" - 12"	Topsoil
12" - 43"	Tan/brown sandy loam
43" - 64"	Tan sand & gravel, loose
64" - 130"	Tan coarse sand, loose

Mottling at 95"
No water
No Refusal

TP-11

Depth	Description
0" - 20"	Topsoil
20" - 47"	Tan/brown sandy loam
47" - 74"	Tan sand & gravel, loose
74" - 120"	Tan coarse sand, loose

Mottling at 113"
No Water
No Refusal

TP-12

Depth	Description
0” - 11”	Topsoil
11” - 70”	Tan coarse sand, loose

Mottling at 15”
Water at 66”
No Refusal

TP-13

Depth	Description
0” - 12”	Topsoil
12” - 34”	Tan/brown sandy loam
34” - 67”	Tan sand & gravel, loose
67” - 120”	Tan coarse sand, loose

Mottling at 115”
Water at 175”
No Refusal

Infiltration Tests

Infiltration Test IT-1
Test depth = 58”

Time (seconds)	Drop (inches)	Rate (inch/second)	Rate (inch/hour)
36	2-1/2	0.0694	250
34	2-1/2	0.0735	265
30	2-1/2	0.0833	300
32	2-1/2	0.0781	281
		AVERAGE	274

Infiltration Test IT-2
Test depth = 50”

Time (seconds)	Drop (inches)	Rate (inch/second)	Rate (inch/hour)
60	1-1/2	0.025	90.0
60	1-1/8	0.01875	67.5
60	1	0.0167	60.1
60	1	0.0167	60.1
60	0.825	0.01375	49.5
60	0.825	0.01375	49.5
60	0.825	0.01375	49.5
		AVERAGE	49.5